COMPETITIVE AND SUSTAINABLE GROWTH (GROWTH) PROGRAMME

UNITE

UNIfication of accounts and

marginal costs for Transport Efficiency

Deliverable 5
Annex 1

The Pilot Accounts for Germany

Version 2.5
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Authors: Heike Link, Louise Helen Stewart (DIW), Claus Doll (IWW), Peter Bickel, Stephan Schmid, Rainer Friedrich, Roland Krüger, Bert Droste-Franke, Wolfgang Krewitz (IER),
with contributions from partners

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Pilot Accounts – Results for Germany

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Table of contents

List of Tables

1 Introduction

1.1 Study context and objectives of this annex report

This annex report contains the full version of the German pilot account developed within the UNITE project. It serves as background report for the results presented in the core body of Deliverable 5 – "Pilot Accounts – Results for Germany and Switzerland" and gives more detailed descriptions on the methodology used and the input data and their reliability and quality. However, the general and detailed discussion of the accounts approach was presented in Link et al. (2000 b) and will be summarised only in this document. This annex report discusses methodologies only in so far as they are necessary background information for understanding the results. In addition to the core accounts for 1998 this annex report also presents the results for 1996 and a forecast for 2005. This annex report was produced jointly by DIW (overall responsibility), IER and IWW. These institutes were responsible for the following results: DIW for infrastructure costs, supplier operating costs, taxes, charges and subsidies; IER for environmental costs excluding the costs of nature, landscape, soil and water pollution; IWW for user costs, accident costs and the costs of nature, landscape, soil and water pollution.

In order to put this annex report into the context of the UNITE project a summary of the aims and research areas of UNITE is given here. The UNITE project endeavours to provide accurate information about the costs, benefits 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, known as "transport accounts", "marginal costs" and "integration of approaches". This annex report belongs to the research area "transport accounts". For a better understanding of the results presented here it has to be borne in mind that the UNITE project distinguishes between ideal accounts on the one hand and the pilot accounts on the other hand. The ideal accounts reflect the perfect situation with the utmost disaggregation, showing factors such as the time and 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. The costs 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, where possible without arbitrary allocation methods.

1.2 The accounts approach of UNITE

1.2.1 Aims of the pilot accounts

The pilot accounts attempt to show the general relationship between 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 b). It should be stressed that the accounts are aimed at providing the methodological and the empirical basis for in-depth policy analysis and monitoring rather than serving as a guide for immediate policy actions such as setting higher/lower prices and charges or opening up/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 taxes 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 the 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. Also, the inclusion of 1996 provides a double check on any major statistical abnormalities that may occur in one year, for example very high infrastructure cost due to tunnelling operations or higher than average accident costs because of major accidents 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.

1.2.2 Core, supplementary and excluded data in the pilot accounts

The pilot accounts have been divided into the classes "core data" and "supplementary data". Core data is the data necessary to do a full basic review of the country accounts. Core data is data within the following categories; infrastructure costs; the part of transport accident costs that is considered to be external to the transport sector; the environmental categories air pollution, noise and global warming and supplier operating costs. Transport revenues and taxes are also documented here. Supplementary 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 efficient and well tried valuation methods have been utilised. Secondly, some costs which can be estimated and valuated are borne by the transport users themselves (for example user time and vehicle operating costs caused by delay). These costs and the methods used to valuate them present valuable further information to the reader, but can not be considered to be part of the overall costs of transport as defined by UNITE. Supplementary data is data within the following categories, congestion costs; the internal part of accident costs including the risk value; and, the environmental costs risk due to the provision of nuclear power and the costs associated with nature and landscape, soil and water pollution. Subsidies also fall within the category supplementary data.

1.2.3 The six UNITE pilot account cost categories

Data for the pilot accounts are collected within six cost and revenue categories that are described in Link et al. (2000 b) and are summarised 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 new investments 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, infrastructure costs are allocated to user groups and types of transport. Where it is possible to quantify the share of joint costs they are separated out and are not allocated.

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 transport and other public transport (tram, metro, bus). Whether other modes also have to be covered depends on the degree of state intervention in the respective countries. The corresponding revenues from the users of transport are included when supplier operating costs are estimated. The difference between such costs and revenues is the net public sector contribution (economic subsidy).

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 environmental effects of 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 are estimated. Note, within the pilot accounts the term congestion costs is used even though delay costs only were calculated. The name of the cost category "user costs" (Link et al. 2000 b, Doll et al. 2000) signifies that we are aware that this category does not cover all aspects of costs related to congestion. The estimation of delay costs as defined here is carried out for all transport modes, provided data is available. This data is classified as supplementary data because although these costs are external to the individual users, they are 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 whole society) is included in the core section of the accounts. The internal part of accident costs however, costs imposed by one user on other users and are therefore treated as supplementary costs.

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.

Taxes, charges and subsidies

In this section, the level of charging and taxation for the transport sector is documented for each mode of transport. Wherever possible, the revenues from taxes and charges are shown for fixed taxes and charges and variable ones. 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 separately considered in this section. Taxes such as VAT that do not differ from the standard rate of indirect taxes are excluded from this study.

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 and eventually cause inefficiency. 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). The subsidies of the transport sector are considered in this section. It should be noted that a complete reporting on subsidies would require an 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) at the federal state level but generally not at the municipal level. Indirect subsidies (e. g. tax reductions and tax exemptions that cause lower revenues of state budgets) are quantified where possible.

1.2.4 The transport modes covered in the pilot accounts

The 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 this disaggregation for the German pilot account. Section 2.1 provides in addition some indicators per mode in order to show the importance and relevance of each mode in the German transport system.

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

Transport modes	Network and institutional differentiation	Means and user breakdown
Road	-Motorways -Other federal roads -Other roads	-Motorcycles -Passenger cars -Buses -Light goods vehicles -Heavy goods vehicles (HGV) rigid non-rigid –Special HGV and agricultural vehicles
Rail	a) National Rail (DB) b) Other Rail (non-DB)	-Passenger transport regional passenger transport long distance passenger transport -Freight transport
Other public transport	–	-Tram, -Metro -Trolley buses
Aviation	-Airports -Air transport	-Passenger -Freight
Inland waterway shipping	-Inland waterways -Inland waterways harbours	–
Maritime shipping	Seaports	–
Source: DIW.		

1.3 Results presentation and guidelines for interpretation

The goal of the data collection and estimation of cost and revenues in each category was a level of disaggregation that shows the pertinent costs and charges of the relevant transport mode. From the available, but very heterogeneous input data and results, a structure for reporting transport accounts has been developed. All results are documented separately for each cost category and are summarised in modal accounts covering all cost and revenue categories. Additionally, a set of data needed as basic data for all cost categories was collected to ensure that commonly used data have consistency between the 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 by partners to ensure consistent results for all cost categories.

The categories studied present a comprehensive estimation of transport costs and revenues. They are however, not a total estimation 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 attributing to environmental costs are not evaluated because no acceptable valuation method has been developed.

It should be noted that due to the separation into core and supplementary data with different levels of uncertainty and with different types (costs borne by transport users themselves versus external costs) care is needed when comparing costs and revenues.

1.4 The structure of this annex report

This annex report contains four major parts. Chapter 2 briefly explains firstly the organisation of the German transport sector and the importance of each mode in order to provide some background information for the interpretation of the pilot accounts. Secondly, the input data that was used in the accounts is described here. The main methodological issues which have arisen during the elaboration of the accounts for Germany are discussed in chapter 3. The results are presented and discussed in chapter 4. The descriptions in these chapters are organised along the categories infrastructure costs, supplier operating costs, congestion costs, accident costs, environmental costs and taxes, charges and subsidies. Chapter 5 presents the summary tables on the German pilot accounts and chapter 6 draws conclusions.

2 Description of input data

2.1 Overview on the German transport sector and basic input data used for all cost and revenue categories

This section aims at providing some basic information on the features of the German transport sector, the organisational structure and the importance of transport modes as far as necessary for understanding and interpreting the pilot accounts. Table 2 therefore presents some main social and economic indicators.

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	%	43.87	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.

Table 3 gives an overview on transport related indicators per mode which will be summarised in the subsequent sections 2.1.1-2.1.5. Additionally, in order to present results based on the same basic data among partners, a set of basic reference data for Germany was developed. This data was commonly used for the calculations in the specific cost categories and is also presented in sections 2.1.1-2.1.5.

Table 3
Basic transport related indicators for Germany 1998 per mode

Indicator	Unit	Road	Rail			Public transport[1)]	Aviation	Inland waterway	Maritime shipping	Total
			DB	Other rail	Total					
Transport performance[2)]										
Passengers carried	mill.	50 616	1 668	271	1 939	7 762	104	0	0	60 422
	%	84	3	0,4	3	13	0,2	0	0	100
Passenger-km	bill. pkm	754	72	1	72	76	38	0	0	940
	%	80	8	0,1	8	8	4	0	0	100
Goods transported[3)]	mill. t	3 197	289[4)]	47[4)]	306	•	2	236	214[5)]	3 955[6)]
	%	86	7	1	8	•	0	6	-	100
Tonne-km[3)]	bill. tkm	316	73	1	74	•	0.7	64	1 023[5)]	454.7[6)]
	%	70	16	0.2	16	•	0	14	-	100
Network length	1000 km	661	38	4	42	3.16	•	7	•	•
Employees	1000	404[7)]	274	13	287	163	47[8)]	8[9)]	14[10)]	923[11)]
Gross investments[12)]	€ mill.	9 827	4 750	378	5 128	2 705	2 378	190	4 080	24 308
	%	40	19	2	21	11	10	1	17	100
Gross capital stock[13)]	€ mill.	450 876	171 312	7 130	178 443	65 903	33 269	11 907	39 119	817 768
	%	58	22	1	23	8	4	2	5	100

[1)] Metro, tram and trolley bus only. – [2)] Transport within Germany. – [3)] Excluding goods transported in pipelines. – [4)] Double counting between DB and other rail companies possible. – [5)] Performance between German ports and to/from ports abroad. – [6)] Without maritime transport. – [7)] Road freight only. – [8)] Including 28000 employees working in airports. – [9)] Excluding employees in harbours. – [10)] Excluding employees in seaports. – [11)] Excluding employees in inland waterway harbours, seaports, storage facilities, shippers etc. – [12)] Excluding land purchase. Including rolling stock except road. At current prices. – [13)] Excluding land value. At prices of 1995.

Source: DIW

2.1.1 Road transport

As in most countries, road transport is the main mode in Germany for passenger and freight transport. In 1998, the modal split shares of road transport in Germany were 84 % of all passengers carried and 81 % of all goods transported. The German road network in 1998 had a length of about 661 000 km representing a gross capital stock of € 451 billion at 1995 prices. This value is over half of the gross capital stock in the whole transport sector. More than one third of all transport investments were spent for roads. The German road network is exclusively in state ownership. Motorways and federal roads are under financial responsibility of the federal government, for the remaining network the federal states, districts and municipalities are responsible.

In 1998, the core year of the pilot accounts, about 628 billion vehicle-km were driven with more than half of these kilometres on motorways and other federal roads (see table 4).

2.1.2 Rail transport

The German rail market is characterised by one dominating company, the national rail company Deutsche Bahn AG (DB). Approximately 180 regional rail companies, partly privately owned but mainly in mixed public-private ownership, also provide rail services. Deutsche Bahn has been restructured since the Railways Act from 1994 was passed, and is now split into five main public limited companies in their own right (DB Fernverkehr & Touristik, DB Regio, DB Cargo, DB Netz, DB Station & Service). Opening up of the track network against payment of track access charges, regionalisation of regional rail passenger transport and considerable refloating measures on the part of the state were the main features of the railway reform which are relevant for UNITE.

In 1998, DB had a share of 3 % in all passengers carried (8 % related to passenger-km) and of 7 % in all goods transported in Germany across all transport modes. The DB network amounted to 38 100 km in 1998 representing a gross capital stock of € 171 billion (at 1995 prices). This represented 21 % of the total gross capital stock of the German transport sector. In the same year 19 % of all transport investment were spent for DB. Table 5 shows the train-km operated by DB in 1998 in the segments regional passenger transport, long-distance passenger transport and freight. This input data was utilised for all cost and revenue categories in the German pilot accounts.

Table 4
Road mileage driven in Germany[1)]
– in million vehicle-km –

	All Roads	Motorways	Other Federal Roads	Other Roads
1996				
Total	**611579**	**182300**	**154519**	**274760**
Mopeds, motorcycles	13373	1577	3202	8615
Passenger cars[2)]	516260	149013	133544	233704
Buses	3603	722	853	2028
Light goods vehicles[3)]	25986	6201	5386	14399
Heavy goods vehicles[4)]	46593	24758	10742	11092
Rigid goods vehicles[5)]	18326	6478	4883	6964
Non – rigid goods vehicles[6)]	28267	18281	5859	4128
Special and agricultural vehicles	5764	49	792	4924
1998				
Total	**627622**	**194711**	**156106**	**276806**
Mopeds, motorcycles	15315	1908	3486	9921
Passenger cars[2)]	525585	157889	134505	233191
Buses	3680	765	875	2041
Light goods vehicles[3)]	29113	6509	5888	16716
Heavy goods vehicles[4)]	48513	27539	10590	10384
Rigid goods vehicles[5)]	17538	6801	4697	6041
Non – rigid goods vehicles[6)]	30975	20738	5894	4343
Special and agricultural vehicles	5415	100	762	4553
2005 [7)]				
Total	***679969***	***211251***	***168685***	***300032***
Mopeds, motorcycles	*16802*	*2288*	*3851*	*10663*
Passenger cars[2)]	*568659*	*170904*	*145351*	*252405*
Buses	*3594*	*753*	*852*	*1989*
Light goods vehicles[3)]	*34146*	*7663*	*6902*	*19581*
Heavy goods vehicles[4)]	*51567*	*29544*	*10988*	*11034*
Rigid goods vehicles[5)]	*16955*	*6598*	*4467*	*5890*
Non – rigid goods vehicles[6)]	*34612*	*22945*	*6522*	*5145*
Special and agricultural vehicles	*5200*	*100*	*740*	*4359*

[1)] Including military vehicles. – [2)] Passenger cars and recreational vehicles. – [3)] Goods vehicles α 3.5 t max. GVW. – [4)] Goods vehicles > 3.5 t max. GVW. – [5)] Lorries without trailer. – [6)] Lorries with trailer, articulated vehicles and ordinary tractors with and without trailer. – [7)] For the forecast 2005 methodology refer to chapter 3.

Source: DIW

Despite of the opening up of the DB network and the beginning of on-track competition, the role of the non-DB rail companies is still minor. About 100 of the companies offered public passenger transport and freight services in 1998. The regional rail companies owned 9 % of the total rail network in Germany and employed 5 % of all employees in the railway sector. In the same year, 13 % of all rail passengers and 14 % of tonnes were transported by the regional railways. Due to the regional character of these companies however, they had only a share of 1 % of all rail passenger-km and 0.4 % of all rail tonne-km. The non-DB rail companies are interesting for the UNITE project due to the fact that one can assume a cost level and cost structure which differ from those of the national rail carrier DB.

Table 5
Train-km of German National Rail (DB) 1996, 1998

	Unit	1996	1998
Train-km			
Passenger transport			
Regional passenger transport	million	501	536
Long distance passenger transport	million	160	181
Freight transport	million	205	225
Source: DB AG.			

2.1.3 Public transport – tram, metro, bus

In 1998, 13% of all passengers were carried by tram, metro, bus and trolley bus. 5 305 public transport companies existed in Germany in 1998.[1] In rail-bound transportation (e. g. trams and similar, metro) they operated a track length of about 3 060 km, the trolley bus network was about 70 km long and the line length of bus routes was 810 000 km.

It should be noted that the delimitation and definition of this transport mode caused difficulties for the pilot accounts. Ideally, the categories local/urban buses, tramways and trolley buses can be differentiated under this mode. In some cases this separation is not feasible. The infrastructure costs of local/urban buses, for example, are included in the road infrastructure costs. Against this background, attention should be paid when the results between the different cost categories are interpreted for the mode urban public transport. A summary table of relevant public transport modes and their position within the accounts is given in table 6.

[1] Excluded are here companies which operate their major business with taxis and rental cars with drivers.

Table 6
Means of public transport per cost category and modal transport account for Germany

UNITE categories	Modal transport account Road account	 Rail (Non-DB) account	 Public Transport account
Infrastructure Costs	All buses	All non-DB rail	Tram, metro
Supplier Operating Costs		All non-DB rail bound in VDV	PT companies in VDV Bus companies not in VDV
Congestion Costs	All buses	Non-DB rail in rail account	Tram, trolley bus (no estimate for metro or light rail)
Accident Costs	All buses	Non-DB rail in rail account	Tram, trolley bus (no estimate for metro or light rail)
Environmental Costs	All diesel buses (i.e. almost all buses)	Non-DB rail in rail account	Metro, light rail, tram, trolley bus
Taxes, Charges and Subsidies	Fuel tax for buses		Subsidies for concessionary fares: all PT except rail

Source: DIW

2.1.4 Aviation

Although the share of aviation in total transport performance in Germany is still low, aviation is one of the fastest growing modes in Germany. During the period between 1991 and 1998 air transport volume and transport performance for passenger transport both have increased by approximately 60%. In 1998, about 104 million passengers with a corresponding transport performance of 38 billion passenger kilometres were carried and almost 2 million tonnes freight were transported. German airports employed 28 000 people, earned revenues of more than € 3 billion and invested € 1.1 billion. Germany is characterised by a decentralised airport system consisting of 17 international airports and a variety of smaller regional airports. Airports in Germany are usually in public ownership, in most cases shared between federal state governments and municipal governments, although a small number of airports are characterised by mixed public/private ownership. Air control services are provided by the German National Air Control (DFS) which is 100% owned by the federal government, but organised as a company of private law. The German Meteorological Services (Deutscher Wetterdienst DWD) supervised by the Federal Ministry of Transport, Building and Housing is responsible for delivering meteorological services for various purposes, amongst them for aviation. Basic input data used for aviation is shown in table 7.

Table 7
Input data aviation 1996, 1998[1)]

	Unit	1996	1998
Takeoffs and landings	1 000	1 602	1 681
Passengers embarking/disembarking[2)]	1 000	110 993	123 894
Cargo loading/unloading[3)]	1 000 t	1 923	1 971

[1)] Commercial aviation only at the 17 international German airports (Berlin-Schönefeld, -Tegel, -Tempelhof, Bremen, Dresden, Düsseldorf, Erfurt, Frankfurt/M., Hamburg, Hannover, Köln/Bonn, Leipzig, München, Münster/Osnabrück, Nürnberg, Saarbrücken, Stuttgart). – [2)] Passengers counted at each boarding/de-boarding airport.– [3)] Excluding air mail.

Source: DIW.

2.1.5 Waterborne transport: inland waterways and maritime shipping

In 1998 waterborne transport carried 11% of all transported goods. The gross capital stock amounted to € 50 billion (inland waterway shipping) and € 39 billion (maritime shipping). Waterborne transport attracted 20% of all gross investments in the transport sector.

2.2 Input data per cost/revenue category

2.2.1 Infrastructure costs

The main input data was a long and disaggregated investment time series per mode, needed for the perpetual inventory model. This was then used to calculate the value of the capital stock and the capital costs. Furthermore, data for running costs had either to be collected from official statistics or had to be estimated based on surveys or (in some modes) on available business reports. Input data was also required for the parameters used in the perpetual inventory model; primarily the assessment of life expectancies for infrastructure assets. In the German version of the perpetual inventory model we have assumed that life expectancies of assets are distributed within a probability function. Since this is a methodological issue we show these assumptions in chapter 3. The input data and an evaluation of their quality are summarised in table 8.

Table 8
Sources and quality of input data for estimating infrastructure costs

	Input data	Level of disaggregation	Quality of data, level of uncertainty
Road	Financial and infrastructure data from the Ministry of Transport and the German Federal Office of Statistics supplemented by own calculations. The data is made available yearly and is published by the DIW annually in "Transport in Figures". Capitalisation of running expenses with a life expectancy of more than one year. Capital stock calculated by DIW.	3 road categories. Figures estimated: Gross and net capital value, capital costs and running costs.	The data is of high quality. Urban road data (length of roads etc.) not available and must be estimated.
Rail	Infrastructure data from the German Federal Office of Statistics, the German National Railways (DB) and the Association of Railways and Public Transport Operators (VDV). Capital stock calculated by DIW. DB running costs were estimated using information from official business reports which, however, has to be considered to be incomplete and inconsistent. VDV is an association of 180 companies that publish an aggregated cost and revenue statement. The infrastructure costs were estimated for the first time for non-DB companies.	The disaggregation is by DB and Non-DB and divided further between tracks and stations. Figures estimated: Gross and net capital value, capital costs and running costs.	The overall quality of investment data is good. The macroeconomic approach of the PIM used in UNITE gives substantially different results to those published in the business accounts of the DB (due to methodological differences). DB Running costs were estimated by DIW. For VDV companies infrastructure data is good, running costs are estimated by DIW based on an VDV survey.
Public Transport	Capital stock calculations by DIW. Information provided by VDV and German Federal Office of Statistics. Aggregated cost and revenue statement of VDV and transport statistics do not quantify running costs of infrastructure.	Tram and metro. Buses are included in the road section. Taxis and rental cars were excluded. Figures estimated: Gross and net capital value, capital costs and running costs. No estimation of running costs possible.	Good infrastructure data. No data available to determine running costs. Response rate of company surveys too low.
Air	Infrastructure capital stock calculated by DIW for all aviation infrastructure services. Running cost information from the Association of German Airports (ADV), German air traffic control (DFS) and German Meteorological Services (GWD).	17 international airports studied. Figures estimated: Gross and net capital value, capital costs and running costs.	Good infrastructure data quality. Running costs estimation fairly good. Aviation related running costs of GWD estimated by DIW.
Inland waterway	All waterway information from the German Federal Ministry of Transport. Capital stock calculations by DIW. Data for port infrastructure from the German port association. Capital stock calculations by DIW. Company surveys completed to establish running costs of ports.	Division between ports and waterways, but no cost allocation to vessel types possible. Figures estimated: gross and net capital value, capital costs and running costs. No running cost estimations possible for ports.	Good infrastructure and running cost data quality for waterways. Non-Transport related costs of waterways (for example power production) could be eliminated. No representative data for the running costs of ports. Response rate of company surveys too low.
Shipping	Investment data from the federal state ministries where seaports exist. Company surveys completed to establish running costs of ports.	Only sea harbours were considered. Figures estimated: gross and net capital value, capital costs and running costs. No running cost estimations possible for harbours.	Good quality of data on investments. However, no data available to determine running costs. Response rate of company surveys too low.

Source: DIW.

2.2.2 Supplier operating costs

As stated in the previous chapter, supplier operating costs are calculated only for public transport and rail services. The main data sources are the German National Railway (DB) and the German Association of Railways and Public Transport Operators (VDV), a group of approximately 180 companies that publish a joint account. However, not all public transport companies belong to this association and the use of this information implies an underreporting of costs. Furthermore, the VDV statistics divide public transport companies into two groups; one which supplies rail transport, and, one which does not supply rail transport. This means that if a company supplying rail transport also supplies other modes of public transport, the total company statistics are shown within the rail providers group. Table 9 summarises the input data used.

Table 9
Sources and quality of input data for estimating supplier operating costs

	Input data	Level of disaggregation	Quality of data, level of uncertainty
Rail	The DB separates transport and infrastructure at a company level, but does not publish sufficient separate financial information. Only overall aggregated data form the DB available. For VDV rail companies only total expenditures were available.	German National rail (DB) and German Non-National rail. For the DB as a whole the following categories: revenue turnover, changes in stock, revenues, material, personnel, depreciation, interest revenues, operating result, other and taxes. For the Non-DB rail companies only total expenditures available.	Supplier operating costs estimated by DIW for the DB. Fairly good data quality. VDV data not disaggregated but presented as total expenditures. Under- reporting possible because not all private rail companies member of VDV.
Public transport	Data from VDV	Tram, metro and buses types of expenditure: material, personnel, capital costs, taxes and other costs.	VDV data as above
Source: DIW.			

2.2.3 Delay costs due to congestion

2.2.3.1 Road transport

a) Motorised individual passenger traffic

The costs perceived by drivers and passengers in motorised individual road transport embrace extra time costs and extra fuel costs in congestion compared to off-peak driving conditions. The following data sources and values were used for the determination of delay costs per vehicle kilometre under free flow and congested conditions:

- The values of travel time per vehicle kilometre were developed out of the values of time by travel purpose provided by the UNITE valuation conventions (Nellthorp et al., 2001). For car and motorcycle travel under free flow conditions the following values per passenger hour were used: Business: € 21.92, private and commuting: € 6.23 and leisure: € 4.16. For congested conditions the values were increased by 50%.
- Vehicle occupancy rates were taken out of Kessel & Partner, IVT (1993) per vehicle type and travel purpose. The shares of travel purposes refer to passenger kilometres. The occupancy rates applied to car travel were 1.2 for business travel, 1.4 for private/commuting and 2.1 for leisure trips.
- The share of trip purposes in individual motorised traffic (passenger kilometres) were taken out of BMVBW/DIW (2000) for all road types and vehicles 1998 as follows: Business 18%, private/commuting 33% and leisure 49%. A further differentiation by road types and vehicle categories (cars and motor cycles) would be appropriate but was not possible due to the data situation.
- Fuel prices for diesel and gasoline were taken out of BMVBW/DIW (2000) as net average prices based on a sample of filling stations. The average fuel price of gasoline and diesel cars was estimated out of the vehicle stock (see Kraftfahrt-Bundesamt 2000), the average annual mileage (see BMVBW/DIW 2000) and the average fuel per type of engine consumption (see FGSV 1997).
- The shares of congested traffic were set according to calculations from the TREMOD traffic model for Germany (reported in ECMT 1999) for motorways and urban roads. The respective shares of congested car traffic ranges between 1.66% on motorways and 1.90% on urban roads. These values could be confirmed by recent estimates of the IWW traffic model VACLAV. For rural roads a share of vehicles kilometres performed under congested conditions of 1.0% was set based on VACLAV model estimates.
- Average speeds of passenger cars and motorcycles by road categories under congested conditions were taken out of the TREMOD traffic model (see ECMT 1999). For cars a congested speed of 20 kph on inter-urban roads and of 10 kph on urban roads was assumed. For motorcycles 20 kph for all road types was reported by TREMOD. For the

reference speed, against which the delay costs under congested conditions are calculated, a weighted average of free flow and bound / disturbed traffic was assumed (see table 10). [2]

Table 10
Basic input data and unit costs in individual road transport

	Average speed kph		Average fuel consumption l / vehicle-km		Traffic volume million vkm		Share of congested traffic (%)
	Normal	Congested	Normal	Congested	Total	Congested	
Car					464 085	7 241.8	1.56
Motorways	120	20	0.10	0.15	156 486	2 597.7	1.66
Trunk roads	75	20	0.08	0.15	133 359	1 333.6	1.00
Urban arterial	58	10	0.07	0.26	141 504	2 688.6	1.90
Other urban	19	10	0.14	0.26	32 736	622.0	1.90
Motorcycle					9 445	141.8	1.50
Motorways	115	19	0.07	0.10	1 908	30.0	1.57
Trunk roads	61	19	0.05	0.10	3 486	34.9	1.00
Urban arterial	39	20	0.04	0.06	3 296	62.6	1.90
Other urban	30	30	0.05	0.06	754	14.3	1.90

Source: IWW.

b) *Road freight transport*

Values of time for road freight transport are given in € per vehicle kilometre in the UNITE valuation conventions (Nellthorp et al. 2001) for light goods vehicles (41.56 €/vkm) and for heavy goods vehicles (44.68 €/vkm). These values of time represent the opportunity costs of time savings for the shipper and the haulier and time-dependent operating costs borne by the haulier. These VOTs were not differentiated by the type of goods transported.

Net fuel prices are taken out of BMVBW/DIW (2000) for gasoline (0.78 €/l) and diesel (0.58 €/l). Average fuel costs per vehicle kilometre for LGVs and HGVs by road type and traffic conditions were derived by characteristic fuel consumption functions (FGSV 1997) and the composition of vehicle fleets (BMVBW/DIW 2000). Table 11 presents core input data and results for the congestion costs in road freight transport for Germany 1998.

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[2] For the cost calculations urban roads are subdivided into arterial roads and side streets (other urban roads) as here different congestion situations must be assumed.

Table 11
Basic input data and unit costs for road freight transport in Germany 1998

	Average speed kph		Average fuel consumption l / vkm		Share of congested traffic %
	Normal	Congested	Normal	Congested	
LGV[1]					
Motorways	112	9	0.14	0.14	1.60
Trunk roads	75	9	0.11	0.14	1.00
Urban arterial	58	5	0.11	0.23	1.74
Other urban	19	5	0.17	0.23	1.74
HGV[2]					
Motorways	85	6	0.35	1.01	1.59
Trunk roads	75	6	0.30	1.01	1.00
Urban arterial	53	6	0.27	0.90	1.90
Other urban	15	5	0.46	0.90	1.90

[1] Light goods vehicles with a max. GVW <3,5t, including special vehicles and agricultural vehicles. - [2] Heavy goods vehicles with a max. GVW >3,5t, including rigid and articulated goods vehicles.

Source: IWW.

c) Public transport services (urban and long distance bus, tram, metro, trolley bus)

Public road passenger transport includes all collective passenger transport services carried out on the road network. In contrast to individual road transport by car, where in addition to time costs fuel costs (and possibly other variable operating costs) influence the decisions of the passenger, this is not the case for public Transport. Since only time costs and fares are costs perceived by the passengers, the fuel cost component is omitted here. Passenger services utilising cars or station wagons (taxis etc.) fall under the category motorised individual passenger transport and are covered within road transport. No separation between long distance buses and urban buses could be made within the German account.

Ideally, data on the share of vehicle kilometres by public transport carried out on networks separated from the common road network is required. As such information is not available, the following simplifying assumptions were made:

- Buses, tramways and trolley buses are operated on the common road network and can be fully considered within the available data for road congestion.

- Underground, urban light rail and rapid mass transport services are normally operated on their own networks, and are not affected by road congestion. These services are partly considered within the rail passenger congestion costs.
- As no delay data is collected in Germany for public transport operating on separated networks (rapid mass transport, light rail or underground services) no estimation of delays was possible.

Unit costs in urban and inter-urban public road transport were determined per passenger kilometre as the respective information available from BMVBW/DIW (2000) was more reliable than estimates of occupancy rates and wagon kilometres. The values of travel time per passenger hour were set according to the UNITE valuation conventions (Nellthorp et al. 2001) for business, private/commuting and leisure travel. The share of trips by travel purpose was taken out of BMVBW/DIW (2000) as follows: Business: 2%, private/commuting: 75% and leisure: 22%.

Delay costs then were defined as the difference between congested and normal travel time, multiplied by the number of pkm performed under congested conditions. The share of vehicle kilometres performed under congested conditions by road type was taken from the TREMOD traffic model (ECMT 1999). For the distribution of passenger kilometres to road types, vehicle occupancy rates by type of service were estimated using passenger counts for bus services (by municipal and private companies), trolley busses and tramways out of BMVBW/DIW (2000). Passenger kilometres by tramway and trolley bus services were entirely allocated to urban roads. The annual passenger mileage in bus transport was distributed to network types assuming that municipal companies mainly operate on urban roads and private companies are mainly present on trunk roads and motorways. Table 12 presents the basic input data for public transport performed on roads.

Table 12
Basic input data for public road transport in Germany 1998

	Traffic Volume Million passenger kilometres		Share of congested traffic %	Average speed kph	
	Total	Congested		Normal	Congested
Bus / Coach	56 639	886			
Motorways	12 595	214	1.7	85	6
Trunk roads	18 274	183	1.0	57	6
Urban arterial	14 147	269	1.9	42	6
Other urban	11 623	221	1.9	13	5
Tramway + Trolley bus [1)2)]	4 652	88			
Urban arterial	2 554	49	1.9	42	6
Other urban	2 098	40	1.9	13	5

1) Values of passenger mileage of municipal companies estimated by the share of seat kilometres.
2) Tram excluding major parts of transport performed on grade-separated networks.

Source: IWW.

2.2.3.2 Rail transport

a) Rail passenger transport

The delays in rail passenger transport were valued on a trip basis. Out of the number of trips per year made by rail passenger services and the delay probability by type of service, the annual number of delay hours was determined. Rail operating costs were not considered, as they are not directly borne by the users.

The shares of travel purposes at the number of trips in rail transport 1998 (business: 6%, private/commuting: 71% and leisure: 23%) were taken out of BMVBW/DIW (2000). With the respective values of normal and delayed travel time reported in the UNITE valuation conventions (Nellthorp et al. 2001) average values of travel time were computed to be € 9.57 per passenger hour for all train services.[3]

[3] A differentiation of the share of travel purposes by train class was not available. Thus, a constant distribution for the whole passenger transport market was used.

The delay probabilities for different train types of DB AG were taken from a survey of Stiftung Warentest.[4] In two observations of train delays at selected German railway stations for the years 1997 and 1999 average delays by train class and degree of late arrival were analysed. Delays in passenger rail transport are defined as late arrivals greater than 5 minutes. According to this definition the average delay probability 1999 was 20.0% (regional trains: 17.3%, Inter-Regio: 18.1%, IC/EC: 24.2%, ICE: 28.9%). The average delay duration was 14.2 minutes in 1999. As direct information for 1996 and 1998 is not available, we used the 1997 and 1999 data for the respective previous year. Table 13 presents the basic input data and the results for rail passenger delay costs 1998.

Table 13
Basic input data for estimating rail passenger transport 1998

	Total Trips 1998 million	Delay probability %
DB AG Total	1 672	20.0
of which		
Local traffic	1 520	17.3
Regional traffic	68	18.1
Inter-city services	53	24.2
High-speed services	31	28.9
Non-DB Railways[1)]	250	:

[1)] No service-specific information available. Local transport only.

Source: IWW.

b) Rail freight transport

The criterion for defining a freight service delay is a late arrival of 15 minutes or longer. Unfortunately, only a rough estimate of a degree of punctuality of something between 80% and 90% in high quality freight transport (combined transport and overnight services) was provided by DB and "Deutsche Kombiverkehr". From the available information we derived the following assumptions for 1998:

- Delay probability of freight trains: 15%.
- Average delay of delayed trains ranges between 15 and 30 minutes. The value used in the calculations was 15 minutes.

[4] The journal of the German consumer's association which regularly surveys and tests the quality of goods and

Transport volume data was only available for all rail freight carriers in Germany (BMVBW/DIW 2000). A distinction between short distance freight traffic, long distance freight and combined transport could not be made. The input data used is shown in Table 13.

Table 14
Basic input data for estimating rail freight delay costs 1998 (all carriers)

Time unit costs by type of service	Average VOT € / tonne	Average delay [2)] Minutes	Total transport volume million tonnes	Delay probability [2)] % of total demand
Total[1)]	0.76	15[3)]	306	15

[1)] DB Cargo and non-DB rail freight carriers. - [2)] Source: Estimates of Kombiverkehr. – [3)] Selected value for average delay.

Source: IWW.

2.2.3.3 Aviation

a) Air passenger traffic

In air passenger transport, delays are considered to be late arrivals of more than 15 minutes. In international air traffic, delays are determined by (1) air traffic control, who can delay flights due to safety and capacity reasons, and by (2) the airlines, represented by the association of European Airlines (AEA). The delay statistics published by Eurocontrol list only those delays caused by measures of air traffic control and thus omit all delays for which the airlines or airports are responsible. Data provided by the AEA only considers delays of AEA members but explicitly lists arrival and departure delays of more than 15 minutes by reason, while Eurocontrol lists delays between 1 and 60 minutes.

Although the current data set provided by AEA is not complete, it is preferred to the partial delay records of Eurocontrol. The available AEA statistics (annual report 2001) contains data on the three major German airports (Düsseldorf; Frankfurt; and, Munich). These airports account for 58% of the total number of arrivals in Germany. For the remaining airports, the share and the duration of delays could not be derived from the present data. Annual delay

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services.

figures show, that the delay situation in 1998 has been similar to 2000 and thus the 2000 values presented in Table 15 were applied to air traffic volumes in 1998.

The value of time per travel purpose was based on Nellthorp et al. 2001. According to this source, delayed travel time was valued 1.5 time the normal travel time for all trip purposes. The share of travel purposes at the number of trips (business: 39%, private/commuting: 0%, leisure: 61%) for 1998 was taken out of BMVBW/DIW (2000). Table 15 shows the basic input data for user cost estimates in air passenger transport for Germany 1998.

b) Freight transport

The statistics of the Association of European Airlines punctuality does not primarily distinguish between passenger and freight flights. Moreover, a considerable amount of freight is loaded in passenger aircraft. For these purposes the probabilities and duration of delays applied to passenger trips were applied as well for air freight transport.[5] The average European value of freight travel time (4 € / tonne-hour for all commodities) was taken out of Nellthorp et al. 2001 and adapted to Germany 1998. Input data for delays in air cargo traffic 1998 is shown in table 15.

Table 15
Basic input data on air traffic delays 1998

Airport	Total arrivals 1998 [1)] (1000 Passengers)	Total cargo 1998[1)] (1000 tonnes)	Total aircraft arrivals 1998 (1000)	Delay rate [2) 3)] (%)	Average delay [3)] (minutes)
Commercial Airports of which	65 340	2 297	815	:	:
Dusseldorf	7 907	68	87	19.2	38.8
Frankfurt-Main	20 295	1 485	203	24.3	36.9
Munich	9 647	127	130	22.1	39.8
Total of selected airports[4)]	37 848	1 680	420	22.7	38.0

[1)] Including arrivals for connecting flights. - [2)] Share of delays >15 minutes. - [3)] 2000 Data. – [4)] Arrivals in selected airports representing 57.9% of all air traffic in Germany.

Source: AEA Punctuality data 2000.

[5] With this approach we neglect the difference in flight times (night / day) of passenger and cargo flights. Further, it is not clear which share of air cargo transport companies is represented by the AEA.

2.2.3.4 Waterborne transport

There is only little knowledge on delay problems in inland navigation and maritime shipping. According to the information from the Wasser- und Schiffahrtsdirektion Südwest (Water and shipping directorate south-west), the only part of the German inland waterway network, where scarcity problems occur, is the river Mosel, but the magnitude of ship delays is not quantified yet. For German seaports, no information on delays could be found.

Table 16
Sources and quality of input data for estimating congestion costs in Germany

	Input data	Level of disaggregation	Quality of data, level of uncertainty
Road	Total vehicle mileage from Transport in Figures (DIW 2000). Congestion data from the TREMOD traffic model. Congestion is defined as stop & go traffic with a travel speed of under 30 kph on inter urban roads and under 10 kph for urban roads. VOT from the UNITE conventions. Vehicle occupancy rates form Kessel and Partner (1993). Traffic volumes and fuel consumption taken from The German Federal Motor Transport Authority. Fuel price and traffic volumes taken from the German Ministry of Transport.	Disaggregation by travel purpose: business, private/commuting leisure and freight. Vehicle disaggregation by car, motorcycle, bus, LGV and HGV. Road disaggregation by: Motorways, trunk roads, urban arterial roads and other urban roads.	Input data is good. Estimation of traffic delays varies between data bases. Empirical data collection shows a lower congestion rate to those estimated in models. The TREMOD data is model based on the share of congestion being 1.7%.
Rail	Basic data from the German National Railway (DB), the German Federal Office of Statistics and the Association of Railways and Public Transport Operators (VDV). Delay probabilities estimated from a delay survey carried out by the German Stiftung Warentest. Congestion defined to be a delay greater than 5 minutes for passenger services and 15 minutes for freight.	Disaggregation by train classes: ICE, Intercity / Eurocity, Interegio (long-distance passenger trains), 3 regional/local train classes.	Data refer only to a sample and are of limited representativeness (10 661 train arrivals at 8 selected stations during the period 05/06/99 – 14/06/99)
Public Transport	Estimation of occupancy rates based on passenger kilometres from IWW. Trip purpose, traffic volumes total vehicle capacity and fleet size were taken from the German Ministry of Transport. VOT from the UNITE conventions.	5 modes of public transport on motorways, trunk roads, urban arterial roads and other urban roads.	Basic data is good. Estimation of occupancy rates plausible when compared to older data.
Air	Delay statistics from EUROCONTROL and the Association of European Airlines (AEA)	58% of total flights covering Dusseldorf, Frankfurt and Munich airports.	Very good data for the 3 major airports. For the remaining airports no estimation is given.
Inland waterway	German Federal Office of Statistics. Water and Shipping directorate south-west.	No delay information available	No information available
Shipping	German Federal Office of Statistics	No delay information available	No information available

Source: IWW.

2.2.4 Accident costs

Input data for estimating accident costs refer firstly to input data per transport mode such as number of accidents, number and severity of injuries, fatalities and material damages. This input data is shown in tables 17-19, remarks on their quality are given in table 20. Secondly, accident costs have five components: medical costs; material damage costs; administrative costs; costs due to production losses; and, the costs of suffering and grief (risk value). The input data for these cost components refer to valuations and unit costs and are summarised in table 21.

A few remarks seem to be necessary for a proper interpretation of tables 17-19. For the calculation of medical costs and material damage in road transport, the specific problem of underreporting must be addressed. According to a survey on the degree of under-reporting of road accidents 1994 (Degener, Meeves 1997) accidents can be reported to the following bodies: to the police, but not to the insurance sector, to insurance companies but not to police or neither to police nor to insurance companies at all. According to the cost category investigated, different reporting levels can be found. The results of the survey estimate figures of total accidents, which are higher than reported to the police or insurance and are presented in tables 18 and 19 as total number of accidents. It should be noted that the columns are not additive, e.g. the total number of cases is not the sum of cases reported to police and those reported to liability insurance. The problem of underreporting occurs only for road transport. Statistics reported for rail, aviation and inland waterway transport can be considered to be correct. The estimation of material damage is restricted to damage to vehicles due to data limitations. No accident data was available for maritime shipping.

Table 17
Basic input data for estimating accident costs: Road cases by network type and degree of severity in Germany 1998[1)]

Road type	Slight damages to property	Severe damages to property	Slight injuries	Severe injuries	Fatalities
All Roads	2 257 650	136 000	388 400	108 900	7 792
Motorways	176 125	10 065	30 300	8 300	803
Trunk roads	666 716	45 235	114 700	49 600	5 081
Urban roads	1 414 809	80 700	243 400	51 000	1 908

[1)] As reported to police.

Sources: BASt, IWW.

Table 18
Basic input data for estimating accident costs: Total number of casualties in Germany 1998

	Casualties reported to police			Casualties reported to insurance			Total number of casualties		
	Slight injuries	Severe injuries	Fatalities	Slight injuries	Severe injuries	Fatalities	Slight injuries	Severe injuries	Fatalities
Road / public transport	388 401	108 900	7 792	419 472	111 077	7 870	494 977	112 188	7 870
Car	243 053	68 147	4 741	262 497	69 510	4 788	309 746	70 205	4 788
Motorcycle	52 719	14 781	1 012	56 936	15 077	1 022	67 185	15 228	1 022
Bus / tramway	2 221	623	2	2 398	635	2	2 830	641	2
Truck drivers	6 946	1 948	266	7 502	1 986	269	8 852	2 006	269
Pedestrians / Cyclists	83 178	23 322	1 721	89 833	23 788	1 738	106 003	24 026	1 738
Others	284	79	50	306	81	51	361	82	51
Rail [1) 2)]	921	226	320	921	226	320	921	226	320
Aviation [2)]	207	156	86	207	156	86	207	156	86
Inland navigation [2)]	20	15	3	20	15	3	20	15	3
Maritime shipping	:	:	:	:	:	:	:	:	:

[1)] Including DB AG and other railway companies. – [2)] Five-year average including passengers and personnel, suicides excluded.

Sources: Statistisches Bundesamt (different time series), BMVBW/DIW (2000), own calculations according to Degener, Meeves (1998).

Table 19
Basic input data for estimating accident costs:
Material damages in German road transport 1998

	Accidents reported to police		Accidents reported to insurance		Total number of accidents	
	Slight	Severe	Slight	Severe	Slight	Severe
Total road accidents	1 744 415	513 235	2 773 619	549 160	3 577 970	626 042
Damage to vehicles	1 744 415	513 234	2 773 620	549 160	3 577 970	626 043
Passenger car	1 390 396	409 076	2 210 729	437 711	2 851 841	498 991
Motorcycle	301 580	88 730	479 512	94 941	618 571	108 232
Bus / Coach	12 704	3 738	20 200	3 999	26 058	4 559
Tramway	:	:	:	:	:	:
Goods vehicle	39 735	11 691	63 178	12 509	81 500	14 260
Others	:	:	:	:	:	:
Public property	:	:	:	:	:	:
Other private property	:	:	:	:	:	:

Source: IWW.

Table 20
Source and quality of data for estimating accident costs by transport mode

	Input data	Level of disaggregation	Quality of data, level of uncertainty
Road	Severity of accidents taken from the German Highway research institute (BASt) and from the Germany Ministry of Transport. Information regarding the allocation of accidents to traffic involvement and the number of accidents from the National Association of Insurance Companies (GDV). Passengers and transport staff are considered, but no accidents resulting from construction or suicides are considered.	7 vehicle categories including public transport. Road types: motorways, trunk roads and urban roads.	Good input data, but the difference between the number of accidents actually occurring and the number reported to the police and to insurance has been estimated using data from GDV and IWW.
Rail	Number and severity of accidents taken from the German National Statistical Office. Passengers and rail transport staff are considered, but no accidents resulting from construction or suicides are considered. 5 year average is used for deriving yearly figure.	Passenger and freight only.	Good official statistics. No problems with underreporting. No division of statistics between German National Railways and Non-National Railways possible.
Public Transport	see road transport	see road transport	see road transport
Air	Number and severity of accidents from the German National Statistical Office. Only passengers and transport staff are considered. 5 year average figure is used.	One total for aviation.	Good official statistics. No problems with underreporting.
Inland waterway	Number and severity of accidents from the German National Statistical Office. Only passengers and transport staff are considered. 5 year average figure is used.	One total for inland waterways.	Good official statistics. No problems with underreporting.
Maritime Shipping	No accident data for shipping available.	No data available	No data available

Source: IWW.

Table 21
Source and quality of data for estimating accident costs by cost category

	Input data	Level of disaggregation	Quality of data, level of uncertainty
Costs of medical treatment	Costs and share of accident types with and without a steady reduction of working power estimated by IWW using data from Baum and Höhenscheid (1999). Direct replacement costs: BASt. Number of victims in employable age group: German Ministry of Transport.	Injuries by severity class and reduction of working power	Average length of illness: IWW estimates. Population statistics: good data. Costs of lost production as proportion of GNP.
Valuation of administrative costs	Hourly costs of police and average time spent per accident from the German Highway Research Institute. No administrative costs of insurance companies or justice are available	Costs of police per transport mode and severity of accident.	Police time required per accident for road and police costs: Good data for road. These costs were transferred to other transport modes and are estimates only. Administrative costs of insurance companies and justice are not evaluated.
Valuation of material damage	Average cost of material damage to vehicles from GDV for road transport only. Estimations for other modes.	By vehicle category	Good average figures for road including public transport, not transferable to other modes. Estimation of other modes by IWW.
Risk Value	UNITE standard values (Nellthorp et al. 2000)	Risk values for accident victims only. No risk value for relatives and friends	Value is based on latest available studies and standardised for UNITE. The high risk value of € 1.62 million for Germany represents the largest cost in this cost category

Source: IWW.

2.2.5 Environmental costs

The commonly used input data such as mileage and energy consumption given in chapter 2 were used for the estimation of environmental costs. Additionally, specific input data per type of environmental costs was required. This data was used to calculate the costs of air pollution (including vehicle operation and fuel/electricity production), global warming, noise, nature and landscape, soil and water pollution and nuclear risk.

2.2.5.1 Air pollution

One of the main input data sources for estimating costs of air pollution was the EcoSense database which was used within the impact pathway method. The basic data used within EcoSense is summarised as follows.

Table 22
Environmental data in the EcoSense database

	Resolution	Source
Receptor distribution		
Population	administrative units, EMEP 50 grid	EUROSTAT REGIO Database, The Global Demography Project
Production of wheat, barley, sugar beat, potato, oats, rye, rice, tobacco, sunflower	administrative units, EMEP 50 grid	EUROSTAT REGIO Database, FAO Statistical Database
Inventory of natural stone, zinc, galvanized steel, mortar, rendering, paint	administrative units, EMEP 50 grid	Extrapolation based on inventories of some European cities
Critical Loads/Levels for nitrogen-deposition for various ecosystems	EMEP 150 grid	UN-ECE
Meteorological data		
Wind speed	EMEP 50 grid	European Monitoring and Evaluation Programme (EMEP)
Wind direction	EMEP 50 grid	European Monitoring and Evaluation Programme (EMEP)
Precipitation	EMEP 50 grid	European Monitoring and Evaluation Programme (EMEP)
Emissions		
SO_2, NO_x, NH_3, NMVOC, particles	administrative units, EMEP 50 grid	CORINAIR 1994/1990, EMEP 1998 TNO particulate matter inventory (Berdowski et al., 1997)

Source: IER.

Receptor data

- *Population data*

  Population data for Germany was taken from the EUROSTAT REGIO database (base year 1996), which provides data on administrative units (NUTS categories). For Germany, NUTS 3 level was used. For impact assessment, the receptor data is required in a format compatible with the output of the air quality models. Thus, population data was transferred from the respective administrative units to the 50 x 50 km^2 EMEP grid by using the transfer routine implemented in EcoSense.

- *Crop production*

  The following crop species were considered for impact assessment: barley, oats, potato, rice, rye, sunflower seed, tobacco, and wheat. Data on crop production were again taken from the EUROSTAT REGIO database for Germany (base year 1996). For impact assessment, crop production data were transferred from the administrative units to the EMEP 50 x 50 km^2 grid.

- *Material inventory*

  The following types of materials are considered for impact assessment: galvanised steel; limestone; mortar; natural stone; paint; rendering; sandstone; and, zinc. As there is no database available that provides a full inventory of materials for Germany, the stock at risk was extrapolated in ExternE from detailed studies carried out in several European cities.

- *Critical loads for ecosystems*

  The EcoSense database provides critical load data for acidification and eutrophication for a wide range of ecosystems from the UN-ECE Co-ordination Centre for Effects for the year 1997 (Posch et al., 1997). The spatial resolution of critical load data is 150 x 150 km.

Emission data

As the formation of secondary pollutants such as ozone or secondary particles depends heavily on the availability of precursors in the atmosphere, the EcoSense database provides a European wide emission inventory for SO_2, NO_x, NH_3, NMVOC, and particles as an input to air quality modelling. As far as available, EcoSense uses data from the EMEP 1998 emission inventory (Richardson 2000, Vestreng 2000, Vestreng and Støren 2000). Where required, data from the CORINAIR 1994 inventory. (http://www.aeat.co.uk/netcen/corinair/94/) and the CORINAIR 1990 inventory (McInnes 1996) are used. For Russia, national average emission data from the LOTOS inventory (Builtjes 1992) were included. Emission data for fine particles are taken from the European particle emission inventory established by Berdowski et al. (1997).

Meteorological data

The Windrose Trajectory Model requires annual average data on wind speed, wind direction, and precipitation as an input. The EcoSense database provides data from the European Monitoring and Evaluation Programme (EMEP) for the base year 1998.

For the calculation of the costs of direct emissions from vehicle operation emission, inventories in spatial disaggregation are needed, i.e. a geo-coded data set for the different air pollutants. For each mode or vehicle category (e.g. road passenger transport, motorcycles, heavy goods vehicles) an emission inventory, giving total vehicle emissions in spatial disaggregation, was produced. This input data is shown in table 23.

Table 23
Direct transport emissions in Germany 1998

	CO_2 mill. tonnes	$PM_{2.5}$ tonnes exhaust	PM_{10} tonnes non-exhaust	NO_x tonnes	SO_2 tonnes	NMVOC tonnes
Road transport						
Motor cycles[1)]	1.4	67	31	2520	83	35890
Passenger cars[2)]	110.5	13047	4631	401293	9870	324450
Buses	2.9	1954	304	36984	1077	7230
Light goods vehicles[3)]	9.7	3714	318	31908	2030	9220
Heavy goods vehicles[4)]	42.2	21680	3370	390234	13136	58480
Total	166.7	40462	8654	862939	26196	435270
Rail transport						
Diesel and electric traction	7.1		751	32524	5798	2544 [5)]
Diesel traction	1.9	559 [6)]	751	28556	385	2215
Electric traction	5.3		192 [a)]	5619	5413	157
Air transport	19.3 [7)]	580		7100	440	7000
Inland waterway shipping	1.2	700		700	400	1600 [8)]

[1)] Incl. mopeds. – [2)] Incl. recreation vehicles. – [3)] Up to 3.5 t max. GVW. – [4)] Over 3.5 t max. GVW. – [5)] Given as "HC". – [6)] Treated as $PM_{2.5}$ in analogy to road HDV. – [7)] CO_2 emission comprise all flight phases (based on fuel taken in Germany), other pollutant emissions only landing and take-off at airports. 52 airports in Germany covered. – [8)] VOC. – [a)] Power plant emissions.

Source: Rail DB (1999), inland waterway UBA, rest IWW.

a) Road transport

Emissions were obtained from a detailed emission model, giving link-based (i.e. geo-coded) information on the emissions of air pollutants. Calculations were based on a national model with geo-coded data on the German road network and on information for the different vehicle categories about the mileage, the technology of the vehicles, the fuel quality and the driving behaviour. Emissions were differentiated by road type: motorways; federal roads; other extra-urban roads; and, urban roads. Furthermore, particle emissions (pm) are split into exhaust and non-exhaust emissions according to their origin. The former result from fuel combustion and are treated as $PM_{2.5}$, which is more harmful than the coarser particle fraction PM_{10}. Non-exhaust emissions, stemming from tyre and break wear, are treated as PM_{10}.

b) Rail transport

Data on total emissions due to electric traction (electricity production) and diesel traction (fuel usage) were taken from DB (1999). The allocation to diesel traction and electric traction was based on the fuel use applying emission factors given in IFEU (1999). The emissions of diesel traction were spatially distributed as in the CORINAIR (1990) emission inventories (SNAP sector 8/2/0 *Other Mobile Sources and Machinery / Rail*). The emissions of electricity production were spatially distributed according to SNAP sector 1/0/0 *Public Power, Cogeneration and District Heating* of the CORINAIR (1990) inventories. Information on the structure of the CORINAIR emission inventories can be found in McInnes (1996). The allocation to passenger and freight trains was based on data on energy consumption for passenger and freight trains from Diekmann et al. (1999).

c) Public transport

For public transport a problem arises from the very limited data available on the mileage of urban buses. Based on the existing data, urban buses cannot be clearly separated from the vehicle category “buses” considered for road transport. To avoid double counting only public transport with electric traction was considered in the emission estimation. Public transport with diesel buses is included in the road transport account.

Energy consumption was calculated based on specific energy consumption factors in kWh/100 km from Diekmann et al. (1999) and vehicle kilometres from DIW: tramways and trolley buses 954 MWh, metros and light rail trains 916 MWh. Data on the power plant mix in electricity production and total emissions in Germany 1998 were taken from BMWi (2000). The emissions were spatially distributed according to SNAP sector 1/0/0 *Public Power, Cogeneration and District Heating* of the CORINAIR 1990 emission inventories.

d) Air transport

The emissions due to aviation were calculated for landing and take-off (LTO) at 52 airports in Germany, based on detailed data on aircraft movements per aircraft type. The data collected covers approximately 85% of all commercial aircraft movements in Germany. Emissions were calculated by means of a detailed emission model using airport specific landing and take-off times, aircraft movements and engine-specific emission factors from ICAO.

e) Inland waterways

Data on total emissions from inland waterway transport are based on Gohlisch (2001). As no spatial distribution was available, the emissions were spatially distributed as in the CORINAIR (1990) emission inventories according to SNAP sector 8/3/0 *Other Mobile Sources and Machinery / Inland Waterways*.

f) Shipping

Damage calculations for maritime shipping emissions (for all of Europe) could not be carried out within this report, but will be completed within the pilot accounts.

With regard to costs due to air pollution, not only the operation of a vehicle or vessel is relevant, but as well the provision of fuel or electricity. Electricity production is considered explicitly in the emission calculations presented above, emissions due to fuel provision have to be quantified. The respective emission factors for petrol, diesel and kerosene are given in table 24. These factors comprise the process steps crude oil extraction, refining and transport.

Table 24
Indirect transport emissions caused by energy and fuel production in Germany 1998

Type of emission	Unit	CO_2	PM_{10}	NO_x	SO_2	NMVOC
Total emissions caused by the production of energy for public transport	1000 t	339000	29	330	790	6
Emissions caused by the production of	g/kg fuel					
Petrol		560	0.105	1.10	1.90	1.80
Diesel		400	0.047	0.96	1.40	0.62

Source: BMWi (2000) for emissions from energy production for public transport, Friedrich and Bickel (2001) for PM_{10}, for fuel production, IFEU (1999) for other pollutants.

2.2.5.2 Global warming

The input data for the calculation of the costs of CO_2 are based directly on the level of CO_2 emission given in the previous section for all modes of transport. The monetary values used for cost calculation are described in chapter 3.

2.2.5.3 Noise

a) Road transport

Compared with information on airborne emissions the data quality concerning noise exposure is rather poor for road transport. Exposure estimates from the German Environmental Protection Agency (Umweltbundesamt) for 1992 were used, as more recent data was not available. A breakdown of the exposure by vehicle and road type was not possible, bearing in mind the UNITE principle of avoiding arbitrary cost allocation. Table 25 shows the input data used to estimate noise costs for road and rail transport.

b) Rail transport

The situation for rail transport is the same as for road transport. Exposure estimates from the German Environmental Protection Agency (Umweltbundesamt) for 1992 were used for the calculations, as more recent data was not available.

For road and rail transport the daytime noise level is defined as 16 hours L_{Aeq} and the night time noise level as 8 hours L_{Aeq}. For the impact calculations, the central value of each of the noise level bands was used. For the class “> 75” dB(A) a value of 77.5 dB(A) was taken, which most probably represents an underestimation (see table 25).

Table 25
Percentage of German population exposed to road and railway noise 1992

	Road		Rail	
Noise level	Day	Night	Day	Night
dB(A)	%	%	%	%
45-50	16.5	17.7	12.4	13.9
50-55	15.8	14.7	14.4	12.5
55-60	17.9	9.8	10.6	7.0
60-65	15.6	4.3	6.3	3.2
65-70	9.1	2.9	2.3	1.1
70-75	5.2	0.2	0.8	0.3
>75	1.5	0.0	0.1	0.1

Source: Umweltbundesamt.

c) Public transport

Noise exposure estimates due to public transport are not available. Parts of the noise costs are included in the accounts for road transport and rail transport, but an allocation cannot be estimated.

d) Air transport

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.

e) Other modes

For inland waterway transport and maritime shipping noise damages can be expected to be negligible.

2.2.5.4 Nature and landscape

The main input data for this type of environmental costs was a comparison of transport infrastructure data from 1950 and 1998. The input data is summarised in tables 26 and 27 and is discussed per mode in the following sections. A detailed background paper is available from the UNITE consortium upon request (Doll 2001).

a) Road infrastructure

Information on the length of the German road network from 1955 was utilised (BMVBW/DIW 2000). The share of “wide” roads (>20m in the case of motorways and >9m in the case of trunk roads) was estimated out of respective data for 1975 (1995) and applied to the values for 1955 and 1996/1998.

The share of roads cutting through ecologically sensitive areas, which is required for the compensation approach, is set according to expert judgements from the Federal Office for Building and Regional Planing with 85% as agricultural area and 15% as forests and semi-natural areas[6]. Estimates for 1960/55 are not possible, thus, the same percentage (85% type II and 15% type III) is applied.

Table 26
Network data for German roads 1955, 1996 and 1998

	1955	1996	1998
Total length by road type (1000 km)			
Motorways	2.660	11.246	11.247
Interstate roads	33.244	41.500	41.400
State roads	71.735	86.800	86.800
County roads	61.313	91.600	91.100
Local roads	:	:	:
Of which cross-town links [6]	42.643	35.700	35.700
Share of "wide" roads	[3]	[4]	[4]
Motorways [1]		81,5%	81,5%
Inter-state roads [2]	17,5%	19,1%	19,1%
State roads [2]	3,7%	5,9%	5,9%
County roads [2]	1,3%	1,8%	1,8%
Local trunk roads			
Length by road class and width (km)			
Motorways >= 20m	0	9.165	9.166
Motorways < 20m	2.660	2.081	2.081
Trunk roads >= 9m 5)	9.253	14.699	14.670
Trunk roads <9m	114.396	169.501	168.930

[1] >=20m. – [2] >=9m. – [3] Data from 1975. – [4] Data from 1995 and 1985. – [5] Including federal trunk roads, country roads and regional roads. – [6] For trunk roads only.

Source: BMVBW/DIW (2000) and estimate by IWW.

The annual growth rates of the network by type of area which determine the average annual costs of nature, landscape, soil- and groundwater pollution is as follows: for motorways with a width of more than 20 m, 213 km/a. For trunk roads with a width of more than 9 m, 127 km/a and with a width less than 9 m, 1282 km/a. The amount of de-icing salts used per year was not available.

b) Rail transport

For rail infrastructure data for 1950 is available for the German Federal Railway (DB), operating in the former Federal Republic of Germany, and for other not state-owned western German companies. The oldest values for the eastern German Railways (Deutsche Reichsbahn)

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[6] 15% of all road infrastructure through forests and semi-natural areas must be considered as the upper limit. A GIS application is currently developed by the BBR. This will be available most likely by the end of 2001.

is given for 1992 by the Federal Statistical Office. Under the observation, that the development of the railway network is very small, these figures were applied with some modifications.

Table 27
Basic data rail infrastructure 1950, 1996 and 1998

Network length in km	1950	1996	1998
DB [1]	30500	40800	38100
Multi-track lanes	12500	17600	17300
Single-track lanes	18000	23200	20800
DR [2)3)]	3044	:	:
Multi-track lanes	1248	:	:
Single-track lanes	1796	:	:
NE-Bahnen [4)5)]	6300	3700	3800
Total [6]	39844	43800	41050
High-speed track [6]		700	850
Conventional Multi-track lanes	13748	16900	16450
Conventional Single-track lanes	26096	26900	24600

[1] Until 1992: Deutsche Bundesbahn, from 1993 Deutsche Bahn AG. – [2] Deutsche Reichsbahn (until 1992). – [3] 1950: Value of 1992 used. – [4] No information on tracks available – Assumption: Single-tracks only. – [5] 1998: Value of 1997 used. – [6] Own estimate – no information available.

Source: IWW.

The annual growth figures show an average annual growth of 18 km/a for high speed tracks and 56 km/a for conventional tracks.

c) Aviation

In Germany, the number of international airports has not grown substantially between 1950 (11 airports) and 1998 (12 airports). However, their size has grown considerably and for this report, we assume that the size of an average airport has increased by a factor 3 since 1950. It can be estimated, that airport infrastructure is more harmful to nature and landscape than other transport infrastructure because when expanding existing airports the possibility of avoiding using ecologically sensitive areas is limited when such areas are adjacent to existing infrastructure.

d) Waterborne traffic

The size of inland waterway ports and seaports is not available, neither for 1950 nor for 1998. The accounts are restricted to inland waterways (= artificial channels and rivers, prepared for shipping). The infrastructure data is taken out of BMVBW/DIW (2000). Between the periods before the German unification (1950 – 1990) and after the unification (1991 onwards) the length of the German inland waterways remained nearly constant. The percentage of areas separated by channels is set equal to road and rail infrastructure.

2.2.5.5 Nuclear risk

For the estimation of nuclear risk due to the production of electricity in nuclear power stations the relevant electricity consumption per transport mode is used. The electricity mix for rail transport has approximately 21% nuclear power and for public transport 29%.

2.2.5.6 Summary

Table 28 presents a summary of all input data used for the estimation of different types of environmental costs and remarks on data quality.

Table 28
Source and quality of input data for estimating environmental costs

	Input data	Level of disaggregation	Quality of data, level of uncertainty
Air Pollution	Vehicle emission data calculated from vehicle mileage (DIW 2000) and emission factors (INFRAS 1999).	The emissions of CO_2, $PM_{2.5}$, PM_{10}, NOx, SO_2 and NMVOC are estimated for road transport (5 vehicle types). The emissions of CO_2, PM_{10}, NOx, SO_2 and NMVOC are estimated for rail (passenger and freight) and for emissions due to the production of petrol diesel and electricity. The emissions of CO_2, $PM_{2.5}$, NOx, SO_2 and NMVOC are estimated for aircraft and inland waterway. Emissions for shipping are not estimated.	Data level high for input data. Use of sophisticated model (IPM) to measure the dispersion and chemical conversion of emissions, the calculation of physical impacts and a valuation of these effects. Even though the model is established and has been previously used for the estimation of emissions of power production and transport within Europe and reflects the current knowledge within the field, it is like all models are accompanied by uncertainties and the values given are best estimates only.
Global warming	Vehicle emission data for CO_2 as above	Road, rail (passenger and freight), public transport, aviation, inland waterways.	Data is of high quality. Uncertainty remains with the valuation of CO_2. A shadow price of €20 per tonne CO_2, has been used. This value is lower than presumed in previous studies, but reflects the latest estimates available.
Noise	Exposure estimates from the German Environmental Protection Agency (UBA) from 1992 used for road and rail transport. Exposure data for aircraft noise based on a study from 1990. Noise exposure for inland waterway and shipping is negligible.	Road (5 vehicle classes), rail (passenger and freight). Public transport: could not be isolated from road account and is included there. Aviation: number of aircraft movements – no disaggregation between fright and passenger.	Exposure data is good, but old. Results dependant on the valuation of illness arising from noise exposure and the reduction in monthly rent values because of noise exposure. These values reflect the latest current knowledge in these areas, but are subject to change.
Nature, landscape, soil and water pollution	Transport infrastructure data from DIW (2000). Comparison between length of road 1955 (taken from German Ministry of Transport) and rail 1950 (taken from the German National Rail) on the one hand and the current infrastructure on the other hand.	All classes of infrastructure are evaluated by transport mode.	Network length data is good for road and rail. Other modes of transport are estimations only. Methods applied for valuation are new and have yet to be proven. Valuations should be considered to be the best estimates using the newest methods available, but the uncertainty must be regarded as very high.
Nuclear risk	Electricity consumption by transport mode. Input data for rail transport from the German National Railways (DB)	Rail transport (passenger and freight), public transport.	Input data has a good quality. Valuation through the application of shadow pricing. The values given in recent literature vary greatly and the results are directly dependant on the used value. For this evaluation a shadow price of € 67 per GWh is used, which can be considered to be relatively low.
Source: IER, IWW.			

2.2.6 Taxes, charges, subsidies

Table 29 gives an overview of the data used. For road, rail and air transport the data quality is considered to be good. For the remaining modes various estimations had to be made.

Table 29
Input data for taxes, charges and subsidies

	Input data	Level of disaggregation	Quality of data, level of uncertainty
Road	Vignette revenues (Bundesamt für Güterverkehr). Revenues from fuel tax from the German Ministry of finance and the DIW, revenues from the yearly vehicle circulation tax from the German ministry of Finance.	7 vehicle categories	Good data, high quality
Rail	Data on tariff revenues and on revenues from track access charges and station charges taken from the business report of DB for 1998. No such data released by DB for 1996. Subsidies taken from an analysis of the federal budget plan. German National Rail data from DB. Tariff revenues of non-DB rail from VDV. No information on track access charges of non-DB rail available. Fuel taxes paid estimated by DIW.	Revenues divided between track access, station, tariff revenues and fuel taxes paid.	Data quality partly good. Estimates of track access charges for 1996 by DIW deviate from the official data of DB for 1998. It is open whether this is due to overestimation of revenues or caused by change of the track access charging system.
Public Transport	Subsidy data and tariff revenues from the German Statistical Office and the DIW. Fuel taxes paid estimated by DIW but included in the road account.	Tariff revenues and subsidies are broken down into 6 classes for a total revenue figure for public transport as a whole.	The data is good, but incomplete. No subsidies given at a municipal level are considered. Fuel tax from public transport is included in the road account.
Air	Detailed information from the German Association of Airports, the German National Air Control and the German Meteorological Services. Revenue losses due to fuel exception and VAT exemption for international tickets for Lufthansa calculated by DIW.	A total of the revenues and subsidies is given for airports, the German National Air Control and the German Meteorological Service.	Good data, extensive research for subsidies to the aviation sector carried out. Indirect subsidies (for example no fuel tax on kerosene, no land tax for airports) were quantified where ever possible.
Inland waterway	Revenues from infrastructure user charges at waterways were obtained from the German Ministry of Transport. Revenues of inland waterway harbours not available. Revenue loss due to fuel tax exemption based on fuel usage by Lufthansa calculated by DIW.	A total figure per year is given.	Data good, but pilotage charges could not be ascertained.
Shipping	Revenues of seaports not available.		
Source: DIW.			

3 Methodological issues

The methodology used in developing the UNITE pilot accounts has been documented in the publication “D2 - The Accounts Approach” by Link et al. (2000 b). In this annex report on the German pilot accounts we will only summarise the methodology as far as it is necessary to understand and interpret the accounting results. We will focus on new methodology or deviations from the general methodology developed in Link et al. (2000 b) and on the methods used to compile the results for 1996 and 2005.

3.1 Methodology for estimating infrastructure costs

Infrastructure costs contain capital costs (depreciation and interests) for new investments and for replacement of assets on the one hand and running costs for maintenance, operation and administration/ overheads on the other hand. 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 a). For the German pilot accounts the perpetual inventory method (see box 1 for a summary description) was applied for all modes, with underlying long investment time series not only for the mode in total, but disaggregated for asset types per mode. Table 30 summarises the disaggregation of infrastructure assets in the German perpetual inventory model and the main parameters, namely the life expectancies of infrastructure asset groups. Generally, assets were valued at constant prices of the respective year of account, except the forecast for 2005, where according to the UNITE valuation conventions the figures are shown at constant prices of 1998. While it was possible to calculate the capital stock separately for tracks and stations of rail and public transport, it was not possible to achieve a complete separation between transport related parts of airports and non-transport related parts. Furthermore, the data situation for all modes did generally not allow a separate presentation of capital costs for new investments and replacement of assets.

While for some modes (roads, inland waterways) running costs could simply be taken either from the public budget statistics of the Federal Statistical Office or from the Ministry of Transport, it was necessary to estimate them for other modes. These estimates are discussed in detail in the following sections.

Box 1
The perpetual inventory model used for the German pilot accounts

The main idea of the perpetual inventory concept, a concept which is used by most OECD-countries for estimating the capital stock of industrial branches, is to capitalise time series of annual investment expenditures by cumulating the annual investments and by subtracting the value of those assets which exceeded their life-expectancy (written down assets) as expressed in the equations below:

$$VG_{t+1} = VG_t + I_{t,t+1} - A_{t,t+1} \quad (1)$$

$$VN_{t+1} = VN_t + I_{t,t+1} - D_{t,t+1} \quad (2)$$

with:
- VG_t : Gross value of assets at time t
- VN_t : Net value of assets at time t
- $I_{t,t+1}$: Investments during t, t+1
- $A_{t,t+1}$: Written down assets during t, t+1 (assets which exceeded life-expectancy)
- $D_{t,t+1}$: Depreciation during t, t+1

As shown in these formulas the perpetual inventory method can be applied for estimating the **gross value** (gross concept) and the **net value** (net concept) of infrastructure assets. The gross value contains the value of all assets which still exist physically in the considered year, e.g. which have not yet exceeded their life expectancy. Thus, $A_{t,t+1}$ denotes those assets which could not be used any longer or which were shut down. It is assumed that the assets are properly maintained and can be used until they exceed their defined life-expectancy.

Within the net-concept the annual depreciation $D_{t,t+1}$ are considered. The net value of assets describes the time-value of all assets which have not yet exceeded life-expectancy. According to the international conventions of the System of National Accounts (SNA) see for example UN (1993), most countries use a linear depreciation method.

The general principle as described above can be refined by more sophisticated approaches which use probability functions for the written down assets. This type of perpetual inventory model was used for the German pilot accounts.

In contrast to simple perpetual inventory models, the refined models assume that the life expectancies of assets within an investment vintage are dispersed over the mean value. A probability function, the so-called survival function, is estimated, which describes the share of assets which are still in use. The inverse function which describes the written down assets $A_{t,t+1}$ was estimated as a polynomial of the third degree in Germany meaning that the probability function of the written-down assets has a right-skewed shape. This approach considers the fact that the investment spent for an asset group consists of parts with different life expectancies which are dispersed within an interval around the mean. Although also in the German method for all elements of the investment I_1 - I_n a linear depreciation is applied, the overall asset group shows in fact a degressive depreciation due to the underlying type of probability function for the written-down assets.

The perpetual inventory model requires in general long time series on annual investment expenditures, information on life expectancies of assets, and initial values of the capital stock (except when the investment time series is as long as the life expectancy). Due to the fact that the use of probability functions in the refined concept implies that not single assets but technically homogeneous groups of assets (earthworks, bridges/tunnels, terminal buildings, pavement and equipment) are considered, investment time series for asset groups (for example pavement, tunnels/bridges, equipment) have to be available.

Table 30
Life expectancies of infrastructure assets per mode as used in the perpetual inventory model for Germany
– in years –

Mode and type of asset	Average life expectancy	Interval of life expectancy[1)]
1. Road		
Earthworks, drainage etc.	116	20 – 180
Pavements	35	5-55
Engineering work (Tunnels, bridges)	68	5-110
Equipment	18	1-30
2. Rail		
2.1 Tracks		
Earthworks, drainage etc.	116	20 – 180
Tracks	33	1-55
Engineering work (Tunnels, bridges)	68	5-110
Equipment	18	1-30
2.2 Stations		
Terminal buildings, buildings of handling facilities	54	1-90
Equipment	24	1-40
3. Tram and metro infrastructure		
Earthworks, drainage etc.	116	20 – 180
Tracks	27	1-45
Engineering work (Tunnels, bridges)	66	1-110
Equipment	18	1-30
4. Inland waterways		
Earthworks, drainage etc.	116	20 – 180
Embankments	47	5-75
Locks, ship lifters etc. (engineering work)	66	1-110
Equipment	18	1-30
5. Inland waterway harbours and seaports		
Earthworks, drainage, bassin etc.	116	20 – 180
Storage buildings, silos, cold storage plants	48	1-80
Quays, locks, ferry bridges	68	5-110
Equipment (cranes, container bridges, elevators etc.)	24	1-40
6. Airports		
Runways (incl. earthwork, drainage etc.)	15	1-25
Equipment	38	5-60
Terminal buildings	12	1-20

[1)] In the German perpetual inventory model it is assumed that the life expectancies of assets within an investment vintage are dispersed over the mean value, e.g. an interval of life expectancies is considered according to empirical findings in Germany for some assets this interval was revised in a way that physical losses of assets start later than in the first year.

Sources: Road construction authorities of the federal states, DB and other rail companies, inland waterway directions etc.

All results are values without VAT, which was eliminated both from the depreciation and from the running costs. Non-transport related infrastructure costs had to be considered for urban roads (market function, general access function in residential areas), inland waterways (flooding prevention, electric power generation) and airports (commercial part of airports such as restaurants, shops etc.).

Cost allocation was only carried out for road (breakdown by vehicle types) and rail (breakdown to passenger and freight transport).

As far as the UNITE accounting years 1996 and 2005 are concerned the general approach was to carry out separate model runs with the perpetual inventory model to calculate capital stocks and derive capital costs. This means that for 2005 investment paths were extrapolated per mode by using existing planning or by extrapolating plausible past trends. Running costs were simply extrapolated from 1998 to 2005 considering the official German forecasts on transport volumes (see BVU/ifo/ITP/PLANCO 2001).

3.1.1 Road

Core year 1998: Capital stock and capital costs were obtained from the perpetual inventory model. Running costs were taken from the public budget statistics of the Federal Statistical Office. Since parts of the figures given there for maintenance and operation contain expenditures spent on assets with a life expectancy of more than one year these parts had to be excluded here and included in the input data used for capital stock calculation. Costs for non-transport related functions were considered for parts of urban roads only, by subtracting the interest for land value of urban roads up to 6 m width (opportunity cost of alternative land use).

Year 1996: The same methodology as for 1998 was applied.

Forecast methodology: Capital stock and capital values were calculated by using the perpetual inventory model. The necessary input data, namely an investment path from 1999 to 2005, was taken from the investment planning of the federal government for motorways and other federal roads in the context of the new master plan for transport infrastructure (see DIW

2000). For other roads an extrapolation of past investment trends was used, assuming an average growth of investments per annum of 1%. Running costs were extrapolated from 1998 by assuming an average growth of 1% p.a. Cost allocation was carried out with the same methodology as for 1998. The necessary input data, namely vehicle mileage per vehicle category, was forecasted by detailed calculations based on the official master plan forecast for passenger-km and tonne-km in road transport (see BVU/ifo/ITP/PLANCO 2001).

3.1.2 Rail – national rail DB

Core year 1998: Capital stock and capital costs were calculated by using the perpetual inventory model. Abolished tracks were considered and eliminated from the capital stock value. Note, that neither the capital stock nor the capital costs derived with the perpetual inventory approach can be compared with figures from the official business account of DB. This is not only because the balance sheet of DB shows only aggregated capital stock figures for the integrated rail company, but mainly due to methodological differences. The main differences between capital stock valuation on a social cost basis (such as the perpetual inventory method) and on a business accounting basis have been discussed in Link et al. (2000 a) in detail. Apart from the “normal” differences of depreciation methods and depreciation periods etc. it has to be considered that all assets of DB were devaluated by 80% in 1994 in order to enable the reform process.

The balance sheet of DB does not present figures on the running costs of DB infrastructure but provides only expenditures for the whole DB group. Therefore, our own calculations and estimates had to be made for identifying those parts of the expenditures related to maintenance, operation and administration of rail infrastructure. Similar to the data for road transport, it had to be taken into account, that often running expenses include maintenance activities with a life expectancy of more than one year which have to be capitalised. The sources used for these estimations were information from the official business report of DB, for example the number of staff employed in the five DB companies (DB Netz, DB Station & Service, DB Reise & Touristik, DB Regio, DB Cargo) and sources from engineering science on track maintenance and operation. It was assumed that rail infrastructure serves fully for transport functions (in contrast to the market space function of roads or the electricity generation at inland waterways).

Up to the end of the 80s DB provided an allocation of costs to transport types based on econometric studies (BMV 1969). Since the 90s DB has not continued to produce this information. Therefore, a top-down method was applied for all DIW-infrastructure cost studies carried out since then. The indicator used (wagon- axle kilometres with a correction factor between regional and long distance passenger transport) matches exactly the cost structure which had been reported by DB in former years. The underlying assumption for the UNITE accounts was that former DB data did correctly reflect the cost structure of transport types and that this cost structure has not changed.

Year 1996: The same methodology as for 1998 was applied.

Forecast methodology: Capital stock and capital costs were calculated by using the perpetual inventory concept. The investment forecast for the tracks stem from the investment planning of the Federal Ministry of Transport (see DIW 2000). The capital stock and the capital costs of stations were estimated by using the ratio between track investments and station investments from the 90s. Running costs of rail infrastructure were extrapolated by assuming an annual average growth of 5%. Cost allocation was carried out with the same approach as for 1998.

3.1.3 Rail – non-DB rail companies

Core year 1998: Capital stock and capital costs were calculated by using the perpetual inventory model. Running costs had to be estimated since no such data was available. The reason for this data situation is that the non-DB companies are integrated companies without any obligation for a separate bookkeeping of transport operations and infrastructure. Furthermore, some of them are non-public rail companies of ports and large industrial companies without official business reports. However, the German Association of Railways and Public Transport Operators (VDV) conducted a survey on infrastructure costs in 1997 which was used for UNITE, in particular for the estimation of running costs (Deutscher Städtetag 1999).

As for the DB it was assumed that the rail infrastructure of these companies serves fully for transport, e.g. no non-transport related costs were subtracted. Cost allocation to passenger and freight transport was not possible.

Year 1996: The same methodology as for 1998 was applied.

Forecast methodology: The investment forecast for the perpetual inventory model was derived from past investment trends during the 90s and assumed an average annual growth rate of investments of 2%. Running costs were extrapolated from those in 1998 by assuming cost increases due to increased train-km from competitive tendering in passenger transport and stagnation of freight train-km. No cost allocation was carried out.

3.1.4 Public transport infrastructure – tram, metro

Core year 1998: For the infrastructure cost calculation a definition of public transport was used which deviates from the term "Öffentlicher Strassenpersonenverkehr" defined in German transport statistics. While German transport statistics include all companies operating transport with buses, trams and similar means, metros and trolley buses, we excluded buses from the estimation of infrastructure costs due to the fact that infrastructure costs caused by buses are included in the road account. The capital stock and capital costs for tram and metro infrastructure were – as for the other modes – calculated with the perpetual inventory model. Serious problems occurred with running cost figures. The official transport statistics do not provide any information on expenditures or costs of this company group but contain only data on turnovers, employees, transport volume, performance and revenues. Furthermore, these companies do not have separate bookkeeping for infrastructure and transport costs. We have sent out questionnaires to a sample of public transport companies, however, the results are not representative and can not be used for the UNITE accounts.

Year 1996: The same methodology as for 1998 was applied. The same data problems did not allow the estimation of running costs.

Forecast methodology: The investment path needed for the perpetual inventory concept was extrapolated from the development between 1991 and 1998 and considered the fact that the official transport forecast for the federal master plan assumes decreasing transport volumes for this mode. A stagnation of investments at the level of 1998 was thus assumed for UNITE. The same input data problems as for 1998 did not allow to estimate running costs of infrastructure for 2005.

3.1.5 Aviation infrastructure

Airports, the national air navigation provider (DFS) and the provider of meteorological services (DWD German Meteorological Services) are included in the evaluation of the aviation infrastructure account.

Core year 1998: Capital stock and capital costs were calculated with the perpetual inventory model. Running costs were estimated based on the business reports of all German international airports, information from ADV (Association of German Airports), DFS (German Air Control) and DWD (German Meteorological Services).

In particular, the information basis for DWD had to be adjusted and supplemented by our own calculations. For example, it was necessary to estimate the value of aviation-related expenditures of DWD, which is an organisation responsible for a whole range of services not only for aviation but also for other areas such as agriculture, climate and environment, maritime transport etc.

Due to data problems it was not possible to estimate the capital stock and capital costs separately for airports, air control and for meteorological services. A separation of costs between airports, air control and meteorological services would only be possible for the running costs which amount to two thirds of total infrastructure costs. Since the separation of capital costs would then be missing we had to aggregate the values.

It also has to be mentioned that the calculation of the capital stock of airports was based on investment time series obtained by applying the institutional principle. This means that all investments within the airport area are taken into account. The investment figures reported by ADV include all investments into land acquired, earthworks, engineering work, terminals/ tower and equipment. It was not possible to exclude the non-transport related investments (and running costs). This implies that in contrast to road, rail, public transport and inland waterway infrastructure the cost account of aviation is not fully comparable. It also means that on the revenue side all airport revenues and not only the transport related ones have to be reported.

Year 1996: The same methodology as for 1998 was applied.

Forecast methodology: Capital stock and capital costs were calculated with the perpetual inventory model. The necessary investment path up to 2005 was extrapolated with an average annual growth rate of 3% assuming that the expansion of Frankfurt airport and the construction of Berlin Brandenburg International airport will start during the forecast period. Running costs were estimated by multiplying the running costs related to the number of starts and landings from 1998 with the starts and landings in 2005 given in the forecast for the German federal master plan on infrastructure development.

3.1.6 Waterborne transport – inland waterways, inland waterway harbours and seaports

Core year 1998: The perpetual inventory model was used for calculating capital stock and capital costs, separately for inland waterways, inland waterway harbours and seaports. The data situation with respect to running cost estimation is, however, rather heterogeneous.

Detailed information on running costs of maintenance, operation and administration of inland waterways were obtained from the Federal Ministry of Transport. Non-transport related costs for electric power generation, flooding prevention etc. were estimated by using information on the shares of these costs on total costs of different types of waterways (canals, canalised rivers, regulated rivers) which was elaborated in BMV (1969). Germany produced statistics on waterway usage (boat-km) by vessels of different load capacity classes until the late 80s, unfortunately this information has not been compiled since then. Because of this lack of basic data, no cost allocation to vessel types was possible.

Serious problems occurred with estimating running costs of port infrastructure. We have conducted company surveys asking for this information but it must be pointed out that the response rate was extremely low. The level of available data is not representative and can not be used within the German pilot account.

Year 1996: The same methodology was applied as for the core year 1998. It was not possible to estimate the running costs of port infrastructure.

Forecast methodology: Capital stock and capital costs were calculated with the perpetual inventory model. The necessary investment paths were taken from the mid-term investment planning of the federal government for inland waterways (see DIW 2000). For inland waterway harbours we extrapolated the investment trends from the 90es with an average annual growth rate of 0.5% and for seaports we used an average annual growth rate of 2% (given the expansion plans of Wilhelmshaven seaport). No running costs could be estimated.

3.2 Methodology for estimating supplier operating costs

For the UNITE pilot accounts 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 public transport and rail transport and is considered to be core data for these transport modes. For the German account this means an analysis of the national rail carrier Deutsche Bahn (DB) and within the DB the subsidiary transport companies: DB Reise & Touristik (long distance rail); DB Regio (regional train passenger transport); and, DB Cargo (freight transport). Furthermore, non-DB rail companies (about 180 companies) and public transport companies (tram, metro, buses) have to be included.

For the estimation of supplier operating costs aggregated annual cost and revenue data was utilised. As far as possible the following categories materials; goods and services; personnel; depreciation; other running costs; and, interest were used.

3.2.1 National rail carrier (Deutsche Bahn – DB AG)

Core year 1998: Deutsche Bahn (DB AG) is obliged, like all other European railways, to separate transport and infrastructure at least at the bookkeeping level. Deutsche Bahn has met this requirement and has even set up three transport companies and two infrastructure companies (for tracks and stations) as companies in their own right operating under the roof of DB Holding. Separate balance sheets and profit/ loss statements for these companies have not been published so far. Only the turnovers, the depreciation (on a business accounting basis and with huge devaluations) and the operating results of these companies are provided in a so-called segment business report. In this form, the data was not ideal for the German account. We were able to utilise the information as a basis for our own estimates of supplier operating costs. The aggregated data did not allow any further disaggregation for vehicle-related costs, service related costs, other costs and administrative costs.

Our estimates are based on the data from the aggregated profit/ loss statement of DB AG, the data available from the segment report and on information available at DIW (for example: engineering studies on material and maintenance for tracks and vehicles, number of personnel per DB company etc.).

Year 1996: The 1998 values were transferred to 1996 by using the number of staff and the transport performance differences between 1996 and 1998.

Forecast methodology: Although DB has released press information several times stating that a cost reduction programme is being developed, no quantitative figures are available on these planned cost reductions. Therefore, we simply extrapolated the 1998 figure by assuming a decrease in the number of staff. However, it should be noted that this extrapolation is only a "guestimate".

3.2.2 Non-DB rail companies

Core year 1998: The data availability for estimating supplier operating costs for non-DB rail companies is poorer than for the DB due to the following facts:

- In contrast to DB these companies are not obliged to establish a separate bookkeeping for transport operations and infrastructure.
- The 180 non-DB rail companies form together with the operators of trams, metros and buses the Association of Railways and Public Transport operators (VDV) which publishes only an aggregated statement of the costs and revenues and of its members. Although an in-depth study on cost structures of these companies has been conducted on behalf of

VDV, Deutscher Städtetag, Deutscher Gemeindetag (1999), this study only gives results for companies with and without rail infrastructure.

- The VDV figures are biased due to the fact that not all public transport companies are members. This means that these figures underreport costs and revenues.

Therefore we present in chapter 4 aggregated figures for all rail-bound VDV companies: all companies providing rail passenger or freight services, or tram, or metro operations, and excluding those which provide only bus operations. We do not use these figures to complete the accounts tables in chapter 5 because of the impossibility of fully separating out the non-rail components, or of separating heavy rail from light rail within public transport.

Year 1996: The same procedure as for 1998 was applied.

Forecast methodology: No extrapolation was done due to the fact that the information presented for 1996 and 1998 was not included into the pilot accounts.

3.2.3 Public transport

Core year 1998: Ideally, supplier operating costs would be estimated separately for companies with tram and metro operations (or their respective business units) and for companies operating bus services (or their respective business units). Furthermore, an analysis of supplier operating costs would require a separate treatment of municipal companies with (at least partly) public ownership on the one hand and private companies on the other hand. However, in section 3.2.2 we have already discussed the data problems which complicate an estimation of supplier costs for public transport. In fact, in chapter 4 we can present some quantitative information from Deutscher Städetag et al. (1999), however, this information is not completely what is required for the pilot accounts. This information refers to the expenditures of all rail bound companies that are members of VDV (e. g. rail companies, companies with tram and metro transport) which are included with their full expenditures. This means that a company which offers tram, metro and bus transport is included with the expenditures from all these business branches. A further serious problem is also that infrastructure related expenditures are included here. Additionally, we were able to obtain information on the expenditures of private bus operators in Germany which operate bus services on the basis of their own line concessions. To give an indication of the importance of these companies it has to be mentioned that they carry about 11 % of all bus passengers in Germany and operate half of the bus line network in Germany.

To summarise this data situation we have to state that the available information on running costs was not detailed enough to base any estimate for the pilot accounts on it.

Year 1996: We refer to the discussion on the core year 1998.

Forecast methodology: No forecast was made due to the data problems described above.

3.3 Methodology for estimating delay costs due to congestion

Core year 1998: The UNITE methodology defines congestion costs as the sum of those time and operating costs perceived by transport users which exceed average time and operating costs. 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) and of passengers and shippers (represented by units of cargo) in public passenger and freight transport. Congested traffic conditions or late arrivals are defined per mode, taking into consideration characteristic fluctuations in travel time and the system-specific consequences of delays. In general the UNITE approach values late arrivals rather than late departures or longer in-vehicle travel times in public transport. Between all road-related transport modes, which include individual motorised traffic, bus, coach and tramway services and road haulage, interdependencies are to be considered and thus a common road model is applied to quantify delays.

Time and operating costs spent under delayed or congested conditions are estimated by using normal or acceptable travel times and operating costs in order to obtain a value of extra time and other resources lost by the users. 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. 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. To establish a basis for the UNITE cost valuations, state of the art research studies for the value of time (VOT) were reviewed and are summarised in "valuation conventions for UNITE" (Nellthorp et al. 2001). The monetary value for travel time delays considers the factor costs given in Nellthorp et al. 2001 by travel purpose and mode for Germany 1998. The specific perception of delayed journeys in passenger transport is recognised by increasing time costs by 50% in all modes.

Delay cost information does not form part of the core data in the UNITE core section of the accounts. It relates to costs that are internal to transport users as a group, and is therefore classed as supplementary data only.

Year 1996: In addition to the benefit transfer of cost figures, which is determined by the economic development, the values of travel time are determined by the mix of travel purpose. Therefore, a general statement on the development of values of time (and fuel prices) can only be given for each mode separately.

Compared to 1998, the shares of the travel purposes "business" and "leisure" in road transport were lower, directly related to the number of passenger kilometres by individual vehicles. As a result, the average VOT (before inflation) was 2.5% lower in 1996 compared to 1998. Considering the price inflation between the years, the difference is 4.5%. Fuel prices in 1996 were approximately 10% higher than 1998 (in 1998 prices, including taxes), with a share of diesel-powered passenger cars slightly higher in 1996. These effects average out for individual road traffic, such that fuel costs basically develop with the general benefit transfer rules. The effects of fuel price developments on road freight transport are also of minor nature for heavy and for light goods vehicles.

In public road transport the share of private trips (commuting, shopping, etc.) in 1996 was considerably lower than in 1998, while leisure trips (spare time and holiday trips) were more important. A slightly higher share of business trips finally gives a VOT (before inflation) of only 0.7% below the 1998 level.

In rail passenger transport, the share of business trips decreased from 1996 to 1998 by 60%. Therefore, the value of time in 1996 (in 1998 prices) was 11% higher than in 1998.

In air passenger transport the share of business trips has increased by about 10% from 1996 to 1998. Thus, the average value of time (in 1998 prices) was 3.2% lower in 1996 compared to 1998.

The development of traffic quality over time is the main cost driver of the congestion category. The following assumptions for the 1996 estimations were made:

- The share of congested traffic in total road traffic (comprising individual, public and freight transport) were taken from the TREMOD traffic model. According to statements by IFEU (1999), the shares are based on traffic observations on different German roads in 1995. Since then, it can be assumed that the increase in traffic demand and capacity extensions of the road network equal out, and thus that the congestion shares remain constant. Thus, the same values were applied for 1998 and 1996.
- The costs of railway delays in 1996 are based on the Results of the 1997 study of Stiftung Warentest e.V. on late arrivals at a sample of major German railway stations. A comparison of the studies in 1997 and 1999 shows, that the punctuality of the DB AG has dropped slightly from 1997 to 1999 (table 31).
- In air transport the 1998 annual report of the Central Office for Delay Analyses (CODA) of Eurocontrol reports an increase in the number of delayed flights from 1996 to 1998 by around 30% and an increase of the delay time per delayed flight by 15%. In contrast to this development on a world-wide scale, the figures for Germany indicate a much less severe development between 1997 and 1998. As the general indicators of Eurocontrol/CODA 2000 show, the situation between 1996 and 1997 remained stable, for the accounting year 1996 the 1997 figures were applied. The development of the Eurocontrol figures then was used to update the AEA delay probabilities used for the 1998 accounts.

Table 31
Development of train delays in Germany from 1997 to 1999

Delay interval		All train classes Increase in %		Local trains [1] Increase in %		Long-distance trains [1] Increase in %	
from (min.)	to (min.)	1999 [2]	1997 [3]	1999	1997	1999	1997
0	2	55	60	61	68	51	56
2	4	20	15	17	12	22	16
4	6	7	9	6	7	8	9
6	11	10	9	8	7	11	10
11	20	6	5	5	4	6	6
21	30	2	1	1	1	2	2
30	-	2	1	1	1	2	2
"Small" delays (Delay time between 2 and 5 minutes)							
Probability (%)		25	21	22	17	27	23
Average delay (minutes)		3.4	3.6	3.4	3.6	3.4	3.6
"Considerable" delays (delay time > 5 minutes)							
Probability (%)		20	19	17	15	22	21
Average delay (minutes)		14.2	13.9	14.2	13.9	14.2	13.9

[1] Values only available for delays from up to 2 minutes. – [2] Source: Test 9/99; Sample of 10661 train arrivals during the period 5.6. – 14.6.1999 at 8 railway stations. – [3] Source: Test 8/97; Sample of 11762 train arrivals during the period 3.6. – 16.6.1997 at 8 railway stations.

Source: IWW.

The development of transport demand was derived from the growth of annual mileage per vehicle category (given in BMVBW/DIW (2000) for most transport modes). The share of annual vehicle mileage remains constant, as for network specific vehicle kilometres, data is only available for 1998 (provided by DIW) and 1994. The growth rates applied are shown in table 32.

Table 32
Development of road transport demand in Germany 1996 to 1998

Mode / type of vehicle	Unit	Total traffic demand			Increase of shares by network type 1998 and 1996 (%)		
		1996	1998	Growth rate (%)	Motorway	Trunk road	Urban road
Road	billion km	610.1	627.6	2.9	31.0	40.9	28.1
Passenger car		519.1	525.6	1.3	31.0	40.9	28.1
Motorcycle		13.4	15.3	14.2	12.5	54.8	32.8
Bus		3.7	3.7	0.0	20.8	38.3	40.9
LGV		30.7	34.5	12.3	38.8	36.4	24.8
HGV		43.2	48.5	12.3	56.8	28.2	15.0
Rail [1)2)]	million km	1 065	1 104	3.7			
Passenger [3)]		873.85	883.2	1.1			
Freight		191.15	220.8	15.5			
Aviation [4)5)]	1000 flights	4 404	4 433	0.7			
Passenger		3 618	3 690	2.0			
Cargo		786	743	-5.5			
Shipping	1000 km	:	:	n.a			

[1)] Engine-km DB AG only. – [2)] Share passenger / Freight by trains at a selected day. – [3)] Including High Speed Rail. – [4)] All flights at all airports. – [5)] Distribution passenger / freight by Efficiency (1 pkm = 0.1 tkm).

Source: Calculations of IWW.

Forecast methodology: Values of travel time and fuel costs were transferred from 1998 to 2005 using the common rules laid down in Nellthorp et al. (2001). For example an average increase of the value of time by 15%. Traffic volumes for 2005 were provided by DIW. Concerning delay probabilities the following assumptions were made:

- Due to the planned introduction of a motorway toll for heavy goods vehicles we estimated that the traffic flow situation will improve slightly on motorways as some HGVs will shift to the trunk road network. This assumption is underlined by the planned massive investments in road capacity extension (Anti-Stau-Programm). We estimated a reduction of the congestion probability on motorways by 2%. At the same time the load and corresponding traffic conditions of the trunk road network will worsen. This will partly be equalled out by federal investments for bypass roads. We estimated an increase of the congestion probability of 5%. For urban roads and public transport we assumed the same increase of 5%.

- For air traffic the available reports of Eurocontrol and the AEA indicate, that capacity problems will increase in the near future in Europe. Therefore, we applied a significant increase in late arrivals of 10%.
- For rail and waterborne transport we expect no significant change in the delay situation.

3.4 Methodology for estimating accident costs

Core year 1998: Materials damage, administration costs, medical costs, production losses and the valuation of the risk associated with using transportation are the subcategories used for the evaluation of accident costs. Each of these subcategories is valued through the use of 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 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. The emphasis within this cost category was placed on medical costs and the cost arising from transport related fatalities. All valuations are documented in the publication "Valuation Conventions for UNITE" Nellthorp et al. (2001).

Accident costs are divided into internal and external accident costs. External accident costs are those costs imposed by the transport user on those outside the transport. 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. Internal costs embrace all costs borne by the individual transport users (for example damages to property not covered by insurance companies and the risk associated with using transport) and costs borne by the community of transport users (including all costs covered by traffic insurance companies). Due to the present data situation it was not possible to divide medical costs into internal and external costs, and thus in a simplified approach this cost component was considered to be totally external to transport users. The remaining internal costs therefore comprise only of the costs of material damages and the risk value. An internal risk value for UNITE means that we implicitly assume that the risk of accidents is fully anticipated by individuals when they decide to take part in transport. External accident costs are considered to be core data while internal accident costs, because the costs are borne by the transport users and not society as a whole, are considered to be additional information only.

The methodology applied here followed the recommendations of Interim Report 8.2 “Accounts Approach for Accidents” of the UNITE project (Doll et al. 2000). The definition of cost categories is broadly in line with the approach of the German Highway Research Institute’s (BASt) report on economic costs of road passenger accidents (BASt 1999), but was extended to other modes and supplemented by information on the costs of material damages. As for the latter, within this account, both the data on physical units (accidents by severity) and on their valuation was very weak. The focus of the present accounts was clearly on external accident costs. Because of the data situation the presentation of a matrix of cost responsibility and cost bearers as proposed in Doll et al. (2000) respectively could not be presented.

a) The costs of medical treatment

The costs of medical treatment of traffic casualties can be broken down into a number of different activities as shown in table 33. According to BASt (1999) injuries can be further divided into two categories, those with a steady reduction of working power (SRWP) and those without SRWP (see Doll et al. 2000). Table 33 shows the unit costs used for valuing costs of medical treatment. The share of injuries entailing a steady reduction of working power (SRWP-cases) were estimated in Baum and Höhnscheid (1999) with 0.3% for slight injuries and 11.9% for severe injuries in road transport. These figures were used for injuries in all modes.

Reliable information on the coverage of costs for the medical system by transport users' insurance companies could not be retrieved. Therefore, all costs related to the medical treatment of accident casualties were considered as external to the transport sector.

Table 33
Average costs for medical treatment per type of action and degree of injury in Germany 1998
- in € per casualty -

Type of action	Slight injuries		Severe injuries		Fatalities
	With SRWP	No SRWP	With SRWP	No SRWP	
Stationary treatment	0.00	0.00	15 984.76	3 389.92	651.91
Ambulant treatment	756.21	182.53	912.67	312.92	52.15
Transport	52.15	52.15	834.44	234.69	391.14
Follow-up treatment	104.31	26.08	443.30	52.15	0.00
Medical aids	0.00	0.00	1 225.59	104.31	0.00
Supporting measures	2 503.32	0.00	2 503.32	0.00	0.00
Rehabilitation	0.00	0.00	651.91	26.08	0.00
Nursing	0.00	0.00	495.45	52.15	0.00
TOTAL per casualty	3 415.99	260.76	23 051.44	4 172.22	1 095.20

SRWP = Steady reduction of working power.
Source: IWW using values from Baum, Höhnscheid (1999).

b) Production losses

According to the methodology described in Doll et al. (2000) the cost category "Production Loss" comprises of two elements:

- The loss of the production power of steadily disabled or traffic fatalities.
- The temporary costs for the victim's employer.

The lost production time per victim takes into consideration the duration of various medical actions and the duration of partial disability preventing the victim taking part in the production process. The effective loss of productive time further considers the degree of disability to work (25% for SRWP-cases and all severe injuries) and the share of victims of employable age (BMVBW/DIW 2000). The respective input data is given in table 34.

Table 34
Composition of the lost working time per degree of injury

Category of treatment	Slight injuries		Severe injuries		Fatality
	No SRWP	SRWP	No SRWP	SRWP	
Stationary treatment (days)	-	-	17	65	
Rehabilitation time (days)	-	-		6	
Nursing (days)	-	-	2	6	
Disability to work (days)	17	79	64	224	
Duration of temporal reduction of working power (days)		294	294	7 392	7 392
Degree of reduction of working power (%)		25%	25%	25%	100%
Share of victims in employable age	83.9%	83.9%	83.9%	83.9%	79.0%
Employment rate	87.7%	87.7%	87.7%	87.7%	87.7%
Net value factor	0.00000	0.00067	0.00067	0.00067	0.00270
Lost working time (years)	0.034	0.308	0.316	4.334	14.035

SRWP = Steady reduction of working power.
Source: IWW using values from Baum, Höhnscheid (1999).

The gross production loss per lost year of working time refers to the production potential of the national economy rather than to the actual GNP. Thus the gross production loss is composed of the GNP per capita in employable age (€ 17668) and the relation between GNP and the production potential (1.04 according to the Cochrane-Orcutt production function). In order to avoid double counting with the Risk Value the future consumption (€ 13308 per capita and year) was subtracted from the gross production potential. The resulting net production potential then was discounted to 1998 using a social interest rate of 3%.

For direct replacement costs a value of € 3025 per fatality or severe injury was provided by BASt 1999.

c) Valuation of administrative costs

Administrative costs are composed of the costs for police, justice and for the insurance sector. In the case of costs for traffic police, reliable information could be provided by the German

Highway Research Institute (BASt), based on the time required for dealing with a traffic accident. The respective hourly wage rate for police officers is € 28.15.

This information is valid for road transport only, but it can be assumed that the time required by police to deal with casualties in other modes is similar to the road case. For material damages this transfer can not be made (see table 35).

Table 35
Time required by traffic police per accident 1998
-in hours-

Unit Costs 1998	Material damages		Injuries		Fatalities
	Slight	Severe	Slight	Severe	
Road	2.7	2.7	1.97	12.79	12.79
Rail	:	:	1.97	12.79	12.79
Aviation	:	:	1.97	12.79	12.79
Inland navigation	:	:	1.97	12.79	12.79
Maritime shipping	:	:	1.97	12.79	12.79

Source: Baum, Höhnscheid (1999)

The estimates of costs to the legal system and to the administration of insurance companies provided by the BASt seem to be rather arbitrary and are not used for the UNITE German account. The administrative costs for traffic police, as considered here, are totally external to the transport sector as they are covered by the general budget and are the only administrative costs evaluated.

d) Valuation of material damages

Information on the average costs of accidents was only available for road accidents (including damages to buses and tramways). Average material damages for other modes or other types of public or private property were not available. For road transport accidents average damage costs could be retrieved by the Organisation of Insurance Companies (GDV 2000), differentiated by passenger cars and other vehicles. Average damage costs of other road vehicles (motorcycles, goods vehicles, tramways and buses) were estimated based on the

German manual on cost benefit analysis for public transport infrastructure projects (BMV 1993).

No direct information could be found on the average value of deductibles borne by the accident parties. For accidents of passenger cars and motorcycles internal estimates of € 150 per accident were applied, while for other vehicles no deductibles were assumed. No estimates of average unit costs was attempted for accidents not reported to insurance companies. Only the average costs of damage to vehicles could be estimated. No costs resulting from damage to public or other private property could be estimated.

Table 36
Average unit costs per material damage of road accidents 1998

Mode of transport & Damage category	Unit costs per case reported to liability insurance		Insurance coverage per case reported	
	Slight	Severe	Slight	Severe
Damage to vehicles				
Passenger car [1]	1 598	14 599	1 448	14 449
Motorcycle [2]	1 027	9 387	877	9 237
Bus / Coach [3]	744	6 798	744	6 798
Tramway [3]	732	6 687	732	6 687
Goods vehicles [3]	744	6 798	744	6 798
Others [3]	732	6 687	732	6 687
Damage to public property	:	:	:	:
Damage to other private property	:	:	:	:

[1] Data from GDV (2000), average deductible = 150 € . - [2] Own estimates based on GDV (2000), average deductible = € 150. - [3] Figures from BMV (1993) factored up to 1998, no deductibles.
Source: IWW.

Due to the non-availability of data estimating the costs of damage to public or non-transport-related private property, all costs of material damages are considered to be totally internal to the transport sector. Unfortunately, it was not possible to obtain information on the significance of the costs related to damage to public property in Germany.

e) The risk value

The Risk Value was set according to the recommendations of the UNITE valuation conventions:

- € 1.62 million for fatalities,
- 13% of € 1.62 million = € 210600 for severe injuries.
- 1% of the value of statistical life = € 16200 for slight injuries.

Risk values for relatives and friends were not considered.[7] For the UNITE accounts, risk value is considered to be fully internal.

Year 1996: The accident cost accounts 1996 are based on actual numbers of accidents and casualties reported by the Federal Statistical Office. As for the core year 1998 we used average cost values for all cost categories, only the benefit transfer rules given in Nellthorp et al. 2001 had to be applied. Concerning the number of physical units the respective data for 1996 was used.

Forecast methodology: Unit costs per injury, fatality and material damage 2005 were derived from the 1998 values by considering the estimated growth in GDP/capita for all damage categories.

The number of physical units 2005 are determined by the growth in transport demand and by the estimated development of accident rates. The growth in transport demand is described by the development of passenger kilometres in passenger transport. This figure considers both vehicle kilometres and the occupancy rate. As in freight transport, the number of goods loaded are irrelevant, only the increase in vehicle kilometres is of interest.

The development of accident rates in road transport was derived from INFRAS/IWW (2000). Here, a slight decrease of road accident by 5% was assumed. For all other modes accident rates were assumed to remain constant between 1998 and 2005.

3.5 Methodology for estimating environmental costs

For the estimation of environmental costs, four subcategories have been developed. These are: air pollution; noise; global warming; costs due to environmental impacts on nature, landscape,

[7] From BASt (1999) an average gratification payment € 730 per fatality from the liability insurance to the victim's relatives is reported. This is taken as the contribution of the responsible party for the internalisation of the costs caused by him.

soil and ground water; and, finally the valuation of the risk associated with nuclear energy production. The first three of these subcategories (air pollution, noise and global warming) are core data, the remaining two categories are additional data.

This section is organised along these subcategories of environmental costs. In sections 3.5.1-3.5.5 we discuss the methodology for the core year 1998. Section 3.6 briefly summarises the procedures applied for the estimates for 1996 and for the forecast 2005.

3.5.1 Air pollution

3.5.1.1 General approach

For quantifying the costs due to airborne pollutants the *Impact Pathway Approach*, the methodology developed in the ExternE project series was applied. A detailed description of the approach can be found in European Commission (1999 a). The impact pathway approach utilises the following steps: emission estimation, dispersion and chemical conversion modelling, calculation of physical impacts, and finally, the monetary valuation of these impacts.

For the calculation of the costs of direct emissions from vehicle operation, emission inventories in spatial disaggregation are needed, i.e. a geo-coded data set for the different air pollutants. For each mode or vehicle category (e.g. road passenger transport, motorcycles, heavy goods vehicles) an emission inventory, giving total vehicle emissions in spatial disaggregation, was produced. For each of these emission inventories, Europe-wide impacts were calculated and subtracted from impacts resulting from a reference inventory without these emissions. This procedure using a reference inventory was required, because of air chemistry processes where "background" emissions play an important role. A description of the computer model EcoSense, which was used for the calculations, including exposure-response functions and monetary values is given in section *a)*, below.

In addition to these regional scale calculations, damages on the local scale – up to about 20 km to each side of a line emission source (e.g. road) – were quantified using a Geographical

Information System. Such detailed, location specific calculations were carried out for emissions from operation of vehicles, aircrafts or vessels as well as for emissions from power plants. For fuel production (comprising the processes fuel extraction, transportation and refining), no information was available on the location of emissions. In this case, an average damage factor per tonne of pollutant emitted in Germany was used.

a) Description of the EcoSense computer model for assessment of costs due to airborne emissions

The EcoSense model has been developed within the series of ExternE Projects on 'External Costs of Energy' funded by the European Commission (see e.g. European Commission 1999a). The model supports the quantification of environmental impacts by following a detailed site-specific 'impact pathway' (or damage function) approach, in which the causal relationships from the release of pollutants through their interactions with the environment to a physical measure of impact are modelled and, where possible, valued monetarily. A schematic flowchart of the EcoSense model is shown in figure 1. EcoSense provides harmonised air quality and impact assessment models together with a comprehensive set of relevant input data for the whole of Europe, which allow a site specific bottom-up impact analysis.

In ExternE, EcoSense was used to calculate external costs from individual power plants in a large number of case studies in all EU countries. While the first generation of the EcoSense model was focused on the analysis of single emission sources, the new 'multi-source' version of the model provides a link to the CORINAIR database, which allows the analysis of environmental impacts from more complex emission scenarios. The CORINAIR database provides emission data for a wide range of pollutants according to both a sectoral ('Selected Nomenclature for Air Pollution' - SNAP categories) and geographic ('Nomenclature of Territorial Units for Statistics' - NUTS categories) disaggregation scheme (McInnes, 1996). A transformation module implemented in EcoSense supports the transformation of emission data between the NUTS administrative units (country, state, municipality) and the grid system required for air quality modelling (EMEP 50 x 50 km^2 grid). Based on this functionality, EcoSense allows a user to change emissions from a selected sector (e.g. road transport) within a specific administrative unit, creates a new gridded European-wide emission scenario for air quality modelling, and compares environmental impacts and resulting damage costs between different emission scenarios. In other words, environmental damage costs are calculated by comparing the results of two model runs:

- A model run using the 'full' European emission scenario as an input to air quality and damage modelling, including emissions from all emission sources in Europe, as well as the emissions from the transport sector considered.
- A second model run in which the emissions from the transport sector considered were set to zero.

The difference in impacts and costs resulting from the two model runs represents the damages due to the transport sector considered.

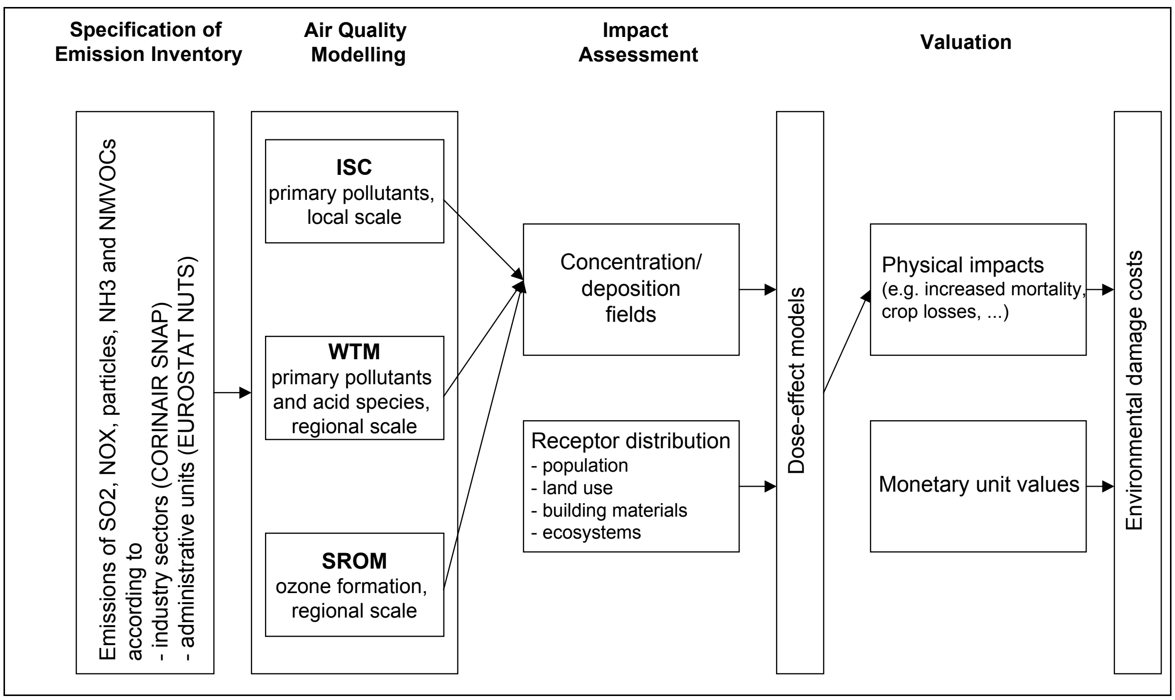

Figure 1: Flowchart of the EcoSense model

In addition to these Europe-wide impacts local scale impacts were quantified using a Geographical Information System and spatially highly disaggregated data (see chapter 2.2.5).

b) Air quality models

Within the UNITE project two air quality models were used from the three available within the Eco-Sense system. The model for local scale effects was not required as they were covered within the GIS environment used.

- The Windrose Trajectory Model (WTM) (Trukenmüller et al. 1995) is used in EcoSense to estimate the concentration and deposition of acid species on a regional scale.
- The Source-Receptor Ozone Model (SROM), based on the EMEP country-to-grid matrices (Simpson et al. 1997), is used to estimate ozone concentrations on a European scale.

c) Dose-effect models

The dose-response functions used within UNITE are the final recommendations of the expert groups in the final phase of the ExternE Core/Transport project (Friedrich and Bickel 2001). The following table give a summary of the dose-response functions as they are implemented in the EcoSense version used for this study.

Table 37
Health and environmental effects included in the analysis of air pollution costs

Impact category	Pollutant	Effects included
Public health – mortality	$PM_{2.5}$, PM_{10} 1) SO_2, O_3	Reduction in life expectancy due to acute and chronic mortality Reduction in life expectancy due to acute mortality
Public health – morbidity	$PM_{2.5}$, PM_{10}, O_3	respiratory hospital admissions
		restricted activity days
	$PM_{2.5}$, PM_{10} only	cerebrovascular hospital admissions
		congestive heart failure
		cases of bronchodilator usage
		cases of chronic bronchitis
		cases of chronic cough in children
		cough in asthmatics
		lower respiratory symptoms
	O_3 only	asthma attacks
		symptom days
Material damage	SO_2, acid deposition	Ageing of galvanised steel, limestone, natural stone, mortar, sandstone, paint, rendering, zinc
Crops	SO_2	Yield change for wheat, barley, rye, oats, potato, sugar beet
	O_3	Yield loss for wheat, potato, rice, rye, oats, tobacco, barley, wheat
	Acid deposition	increased need for liming
	N, S	fertilisational effects

1) including secondary particles (sulphate and nitrate aerosols).

Source: IER.

d) Exposure-response functions for the quantification of health effects

Table 38 lists the exposure response functions used for the assessment of health effects. The exposure response functions are taken from the 2nd edition of the ExternE Methodology report (European Commission 1999a), with some small modifications resulting from recent recommendations of the health experts in the final phase of the ExternE Core/ Transport project (Friedrich and Bickel 2001).

Table 38
Quantification of human health impacts due to air pollution[1)]

Receptor	Impact Category	Reference	Pollutant	f_{er}
ASTHMATICS (3.5% of population)				
Adults	Bronchodilator usage	Dusseldorp et al., 1995	PM_{10} Nitrates $PM_{2.5}$ Sulphates	0.163 0.163 0.272 0.272
	Cough	Dusseldorp et al., 1995	PM_{10}, Nitrates $PM_{2.5}$ Sulphates	0.168 0.168 0.280 0.280
	Lower respiratory symptoms (wheeze)	Dusseldorp et al., 1995	PM_{10} Nitrates $PM_{2.5}$ Sulphates	0.061 0.061 0.101 0.101
Children	Bronchodilator usage	Roemer et al., 1993	PM_{10} Nitrates $PM_{2.5}$ Sulphates	0.078 0.078 0.129 0.129
	Cough	Pope and Dockery, 1992	PM_{10} Nitrates $PM_{2.5}$ Sulphates	0.133 0.133 0.223 0.223
	Lower respiratory symptoms (wheeze)	Roemer et al., 1993	PM_{10} Nitrates $PM_{2.5}$ Sulphates	0.103 0.103 0.172 0.172
All	Asthma attacks (AA)	Whittemore and Korn, 1980	O_3	4.29E-3
ELDERLY 65+ (14% of population)				
	Congestive heart failure	Schwartz and Morris, 1995	PM_{10} Nitrates $PM_{2.5}$ Sulphates CO	1.85E-5 1.85E-5 3.09E-5 3.09E-5 5.55E-7
CHILDREN (20% of population)				
	Chronic cough	Dockery et al., 1989	PM_{10} Nitrates $PM_{2.5}$ Sulphates	2.07E-3 2.07E-3 3.46E-3 3.46E-3
ADULTS (80% of population)				
	Restricted activity days (RAD)	Ostro, 1987	PM_{10} Nitrates $PM_{2.5}$ Sulphates	0.025 0.025 0.042 0.042
	Minor restricted activity days (MRAD)	Ostro and Rothschild, 1989	O_3	9.76E-3
	Chronic bronchitis	Abbey et al., 1995	PM_{10} Nitrates $PM_{2.5}$ Sulphates	2.45E-5 2.45E-5 3.9E-5 3.9E-5
ENTIRE POPULATION				
	Chronic Mortality (CM)	Pope et al., 1995	PM_{10} Nitrates $PM_{2.5}$ Sulphates	0.129% 0.129% 0.214% 0.214%
	Respiratory hospital admissions (RHA)	Dab et al., 1996	PM_{10} Nitrates $PM_{2.5}$ Sulphates	2.07E-6 2.07E-6 3.46E-6 3.46E-6
		Ponce de Leon et al., 1996	SO_2 O_3	2.04E-6 3.54E-6
	Cerebrovascular hospital admissions	Wordley et al., 1997	PM_{10} Nitrates $PM_{2.5}$ Sulphates	5.04E-6 5.04E-6 8.42E-6 8.42E-6
	Symptom days	Krupnick et al., 1990	O_3	0.033
	Cancer risk estimates	Pilkington et al., 1997; based on US EPA evaluations	Benzene Benzo-[a]-Pyrene 1,3-buta-diene Diesel particles	1.14E-7 1.43E-3 4.29E-6 4.86E-7
	Acute Mortality (AM)	Spix et al. / Verhoeff et al.,1996	PM_{10} Nitrates $PM_{2.5}$ Sulphates	0.040% 0.040% 0.068% 0.068%
		Anderson et al. / Touloumi et al., 1996	SO_2	0.072%
		Sunyer et al., 1996	O_3	0.059%

1) The exposure response slope, f_{er}, has units of [cases/(yr-person-µg/m^3)] for morbidity, and [%change in annual mortality rate/(µg/m^3)] for mortality. Concentrations of SO_2, PM_{10} , PM_{10}, sulphates and nitrates as annual mean concentration, concentration of ozone as seasonal 6-h average concentration.

Source: Friedrich and Bickel 2001.

e) Exposure-response functions for the quantification of impacts on crops

Functions are used within the model to quantify changes in crop yields due to the emissions of SO_2, nitrates, ozone and acids.

f) Exposure-response functions for the quantification of material damage

Functions were developed to quantify and value damages to limestone, sandstone, natural stone, mortar, rendering, zinc and galvanised steel and paint due to the effects of air pollution.

g) Acidification and eutrophication of ecosystems

There are no effect models available to quantify the expected damage to ecosystem resulting from exceeding of critical loads. Therefore, such effects were not quantified in the present study.

3.5.1.2 Monetary values

Table 39 summarises the monetary values used for valuation of transboundary air pollution. According to Nellthorp et al. (2001) average European values should be used for transboundary air pollution costs, except for the source country, where country specific values were used. These were calculated according to the benefit transfer rules given in Nellthorp et al. (2001).

Table 39
Monetary values (factor costs) for health impacts (€$_{1998}$)

Impact	Monetary value (rounded)
Year of life lost (chronic effects)	75 000
Year of life lost (acute effects)	130 000
Chronic bronchitis	138 000
Cerebrovascular hospital admission	14 000
Respiratory hospital admission	3 600
Congestive heart failure	2 700
Chronic cough in children	200
Restricted activity day	100
Asthma attack	70
Cough	34
Minor restricted activity day	34
Symptom day	34
Bronchodilator usage	32
Lower respiratory symptom	7

Source: Own calculations based on Friedrich and Bickel 2001 and Nellthorp et al. (2001).

3.5.1.3 Discussion of uncertainties

In spite of considerable progress made in recent years the quantification and valuation of environmental damage is still linked to significant uncertainty. This is the case for the Impact Pathway Methodology as well as for any other approach. While the basic assumptions underlying the work in ExternE are discussed in detail in European Commission (1999a), an indication of the uncertainty of the results is given below as well as the sensitivity to some of the key assumptions.

Within ExternE, Rabl and Spadaro (1999) made an attempt to quantify the statistical uncertainty of the damage estimates, taking into account uncertainties resulting from all steps of the impact pathway, i.e. the quantification of emissions, air quality modelling, dose-effect modelling, and valuation. Rabl and Spadaro show that - due to the multiplicative nature of the impact pathway analysis - the distribution of results is likely to be approximately lognormal, thus it is determined by its geometric mean and the geometric standard deviation σ_g. In ExternE, uncertainties are reported by using uncertainty labels, which can be used to make a meaningful distinction between different levels of confidence, but at the same time do not give a false sense of precision, which seems to be unjustified in view of the need to use subjective judgement to compensate the lack of information about sources of uncertainty and probability distributions (Rabl and Spadaro 1999). The uncertainty labels are:

A = high confidence, corresponding to σ_g = 2.5 to 4;

B = medium confidence, corresponding to σ_g = 4 to 6;

C = low confidence, corresponding to σ_g = 6 to 12.

According to ExternE recommendations, the following uncertainty labels are used to characterise the impact categories addressed in this report:

Mortality:	B
Morbidity:	A
Crop losses:	A
Material damage:	B.

Beside the statistical uncertainty indicated by these uncertainty labels, there is however a remaining systematic uncertainty arising from a lack of knowledge, and value choices that influence the results. Some of the most important assumptions and their implications for the results are briefly discussed in the following.

- **Effects of particles on human health**

  The dose-response models used in the analysis are based on results from epidemiological studies which have established a statistical relationship between the mass concentration of particles and various health effects. However, at present it is still not known whether it is the number of particles, their mass concentration or their chemical composition which is the driving force. The uncertainty resulting from this lack of knowledge is difficult to estimate.

- **Effects of nitrate aerosols on health**

  We treat nitrate aerosols as a component of particulate matter, which we know cause damage to human health. However, in contrast to sulphate aerosol (but similar to many other particulate matter compounds) there is no direct epidemiological evidence supporting the harmfulness of nitrate aerosols, which partly are neutral and soluble.

- **Valuation of mortality**

  While ExternE recommends to use the Value of a Life Year Lost *rather than the* Value of Statistical Life *for the valuation of increased mortality risks from air pollution (see European Commission, (1999 a) for a detailed discussion), this approach is still controversially discussed in the literature. The main problem for the* Value of a Life Year Lost *approach is that up to now there is a lack of empirical studies supporting this valuation approach.*

- **Impacts from ozone**

  As the EMEP ozone model, which is the basis for the Source-Receptor Ozone Model (SROM) included in EcoSense does not cover the full EcoSense modelling domain, some *of the ozone effects in Eastern Europe are omitted. As effects from ozone are small compared to those from other pollutants, the resulting error is expected to be small compared to the overall uncertainties.*

- **Omission of effects**

  The present report is limited to the analysis of impacts that have shown to result in major damage costs in previous ExternE studies. Impacts on e.g. change in biodiversity, potential effects of chronic exposure to ozone, cultural monuments, direct and indirect economic effects of change in forest productivity, fishery performance, and so forth, are omitted because they currently cannot be quantified.

3.5.2 Global warming

The method of calculating costs of 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 difference how and where the emissions take place.

A shadow value of € 20 per tonne of CO_2 emitted, was used for valuing CO_2 emissions, which reflects the costs of meeting the Kyoto targets in Germany (Fahl et. al. 1999) and Belgium (Duerinck 2000). This value lies within a range of values of € 5 to € 38 per tonne of CO_2 avoided presented by Capros and Mantzos (2000). These authors calculated shadow prices for the EU to meet the Kyoto targets with and without emission trading.

Looking further into the future, more stringent reductions than the Kyoto aims are assumed to be necessary to reach sustainability. Based on a reduction target of 50% in 2030 compared to 1990, INFRAS/IWW (2000) use avoidance costs of € 135 per t of CO_2; however one could argue that this reduction target has not yet been accepted.

A valuation based on the damage cost approach, as e.g. presented by ExternE (Friedrich and Bickel 2001), would result in substantially lower costs. Due to the enormous uncertainties involved in the estimation process, such values have to be used very cautiously.

3.5.3 Noise

Noise costs were quantified for a number of health impacts calculated with new exposure-response functions, plus amenity losses estimated by hedonic pricing.

The methodology for quantifying noise costs was extended to the calculation of physical impacts. Costs for the following endpoints were quantified:

- Myocardial infarction (fatal, non-fatal)
- Angina pectoris
- Hypertension
- Subjective sleep quality

A large number of hedonic pricing studies has been conducted, giving NSDI values (Noise Sensitivity Depreciation Index – the value of the percentage change in the logarithm of house price arising from a unit increase in noise) ranging from 0.08% to 2.22% for road traffic noise. Soguel (1994) conducted a hedonic pricing study in the town of Neuchatel in Switzerland. Rather than using housing prices, the dependent variable was monthly rent, net of charges. The coefficient on the noise variable in this study suggested a NSDI of 0.9. This value is similar to the average derived from European studies and was taken for our calculations.

Table 40
Valuation of health impacts due to noise exposure
– in € –

Endpoint	Value	Unit
Myocard infarction (fatal, 7 years of life lost)	80600	€ per YOLL
Myocard infarction (non-fatal)	680	€ per cardiology-related inpatient day
Myocard infarction (non-fatal)	100	opportunity costs due to absenteeism from work in € per day
Myocard infarction	14360	€ per case to avoid morbidity (disutility)
Angina pectoris	680	€ per cardiology-related inpatient day
Angina pectoris	100	opportunity costs due to absenteeism from work per day
Angina pectoris	230	€ per day to avoid morbidity (Disutility)
Hypertension	350	€ per inpatient day
Subjective sleep quality (COI)	220	€ per year
Subjective sleep quality (WTP)	370	€ per year

COI = Cost of illness. – WTP = Willingness-to-pay. – YOLL = Year of life lost.

Source: Metroeconomica (2001) and own calculations

As railway noise is perceived as less annoying than road noise, a bonus of 5 dB(A) was applied. This is in line with noise regulations in a number of European countries (e.g. Switzerland, France, Denmark, Germany; see INFRAS/IWW 2000).

Estimates of exposure due to air transport noise are taken from IWW/Infras 1995, which are based on the OECD Environmental Data Compendium 1993, including interpolation of data for noise intervals not covered by OECD data. The reference year of the data is 1990; it is assumed that the introduction of quieter aircraft is compensated by the aircraft movements up to 1996. From 1996 to 1998 an increase according to the increase in aircraft movements is assumed, as for 1998 to 2005.

The costs due to amenity losses and health effects were quantified based on the same approach as for road and rail transport. The valuation of amenity losses due to aircraft noise has to be interpreted with caution, because of a lack of empirical data to date. For the physical endpoint "hypertension" only hospital admissions are included, leading to an underestimation, because the major share of hypertension cases needs a long-term medical treatment, which is neglected in the current approach. Costs due to sleep disturbance could not be quantified because of a lack of noise exposure data for the time between 23.00 and 7.00 hours (IWW/Infras 2000).

3.5.4 Costs due to impacts on nature, landscape, soil and groundwater

3.5.4.1 General approach

The methodology applied to determine the annual costs of the year of investigation (here 1998) follows the approach taken by INFRAS/IWW (2000). According to this methodological approach, the costs of nature and landscape are defined as the share of the accounting period at the total loss of ecological resources caused by the construction of transport infrastructure from a defined base year until the year of accounting.

The damages to nature and landscape are monetarised by estimating the costs of compensating nature for the land taken by new infrastructure. This includes the “installation” of new biotopes where natural areas are destroyed, the remediation of soil and groundwater and the alternative unsealing of sealed ground. The result of this approach was total compensation or repair costs discounted to the year of accounting.

In contrast to the cost categories accidents and environmental health, in the cost category nature and landscape we do not explicitly consider the infrastructure built in the accounting year. In order to express the long-term impacts of consuming natural resources we consider the development of ecology from a state where nature is considered to be more or less intact. According to INFRAS/IWW (2000) the year 1950 was used as the reference year. The costs for the reporting period then are determined by subdividing the total costs after the reference year by the respective number of years. We do not apply a discount rate on past costs caused to changes of nature and landscape, damages in the future are valued as high as damages caused today.

We assume further that the average damage to natural resources caused by the installation of infrastructure projects did not differ in general and that accordingly the average costs per additional square metre of transport assets constructed is equal over time. Transport infrastructure was considered separately for each mode.

The estimation of costs associated with repair and compensation measures is a very complex task, because the growth of alternative biotopes e.g. takes a long time. In this field no time series of respective cost estimates, which would allow to determine the development of the scarcity of nature are available. Further, the minor importance of the costs associated with nature and landscape effects in comparison to other cost blocks does not justify evaluate the total project installation reports of the infrastructure constructed in the period between the reference year and accounting year. Accordingly, it is assumed that the negative scarcity effect and the positive influence of improved construction practices are balancing out and that the costs of the accounting period is determined as the total costs divided by the number of years since the reference year.

The cost values used are characterised by the cost category, the type of area affected and the type of infrastructure. These elements are briefly discussed below.

Due to the similarity of the costs of nature and landscape and the costs of soil and water pollution they were commonly treated and estimated in the UNITE accounts (see Bickel et al. 2000). The cost categories considered under the joint cost item “Nature, landscape, soil and groundwater effects” are:

- **Habitat losses and deterioration of biodiversity.** Included are the loss of natural habitats and barrier effects caused by the existence of transport infrastructure. For the monetarisation a compensation costs approach is used, which estimates the costs for establishing new natural areas of the same type destroyed somewhere else.
- **Sealing effects:** Starting from the idea that every newly sealed area has to be unsealed at another location, sealing effects are valued by a compensation cost approach, estimating the de-sealing costs per square metre of directly covered ground.
- **Soil and groundwater contamination:** The sources for soil and groundwater contamination are manifold (see Bickel et. al. 2000). Here, the single pollutants are considered jointly by applying a decontamination cost value per m^3. Starting from a constant depth of pollution (20 cm), out of this a value per m^2 of impaired land can be computed.[8]
- **Groundwater pollution and winter maintenance:** These two effects are summarised together as (1) they are both hardly quantifiable and as (2) the use of de-icing salts for winter maintenance directly impacts the quality of groundwater.

3.5.4.3 Valuation

Table 41 summarises the cost values applied by cost type and type of biotopes. The following sections discuss these values more in detail.

a) Habitat loss and biodiversity

For the estimation of the economic costs due to the loss or deterioration of natural habitats a compensation cost approach according to IWW et. al (1998) was applied. The costs associated are:

- Annual costs for building up an alternative habitat (€ 300-400), discounted over the time the biotope requires to grow (up to 50 years).
- Opportunity costs of the land used for the compensation habitat (up to € 700 /a) discounted over the period of lost use (150 years).

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[8] Due to the non-availability of monetary estimates of groundwater pollution this item is - as stated in IR 9,2 - not considered explicitly.

- Initial costs for establishing the compensation habitat (up to € 90 000).
- Costs of purchasing the area of the alternative habitat (€ 60 000).

Table 41
Valuation of effects on nature and landscape
– in €/ m²–

Nomenclature according to the CORINE land use data set Affected area: Description	Habitat loss Sealed + Impaired €/m²	Ground sealing Sealed €/m²	Soil & water Impaired €/m²	Other effects Sealed e/ m²
Artificial surfaces		25,6	7.2	10
Agricultural areas	7,3	25,6	7.2	10
Forests and semi-natural areas	40,0	25,6	7.2	10
Wetlands	46,9	25,6	7.2	10
Water bodies	51,7	25,6	7.2	10
Average	10,2	25,6	7.2	10

Source: IWW.

Out of the detailed values of different classes of target biotopes, mean figures for biotopes were derived and applied to the "compensation area" by infrastructure asset. The values used for the German accounts are given in table 42 by type of target biotope.

b) Unsealing costs

The costs of unsealing ground covered by solid transport infrastructure contain the costs for transport and deposit of materials sealing ground elsewhere. According to INFRAS/IWW (2000) cost estimates range between € 13 and 42 per m^2. Here, a mean value of € 25.6 per square metre was applied.

Unsealing costs are applied to the sealed area associated to transport infrastructure whereby sealing factors were considered.

Table 42
Compensation costs by target biotopes

Group of biotope structure	Target biotope	Total compensation costs in € per ha (dependent on developing time)
Waters	Springs	376.656
	Irregular small running waters	949.246
	Oligotrophic still waters	419.859
	Dystrophic still waters	1.004.010
	Mesotrophic still waters	363.269
Average costs		**517.217**
Extensive used biotopes of dry Habitats	Xeric grassland communities	541.557
	Miniature bush land	632.830
	Semidry grassland communities	296.335
	Bristly grassland communities	288.425
Average costs		**438.113**
Extensive used biotopes of humid Habitats	Bog, fen, marsh	614.576
	Reed	443.590
	Peat dig	620.661
	Temporary still waters	299.377
Average costs		**468.538**
Forests, other wooded area	Field wood	444.198
	Natural mixed deciduous forest	626.746
	Mountainous coniferous forest	498.962
	Pine forest	389.434
	Low forest	295.118
	Middle forest	486.793
	Deciduous/mixed forest	262.868
	Coniferous forest	174.637
Average costs		**395.519**
Natural forest		**456.368**
Silviculture		**219.057**
Green land, extensive	Fresh	190.458
	Humid, wet	226.967
Average costs		**206.887**
Green land, intensive		**73.019**
Arable land, extensive	Fallow	92.491
	Extensive culture	147.863
Average costs		**121.698**
Arable land, intensive		**73.019**
Special cultures, extensive		**304.245**
Special cultures, intensive		**73.019**
Source: IWW.		

c) Soil and groundwater pollution

Ground material contaminated by transport activities along infrastructure assets has to be carried off and deposited. Therefore, the costs applied per m^2 need to take into consideration the treatment costs per m^3 of ground and the depth of contamination. In both cases we followed INFRAS/IWW (2000) and assumed costs of € 35 / m^3 and a contamination depth of

20 cm. The resulting cost value of € 7.2 / m^2 was applied to the contaminated area (impaired) area alongside or around the infrastructure facilities for all types of biotopes.

d) Further Effects

For estimating the costs of further effects on nature and landscape such as barrier effects and visual intrusion we used a unit value of € 10 / m^2 from INFRAS/IWW (2000) which was based on expert estimates.

3.5.5 Costs due to nuclear risks

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 (1999b) was adapted to the UNITE valuation conventions, resulting in a value of €67 per Gigawatthour (GWh; 1 GWh = 10^9 Wh). As sensitivity, a shadow price for Switzerland of €15000 per GWh was also applied. This shadow price was based on damage density functions for the calculation of the risk of nuclear power production (see Zweifel and Umbricht 2000).

3.5.6 Methodology for 1996 and for the forecast to 2005

Concerning environmental costs, the quantifiable differences between the account years 1996 and 1998 are quite small. Firstly, the activities (vehicle mileage, number of starts and landings of aircraft) and emission factors do not change considerably within two years. Secondly, the actual changes are difficult to detect, as much of the required data is not available in sufficient detail. It has to be born in mind that the estimates changes from 1996 to 1998 are comparably rough and thus have to be interpreted with caution. This is even more the case for the forecast to the year 2005, as the estimation of future developments is even more uncertain.

According to Nellthorp et al. (2001) values change proportionally to real incomes. Hence, values were adjusted according to changes in real GDP per capita. This results in a factor of 0.982 for the 1996 values relating to 1998 values (based on Nellthorp et al. (2001) - Annex 2) and a factor of 1.157 for 2005 values relating to 1998 values (assuming growth rate of 2.1% per year – source: DIW). These factors were applied for all cost categories and modes.

Table 43 shows the basis, on which the 1996/2005 air pollution and global warming costs were estimated.

Table 43
Basis of estimations for the year 1996 and the forecast for 2005 of air pollution and global warming costs from 1998

Mode	1996	2005
Road	Mileage	mileage, change of specific emissions per km
Rail	emission data DB (1999) power plant mix as 1998	mileage; change in specific energy use per km power plant mix and diesel emission factors as 1998
Public Transport	energy consumption calculated as for 1998 (from mileage data and consumption factors per km) power plant mix as 1998	energy consumption forecast; share tram/trolley bus – metro and other estimated based on energy consumption forecast and (total) mileage forecast power plant mix as 1998
Aviation	number of take-offs	costs due to pollutants: increase in number of landings and take-offs at German airports + specific emission forecast (NO_x) CO_2 and fuel production: fuel use forecast
IWW	emission data (except diesel use/CO_2) Gohlisch (2001); diesel use/CO_2 based on Diekmann et al. (1999).	diesel use from forecast; assumption that emission factors per kg diesel as for 1998; emissions rise proportionally to increase in diesel use (+ 11.2%)
Source: IWW.		

The changes in noise costs for road and rail were estimated according to the changes of mileage. Costs of the category “nature, landscape, soil and water pollution” were only adjusted by the valuation changes. These costs are defined as the assessment of an average annual increase in the land occupancy by transport infrastructure. As with roughly 50 years, the averaging period is rather long, fluctuations in the actual additional building activities in transport are negligible within the comparably narrow time horizon (1996 to 2005) of the UNITE accounts.

3.6 Methodology for estimating taxes, charges and subsidies

3.6.1 General issues

The general methodology for collecting, supplementing and estimating transport related taxes, charges and subsidies was as far as practically possible based on "Accounts Approach for Taxes, Charges and Subsidies", Macario et al. (2000). For the German pilot accounts it was fine-tuned by using the methodology described for example in BMV (1969), DIW (1994), DIW (2000) for the revenues. For quantifying subsidies the definitions given in DIW (2001) were applied.

Before discussing the methodology in detail per mode it seems to be necessary describe the following methodological issues and problems:

- The aim of the UNITE accounts was not to compile a complete data set of all taxes, charges and subsidies of the transport sector. The aim was rather to define 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.
- Although the scope of taxes and charges included in the analysis was defined along 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 changing justification of taxation purposes, levels, structures and (eventually existing) earmarking procedures (see "The Accounts Approach" Link et al. (2000 b) for a more detailed discussion). Furthermore, the example of fuel taxation shows that taxes can be linked to different cost categories. An example for this is the situation in Germany: the fuel tax includes a part earmarked for infrastructure financing, a part dedicated to general revenue raising and since 1999 an eco-tax part, initiated due to environmental concerns but earmarked for funding social security systems.
- 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 in the German pilot account 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 were quantified whenever possible and reported separately. It should be noted, however, that due to the fact that certain modes or user groups are exempted from taxes the accounts show either no entries or lower numbers (in case of tax reduction) at the revenue side. Thus, indirectly these tax exemptions are considered even when not quantitatively reported. This data is additional information only.
- VAT is reported as an additional information if and only if VAT rates in transport differ from those paid in other sectors of the economy. Note, that the basic principle for the UNITE accounts is a net principle, e.g. a reporting on a factor cost basis (see Nellthorp et al. 2001).

3.6.2 Methodological issues per mode

3.6.2.1 Road transport

1. Revenues that relate directly to a specific cost category

Infrastructure use charges are recorded as fixed charges or variable charges. Under fixed charges falls the HGV-Vignette to be paid for motorway use according to the Euro-Vignette agreement. For the forecast year 2005 the HGV charge for motorway use is recorded as a variable charge as it will be distance related.

2. Other revenues (that do not relate directly to a specific cost category)

Taxes falling under this heading include:

- fuel tax (without eco-tax)
- eco-tax: relevant for 2005 only
- vehicle circulation tax
- insurance tax

The total revenues from the HGV vignette in 1996 and 1998 were obtained from BAG (Bundesamt für Güterverkehr). The vignette revenues per vehicle type were estimated by using the mileage driven and information of BAG on revenues by axle configurations. For 2005 we have estimated the revenues from the new distance-related HGV charging scheme by using our mileage forecast. Note, that the charge level has not yet been defined. Under discussion recently was an average charge of € 0.12 per vehicle-km combined with a possible reduction of the circulation tax. In order to be consistent with all other forecasts for the German pilot account, all which were based on the official forecasts for the federal master plan on transport infrastructure (see BVU/ifo/ITP/Planco 2001), we have used the charge level which was assumed here, specifically € 0.08 per vehicle-km with no reduction in other taxes.

The total revenues from fuel taxation were taken from BMVBW/DIW (2000). This total was disaggregated to vehicle types by using the mileage figures and specific fuel consumption per vehicle type, fuel type and operation as single vehicle/ vehicle with trailer. The forecast for 2005 was based on our mileage forecasts and on the assumptions regarding specific fuel consumption as described in chapter 2.

The revenues from the annual circulation tax were obtained by the Federal Ministry of Finance. The allocation of revenues to road types was made using our own estimates. We have used the share of capital costs of road types in total road capital costs as an indicator for this allocation procedure. This is based on the underlying idea that the annual circulation tax is a proxy for the provision costs of roads. The total revenues from the circulation tax in 2005 were obtained from the Ministry of Finance, the structure per vehicle group was extrapolated by using the shares of 1998.

Finally, it has to be mentioned that we did not estimate the revenues from parking charges. According to information provided by selected municipalities, the annual revenues from parking meters balanced with the costs of operating these parking schemes.

3.6.2.2 Rail transport – German National Railways (DB)

1. Revenues that relate directly to a specific cost category

Here we have considered the revenues from track access charges and station charges as being directly related to infrastructure costs. For 1998 DB has officially reported these figures, however, without any disaggregation by transport types (regional passenger transport, long-distance transport, freight). For 1996 the situation is different: no official information from DB was published. However, the linear structure of the track access charges at that time, the knowledge about the basic prices and available data sets at DIW allowed to estimate the total track access charges paid and also the amount paid by different types of transport. It was not possible to estimate the revenues from station charges in 1996.

The tariff revenues of DB (given in the business report) were also included in the analysis of UNITE as this revenue category directly corresponds to the supplier operating costs.

2. Other revenues (revenues that do not relate directly to costs)

Under this category falls the fuel tax paid for diesel consumption in the rail sector which was calculated based on information on energy consumption. The 2005 figure was estimated by using the official mileage forecast and the specific energy consumption from the federal master plan on transport infrastructure.

A special problem when discussing rail is to quantify the level of subsidisation. Subsidies to DB are granted for several purposes. First of all, the financial measures taken within the railway reform process 1994 have to be mentioned. They contained the taking over of outstanding debts of the two former rail companies DB and DR, subsidies for additional costs of material and personnel arising from the outmoded technology used at the East German DR and for costs of "catching up" investments for the East German DR and expenses arising from DR's ecological legacies, the taking over of obligations concerning civil servants employed by DB and the adjustment of the opening balance sheet of DB AG. Since these subsidisation measures are only available as total figures, an allocation to single years is only partly possible. The methodology applied for the German pilot accounts used here was to analyse the federal budget plans.

Second, there are subsidies for infrastructure financing. These subsidies are already reflected at the cost side since the input data for the capital stock model contain all investments independent of the financial source. Third, DB receives compensation payments for reduced tariffs for certain social groups. Furthermore, since 1996 regional rail passenger transport has been regionalised meaning that from 1996 onwards regional authorities have functional and financial responsibility for this type of transport. The federal government transfers parts of fuel tax revenues to the federal states (Länder) who use these revenues to pay regional rail services ordered either from DB or competing companies. It was possible to quantify the total amount of these transfers, however, a breakdown to DB and competing companies was not made.

3.6.2.3 Non-DB railways

1. Revenues that relate directly to a specific cost category

The definition and estimation of direct allocatable revenues from taxes and charges of non-DB railways was complicated. The company survey carried out by VDV which was used for the infrastructure cost calculation for non-DB railways also contained a questionnaire on infrastructure user charges. However, only one third of the companies who took part in the survey filled in the respective questions. Given the fact that the total number of companies approached in the survey represented only half of all companies, the number of answers on track revenues was not sufficient for exploding the sample. Therefore, we do not report figures on infrastructure user charges in the German pilot accounts.

Tariff revenues, as the corresponding item to the supplier operating costs, were taken from BMVBW/ DIW (2000). They include subsidies paid for reduced tariffs for certain social groups.

2. Revenues that do not relate directly to a specific cost category

Revenues from fuel taxes paid for Diesel traction were calculated out of energy consumption figures given in BMVBW/ DIW (2000).

It was not possible to quantify subsidies paid to non-DB railways. Due to the fact that they are partly in the ownership of federal states and municipalities, this would have required an analysis of all respective public budget plans.

3.6.2.4 Public transport excluding rail

1. Revenues that relate directly to a specific cost category

Taxes and charges which could be directly compared with infrastructure costs do not exist for this mode of transport. For tariff revenues and at least parts of subsidies, the federal Statistical Office provides a good data base. VAT was estimated considering the reduced VAT rates for scheduled public transport and the special forms of scheduled transport such as buses to work, school etc. and was subtracted from the tariff revenues.

2. Revenues that do not relate directly to a specific cost category

Due to lack of data on energy consumption (as a separate figure for public transport excluding rail) it was not possible to estimate revenues of the state from fuel taxation. However, it should be borne in mind that the road account contains the fuel tax paid by buses, most of this item referring to public transport.

The only subsidies for public transport reported in the UNITE account are compensation payments for reduces tariffs or transport types with free tickets. Infrastructure subsidies are already considered at the cost side like in all other modes due to the principle of including all investments independent of their origin and/ or financial source. Subsidies paid to municipal companies for running costs, for debts etc. were not estimated since this would have required to analyse all respective financial flows in all municipal budgets.

3.6.2.5 Aviation

1. Revenues that relate directly to a specific cost category

Included in these revenues are airport revenues which contain start and landing fees, parking fees for aircraft and revenues from ground services.

Detailed information on these revenues was obtained from the German Association of Airports (ADV). The information provided by ADV also includes other, non-transport related airport revenues such as revenues from renting and leasing and from concession charges. These types of revenues are presented separately as additional information. Due to the fact that at the cost side the separation between transport related costs and non transport related costs was not possible, these costs are presented as total costs. Total revenues were also used in this account. The forecast of these revenues to 2005 was done by multiplying the forecasted number of starts and landings with the unit values from 1998. Non-transport related airport revenues were extrapolated by using the forecasted number of passengers.

Further revenues that correspond directly to infrastructure costs are the revenues of the German National Air Control (DFS) and those of the meteorological services provided by DWD. The forecast to 2005 was done by using the forecasted flight-km.

2. Revenues that do not relate directly to a specific cost category

Aviation is exempted from fuel taxes. The tax loss due to this exemption can be considered to be an indirect subsidy. VAT is not charged on the price of international tickets. This can also be considered to be an indirect subsidy. Revenues that are lost because of these exemptions have been calculated for the base year 1998 for Lufthansa, based on the amount of kerosene tanked in Germany and revenues from international ticket sales.

Subsidies for infrastructure financing are – like in all modes – considered at the cost side. Subsidies for compensation payments to DFS for military flights and other flights which are exempted from charges are shown separately.

3.6.2.6 Inland waterways

1. Revenues that relate directly to a specific cost category

These revenues consist of all infrastructure user charges such as canal charges, waterway charges, pilotage charges and charges, fees and other payments at inland waterway harbours. Revenues of companies operating waterborne transport were not estimated since in the UNITE conventions it was agreed to estimate supplier operating costs (and the respective revenues) for rail and public transport only.

As diesel for inland waterway ships is exempt from tax, it would be theoretically possible to estimate the revenue loss due to this exemption. The amount of diesel tanked in Germany in the shipping sector is low, due to the relative high fuel price the majority of fuel is tanked outside of Germany for example in the Netherlands. Because of this situation, no fuel tax revenue loss was calculated for shipping.

In contrast to waterways, no data on revenues of inland waterway harbours were available. Extrapolation of the waterway user charges was done by using the forecasted tonne-km. No further revenues were estimated.

3.6.2.7 Maritime shipping

1. Revenues that relate directly to a specific cost category

Revenues in maritime shipping which have a direct relation to infrastructure costs are charges, fees and other payments at seaports and pilotage charges, as far as they do not belong to such coastal areas which are still defined as inland waterways. It was not possible to estimate these revenues.

Revenues of operators in maritime shipping as a category corresponding to supplier operating costs were not estimated since in the UNITE conventions it was agreed to estimate supplier operating costs (and the respective revenues) for rail and public transport only.

2. Revenues that do not relate directly to a specific cost category

No such revenues were estimated.

3.7 Excursion: The German transport forecast used as a basic for the pilot accounts 2005

Forecast

The 2005 forecast for the UNITE accounts is based on an official transport forecast for Germany up to the year 2015. This study, which has not yet been published, was made available by the German Ministry of Transport, Building and Housing (BVU/ifo/ITP/Planco 2001).

The forecast for UNITE was carried out by the DIW using 2015 and 1997 as reference years and interpolating for 2005 by assuming a constant yearly growth rate between the years 1998 and 2015.

Forecast model description

The basis prognosis for road, rail, air and water transport uses a model approach to estimate the transport increases over time. This model takes into account the following factors: development of socio-economic data (e.g. population, GDP), transport policy measures (especially congestion costs), present and planned transport infrastructure, the technical condition and the capacity of the infrastructure and other elements of transport supply. The data for these estimations is taken from official sources, for example the German Ministry of Transport, Building and Housing. The models for road, rail and air transport are interconnected, so that changes in one mode are reflected within other modes.

The network model used also considers the whole of the European transport system for land transport and for air transport an intercontinental model is used. Within all modes infrastructure being constructed, officially planed infrastructure and major infrastructure changes within the European transport systems are considered. The so called "Anti-Stau-Programm" (ASP) a new project to prevent road traffic congestion and special projects for increased investment in rail transport infrastructure were also considered.

The forecast makes use of 3 scenarios based on theoretically possible political decisions. For the UNITE pilot accounts 2005 we have used the trend scenario, which is based on minimal political controlling measures but takes into account the introduction of road pricing for heavy goods transport using motorway infrastructure.

a) *Road transport*

2005

For individual road passenger transport the price of fuel, the specific vehicle fuel consumption and the number of vehicles are the most important factors for the prognosis. A fuel price increase of 1.1% p.a. (in real terms) has been estimated but an overall slight reduction in total fuel usage (–0.03% p.a.) is expected due to a reduction of fuel use per kilometre. No effects of possible road pricing instruments (vignette for private vehicles) were taken into account.
For the estimation of vehicle numbers, the main factor taken into account was the population over 18 years old, meaning that part of the population having a drivers licence. It is estimated that in 2015 41.4 million private vehicles will be registered in Germany which results in an average of 719 vehicles per 1000 citizens over 18 years of age. The expected mileage for all vehicles increases at the same rate as the increase in vehicles which actually represents a constancy of miles driven per vehicle.

For road goods transport, the price of diesel fuel is expected to increase by 1.4% p.a. (in real terms). A slight reduction of fuel usage per kilometre is also estimated for these vehicles. The introduction of a kilometre charge on federal motorways for vehicles weighing 12 tonnes and more will be brought into use in 2003. Although the charge per kilometre has not yet been decided on, one can assume that it will be higher than the 0.15DM/km (approximately € 0.08/km) used in this forecast.

For public transport it is assumed, that the extension of infrastructure will continue. The transport performance, expressed in passenger-km, is in BVU/ifo/ITP/Planco 2001 forecasted to decline slightly up to 2015 (annual growth rate -0.16%).

b) *Rail transport*

2005

For rail, not only the future rail network and rolling stock are taken into account for the model approach used but also improvement of services (e.g. reduction of transport time). The passenger ticket prices remain more or less constant over the time frame of the prognosis, estimations for freight transport show a slight decrease in costs. BVU/ifo/ITP/Planco (2001) forecast for all rail companies a slight decrease of regional rail passenger transport (annual growth rate: –0.03%), an increase of long-distance rail passenger transport by 1.79% per year, and an increase of rail freight transport performance by 1.33% per year. No separate forecasts for DB and non-DB companies are made.

c) Air transport

For air transport a similar model to land transport is used taking not only German airlines but also airline alliances into account. The information used for the air transport simulations were developed with the German Aerospace Centre (DLR). The number of possible starts and landings were considered and also the potential changes resulting from a noise related contingent for airlines rather than the present method of airline slot allocation was considered. The competition between European airports and possible resulting changes within Germany were also considered within the model. For the forecast, it was estimated that the prices of air tickets would remain fairly constant over the forecast period. BVU/ifo/ITP/Planco (2001) estimate for 2015 an increase of aircraft-km by 82% (territorial principle) and by 113% (principle of origin) compared by 1997. The passenger-km are forecasted to increase by 120% and 161% respectively.

d) Inland Waterway

For inland waterways the network model is also applied. For this transport mode, the length of the network, the direction of water flow and the number of locks were considered. Changes in the infrastructure in Germany and the European area were considered as was connecting transport in harbours. A reduction of transport costs is estimated for inland waterway shipping. This reduction is based on the use of larger ships and better utilisation of the transport mode on the whole. BVU/ifo/ITP/Planco (2001) estimate an increase of tonne-km in inland navigation by 1.98% per year.

e) Shipping

No estimations of the changes in maritime shipping were carried out in the official prognosis.

f) Fuel and the emission of CO_2

The forecast for fuel usage takes the fluctuating price for crude oil into account. Other factors considered are the natural reserves of crude oil, reaching planned CO_2 reduction levels, the Euro exchange rate and technical improvements that achieve reduced fuel usage. The planned increases in the German eco-tax (0.06 DM/litre*a) are considered.

4 Results

4.1 Infrastructure costs

While in Germany a considerable methodological knowledge as well as the respective data is available for road, German National Railway (DB), inland waterways and airports, it was the first time that infrastructure costs for non-DB railways, public transport infrastructure such as tram and metro, inland waterway harbours and seaports had been estimated. Ultimately the data did not allow for a full disaggregation of costs for all modes. However, capital costs were obtained in each case, and total infrastructure costs for road, rail, air and inland waterways.

In the following we present the results for the core year 1998, the year 1996 and the forecast year 2005 per mode.

4.1.1 Road transport

In 1998 the German road network had a gross value of € 531 billion and a net value of € 397 billion with capital costs of € 21 billion at 1998 prices (see table 44). The respective figures for 1996 in table 44 are € 535 billion (gross value) and € 399 billion (net value). These are expressed at 1996 prices and show the phenomenon that the price index for road construction in Germany has fallen since 1995. Therefore, the values for 1996 are higher than for 1998. A rough correction to 1998 prices would yield a gross value of € 528 billion and a net value of € 394 billion for 1996.[9] For 2005 we estimated at 1998 prices a gross value of € 572 billion and a net value of € 417 billion, e.g. an increase of 8% and 5% respectively, compared to the core year 1998.

Note, that the high values of the capital stock imply a high share of capital costs in total infrastructure costs which was more than 70% in 1998 and for motorways even 78% of the total road network (these figures refer to total infrastructure costs including VAT and non-transport related costs).

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[9] Actually, all investment time series per asset type would have to be transferred to 1998 prices by using asset specific price indices. Due to the expense of time we used the time series at 1996 prices.

Table 44
Capital value, total infrastructure costs and costs of motorised road traffic in Germany 1996, 1998 and 2005[1) 2)]
– € million –

	All roads	Motorways	Other federal roads	Other roads
	1996			
Gross capital value [3)]	535 033	94 120	81 956	358 957
Net capital value [3)]	399 598	71 104	58 602	269 883
Capital costs [4)]	21 226	3 741	3 219	14 266
Running costs	7 905	918	1 401	5 586
Total infrastructure costs[5)]	29 131	4 659	4 620	19 852
Out of these: VAT [6)]	1 470	267	200	1 003
Non-transport related costs	1 456	0	0	1 456
Transport related infrastructure costs [7)]	26 205	4 392	4 420	17 393
Transport related infrastructure costs at 1998 prices [7)]	25 889	4 340	4 367	17 183
	1998			
Gross capital value [3)]	530 789	93 123	81 149	356 517
Net capital value [3)]	396 887	70 374	58 073	268 440
Capital costs [4)]	21 037	3 701	3 187	14 149
Running costs	8 063	1 048	1 341	5 674
Total infrastructure costs[5)]	29 100	4 749	4 528	19 823
Out of these: VAT [6)]	1 469	266	201	1 002
Non-transport related costs	1 455	0	0	1 455
Transport related infrastructure costs [7)]	26 176	4 483	4 327	17 366
	2005			
Gross capital value [3)]	572 032	111 363	88 955	371 714
Net capital value [3)]	417 181	81 499	62 183	273 499
Capital costs [4)]	22 081	4 287	3 381	14 413
Running costs	8 244	1 139	1 374	5 731
Total infrastructure costs[5)]	30 325	5 427	4 755	20 144
Out of these: VAT [6)]	1 516	326	190	1 000
Non-transport related costs	1 516	0	0	1 516
Transport related infrastructure costs [7)]	27 293	5 100	4 565	17 628

[1)] 1996 at 1996 prices, 1998 at 1998 prices, 2005 at 1998 prices. – [2)] Including buses. - [3)] Including land value. As of 31 December.- [4)] Including land costs. Calculated as average over the year. Interest was calculated with a social interest rate of 3%.- [5)] Including VAT. [6)] VAT included in running costs and depreciation - [7)] Excluding VAT.

Source: DIW.

The running costs of infrastructure were € 8.1 billion in 1998. Out of these 30% were spent for motorways and other federal roads. In 1996 € 7.9 billion were spent for running costs of road infrastructure. With the forecast methodology described in chapter 3 we estimate running costs of € 8.2 billion for 2005.

Total transport related infrastructure costs of roads amounted to € 26 176 million in 1998, with motorways and other federal roads accounting for one third of this total. Due to the decreasing price index of road construction we have obtained a higher cost figure for 1996 than for 1998: expressed at 1996 prices, total road infrastructure costs amounted to € 26 205 million. A rough estimate at 1998 prices is included in table 44, the total infrastructure cost figure for 1996 expressed at 1998 prices is € 25 889 million.

As mentioned in chapter 3, cost allocation to vehicle types was carried out by applying the official German method developed by BMV (1969) and used in all DIW infrastructure cost accounts in Germany (see for example DIW (1992) and DIW 2000). Note, that the problem of avoiding arbitrary cost allocation was discussed in detail in interim report 5.2 of the UNITE project (see Link et al. 2000 a). Link et al. (1999) contains a quantitative comparison of European cost allocation methods applied to different data sets. This comparison has shown that, first of all, the different methods used in Europe yield extremely heterogeneous results regarding the share of costs allocated to vehicle types. Furthermore, the comparison has made clear that the German allocation method allocates, from all methods (apart from the UK method), the highest share of costs to HGV. These facts have to be taken into account when interpreting the results of the allocation procedure which are shown in the tables 45 and 46.

In 1998, passenger cars had a share of 52% of road infrastructure costs while 38% were allocated to heavy goods vehicles. This picture changes when analysing motorways where heavy goods vehicles operate more mileage than on other road types: more than half of all infrastructure costs at motorways were allocated to HGV (58%) while the share of passenger cars amounted to 39%. These shares remain unchanged in our forecast for 2005. Note, that the average costs (€ per vehicle-km) are highest for the category other roads. This reflects simply the effect of dividing total costs by mileage which is for the category "other roads" much lower than for motorways and other federal roads.

Table 45
Total road infrastructure costs by vehicle types in Germany 1996, 1998, 2005
– € million –

Vehicle types	All roads	Motorways	Other federal roads	Other roads
	1996 (at 1996 prices)			
Motorcycles [1)]	154	9	26	119
Passenger Cars[2)]	13 752	1 737	2 483	9 532
Buses	372	31	64	277
Light Goods vehicles[3)]	1 226	130	177	920
Heavy Goods vehicles[4)]	9 925	2 483	1 584	5 858
Rigid goods vehicles[5)]	2 137	328	398	1 410
Non rigid goods vehicles[6)]	7 788	2 154	1 186	4 448
Special and agricultural vehicles	775	3	87	685
All vehicles	**26 204**	**4 393**	**4 421**	**17 391**
	1996 (at 1998 prices)			
Motorcycles [1)]	152	9	26	118
Passenger Cars[2)]	13 587	1 716	2 453	9 418
Buses	367	30	63	274
Light Goods vehicles[3)]	1 212	129	174	909
Heavy Goods vehicles[4)]	9 806	2 453	1 565	5 788
Rigid goods vehicles[5)]	2 111	325	393	1 394
Non rigid goods vehicles[6)]	7 694	2 129	1 172	4 394
Special and agricultural vehicles	766	3	85	677
All vehicles	**25 890**	**4 340**	**4 366**	**17 184**
	1998 (at 1998 prices)			
Motorcycles [1)]	172	10	28	134
Passenger Cars[2)]	13 560	1 728	2 441	9 390
Buses	363	30	64	269
Light Goods vehicles[3)]	1 325	128	187	1 010
Heavy Goods vehicles[4)]	10 044	2 580	1 525	5 939
Rigid goods vehicles[5)]	1 977	328	382	1 267
Non rigid goods vehicles[6)]	8 068	2 252	1 143	4 672
Special and agricultural vehicles	713	7	82	624
All vehicles	**26 177**	**4 483**	**4 327**	**17 366**
	2005 (at 1998 prices)			
Motorcycles [1)]	*186*	*12*	*31*	*143*
Passenger Cars[2)]	*14 211*	*1 973*	*2 593*	*9 645*
Buses	*339*	*31*	*61*	*248*
Light Goods vehicles[3)]	*1 496*	*157*	*217*	*1 122*
Heavy Goods vehicles[4)]	*10 397*	*2 920*	*1 586*	*5 892*
Rigid goods vehicles[5)]	*1 833*	*332*	*351*	*1 150*
Non rigid goods vehicles[6)]	*8 564*	*2 588*	*1 234*	*4 742*
Special and agricultural vehicles	*662*	*7*	*78*	*577*
All vehicles	***27 291***	***5 100***	***4 566***	***17 627***

[1)] Including mopeds. – [2)] Including recreational vehicles. – [3)] Up to 3,5 t max. GVW – [4)] Over 3,5 t max. GVW. – [5)] Lorries with trailer. – [6)] Lorries with trailer, articulated vehicles, ordinary tractors with trailer.

Source: DIW.

Table 46
Average road infrastructure costs per vehicle km 1996, 1998, 2005
– € per vehicle km –

Vehicle types	All roads	Motorways	Other federal roads	Other roads
	1996 (at 1996 prices)			
Motorcycles[1)]	0.0115	0.0056	0.0081	0.0139
Passenger cars[2)]	0.0266	0.0117	0.0186	0.0408
Buses	0.1031	0.0423	0.0746	0.1368
Light goods vehicles[3)]	0.0472	0.0210	0.0328	0.0639
Heavy goods vehicles[4)]	0.2130	0.1003	0.1475	0.5281
Rigid goods vehicles[5)]	0.1166	0.0507	0.0815	0.2025
Non rigid goods vehicles[6)]	0.2755	0.1179	0.2024	1.0774
Special and agricultural vehicles	0.1344	0.0714	0.1092	0.0996
All vehicles	**0.0428**	**0.0241**	**0.0286**	**0.0633**
	1996 (at 1998 prices)			
Motorcycles[1)]	0.0114	0.0055	0.0080	0.0137
Passenger cars[2)]	0.0263	0.0115	0.0184	0.0403
Buses	0.1019	0.0418	0.0737	0.1351
Light goods vehicles[3)]	0.0466	0.0208	0.0324	0.0631
Heavy goods vehicles[4)]	0.2105	0.0991	0.1457	0.5218
Rigid goods vehicles[5)]	0.1152	0.0501	0.0806	0.2001
Non rigid goods vehicles[6)]	0.2722	0.1164	0.2000	1.0645
Special and agricultural vehicles	0.1328	0.0706	0.1079	0.0984
All vehicles	**0.0423**	**0.0238**	**0.0283**	**0.0625**
	1998 (at 1998 prices)			
Motorcycles[1)]	0.0112	0.0052	0.0079	0.0135
Passenger cars[2)]	0.0258	0.0109	0.0182	0.0403
Buses	0.0985	0.0392	0.0728	0.1318
Light goods vehicles[3)]	0.0455	0.0196	0.0318	0.0604
Heavy goods vehicles[4)]	0.2070	0.0937	0.1440	0.5719
Rigid goods vehicles[5)]	0.1127	0.0482	0.0814	0.2097
Non rigid goods vehicles[6)]	0.2605	0.1086	0.1939	1.0757
Special and agricultural vehicles	0.1316	0.0667	0.1072	0.1372
All vehicles	**0.0417**	**0.0230**	**0.0277**	**0.0627**
	2005 (at 1998 prices)			
Motorcycles[1)]	*0.0111*	*0.0055*	*0.0080*	*0.0134*
Passenger cars[2)]	*0.0250*	*0.0115*	*0.0178*	*0.0382*
Buses	*0.0944*	*0.0408*	*0.0713*	*0.1245*
Light goods vehicles[3)]	*0.0438*	*0.0205*	*0.0314*	*0.0573*
Heavy goods vehicles[4)]	*0.2016*	*0.0988*	*0.1443*	*0.5339*
Rigid goods vehicles[5)]	*0.1081*	*0.0503*	*0.0787*	*0.1952*
Non rigid goods vehicles[6)]	*0.2474*	*0.1128*	*0.1892*	*0.9217*
Special and agricultural vehicles	*0.1274*	*0.0697*	*0.1055*	*0.1324*
All vehicles	***0.0401***	***0.0241***	***0.0271***	***0.0587***

[1)] Including mopeds. – [2)] Including recreational vehicles. – [3)] Goods vehicles < 3.5 t max. GVW, includes also light goods vehicles with trailer. – [4)] Goods vehicles > 3.5 t max. GVW. – [5)] Lorries without trailer. – [6)] Lorries with trailer, articulated vehicles, ordinary tractor with trailer.

Source: DIW.

4.1.2 National railways (Deutsche Bahn DB)

The gross value of the capital stock of DB Netz track network amounted to € 127.5 billion in 1998, the net value was € 87.1 billion. The respective figures for the stations are € 36.9 billion (gross value) and € 23.9 billion (net value). From these figures capital costs of € 5.1 billion for the tracks and € 1.4 billion for the stations were derived. Since these values were derived with the macro-economic approach of the perpetual inventory model (see chapter 3) they cannot be compared with figures from the official business account of DB. This is not only because the balance sheet of DB shows only aggregated capital stock figures for the integrated rail company, but mainly due to methodological differences. The main differences between capital stock valuation on a social cost basis (such as the perpetual inventory method) and on a business accounting basis have been discussed in the interim report 5.2 of the UNITE project (Link et al. 2000 a) in detail. To the “normal” differences of depreciation methods and depreciation periods etc. is added in the case of DB, the fact that all assets of DB were devaluated by 80% in 1994 in order to enable the reform process. The running costs of DB for the track network were estimated to € 5.2 billion, those for the stations to € 0.9 billion.

Table 47 shows the figures for 1996 and 2005, which we will not discuss here in detail. Note, however, that in contrast to road, the capital values for 1996 (at 1996 prices) are lower than those for 1998 at 1998 prices since the relevant price indices for rail (which has for example a higher share of equipment goods than road) show a “normal” increasing shape.

Table 47
Capital value and total infrastructure costs of tracks and stations of DB (Deutsche Bahn AG) 1996, 1998, 2005[1)]
– in € million –

	Rail (DB)		
	Tracks	Stations	Total
	1996		
Gross capital value [2)]	126 530	36 382	162 912
Net capital value [2)]	86 161	23 360	109 521
Capital costs [3)]	5 052	1 409	6 461
Running costs	5 035	886	5 921
Total infrastructure costs[4)]	10 087	2 295	12 382
Out of these: VAT [5)]	0	0	0
Non-transport related costs	0	0	0
Transport related infrastructure costs [6)]	10 087	2 295	12 382
Transport related infrastructure costs at 1998 prices	10 140	2 307	12 447
	1998		
Gross capital value [2)]	127 533	36 948	164 481
Net capital value [2)]	87 060	23 895	110 955
Capital costs [3)]	5 087	1 430	6 517
Running costs	5 190	914	6 104
Total infrastructure costs[4)]	10 277	2 344	12 621
Out of these: VAT [5)]	0	0	0
Non-transport related costs	0	0	0
Transport related infrastructure costs [6)]	10 277	2 343	12 621
	2005		
Gross capital value [2)]	*147 728*	*42 632*	*190 360*
Net capital value [2)]	*106 023*	*28 486*	*134 509*
Capital costs [3)]	*5 971*	*1 632*	*7 603*
Running costs	*5 450*	*959*	*6 409*
Total infrastructure costs[4)]	*11 421*	*2 591*	*14 012*
Out of these: VAT [5)]	*0*	*0*	*0*
Non-transport related costs	*0*	*0*	*0*
Transport related infrastructure costs [6)]	*11 421*	*2 591*	*14 012*

[1)] 1996 at 1996 prices, 1998 at 1998 prices, 2005 at 1998 prices. – [2)] Including land value. As of 31 December. – [3)] Including land costs. Calculated as average over the year. Interests were calculated with a social interest rate of 3%. – [4)] Including VAT. – [5)] VAT included in running costs and depreciation. – [6)] Excluding VAT.

Source: DIW.

Total infrastructure costs of DB amounted to € 12.6 billion in 1998, out of these € 10.3 billion for the track network and € 2.3 billion for the stations. These figures do not include abolished tracks, which were already eliminated in the process of capital stock valuation. It was assumed that rail infrastructure serves fully for transport functions (in contrast to the market space function of roads or the electricity generation at inland waterways).

Table 48
Total and average track costs of DB Netz (Deutsche Bahn AG) 1996, 1998, 2005

Type of transport	Train km (million)	Total infrastructure costs (€ million)	Average infrastructure costs (€/ train km)
	1996 (at 1996 prices)		
Passenger transport[1) 2)]	661	4 539	6.87
Long distance passenger transport	160	1 135	7.09
Regional passenger transport[2)]	501	3 404	6.79
Freight transport[1)]	205	5 548	27.06
Total	**866**	**10 087**	**11.65**
	1996 (at 1998 prices)		
Passenger transport[1) 2)]	661	4 563	6.90
Long distance passenger transport	160	1 141	7.13
Regional passenger transport[2)]	501	3 422	6.83
Freight transport[1)]	205	5 577	27.20
Total	**866**	**10 140**	**11.71**
	1998 (at 1998 prices)		
Passenger transport[1) 2)]	717	4 625	6.45
Long distance passenger transport	181	1 156	6.39
Regional passenger transport[2)]	536	3 469	6.47
Freight transport[1)]	225	5 653	25.12
Total	**942**	**10 278**	**10.91**
	2005 (at 1998 prices)		
Passenger transport[1) 2)]	:	*5 140*	:
Long distance passenger transport	:	*1 285*	:
Regional passenger transport[2)]	:	*3 855*	:
Freight transport[1)]	:	*6 281*	:
Total	**:**	***11 421***	**:**

1) Including single locomotive-km. – 2) Including S-Bahn Berlin and Hamburg. – : = data not available.
Source: Deutsche Bahn AG, DIW.

Table 48 shows the allocated track costs based on the methodology described in chapter 3 and as an additional information the train- km of the different rail transport types. A further disaggregation to types of networks, for example for high speed lines, was not possible due to the insufficient data. An allocation of station costs to transport types was not possible, either. Some explanatory remarks on the cost allocation for 2005 seem to be necessary. The forecast on transport performance which was used for the pilot account 2005 (BVU/ifo/ITP/Planco 2001) provided only figures for rail transport in total, combining DB and non-DB transport performance. We decided not to produce train-km separately for DB and non-DB companies due to an extremely high uncertainty. We are aware of plans to operate a large part of the regional rail network as joint companies of DB, non-DB and municipalities. These companies will probably also own the tracks. Given this situation it seems impossible to give serious estimations on train-km operated on DB-tracks and tracks of non-DB companies. For the cost allocation we therefore used the ratio of train-km per traffic type from 1998. However, we do not present average costs since the train-km data is missing.

4.1.3 Other rail companies

The non-DB rail companies are interesting for the UNITE project due to the fact that one can assume a cost level and cost structure which differ from those of the national rail carrier DB. Although in the basic study on infrastructure cost accounting in Germany (BMV 1969) a cost account for these companies was also established there have been no official studies in all the subsequent years. The figures presented in this report therefore, are the first figures on the infrastructure costs of non-DB rail companies on a social cost basis which have been calculated since 1969.

As table 49 shows, the capital stock of non-DB railways (tracks and stations together) had in 1998 a gross value of € 8.0 billion and a net value of € 6.2 billion. The corresponding capital costs amounted to € 319 million.

Based on a survey on infrastructure costs in 1997 which was conducted by the German Association of Railways and Public Transport Operators (VDV) we estimated running costs of rail infrastructure of € 267 million for 1998. As for DB it was assumed that rail infrastructure of these companies serves fully for transport, e.g. no non-transport related costs were subtracted.

Table 49
Capital value and infrastructure costs of non-DB rail companies 1996, 1998, 2005
– in € million –

	Rail (non-DB)		
	Tracks	Stations	Total
	1996		
Gross capital value [2)]	4 844	2 692	7 536
Net capital value [2)]	3 757	1 911	5 668
Capital costs [3)]	198	85	283
Running costs	:	:	263
Total infrastructure costs[4)]	:	:	546
Out of these:			
VAT [5)]	0	0	0
Non-transport related costs	0	0	0
Transport related infrastructure costs [6)]	:	:	546
Transport related infrastructure costs at 1998 prices	•	•	569
	1998		
Gross capital value [2)]	5 178	2 859	8 037
Net capital value [2)]	4 093	2 073	6 166
Capital costs [3)]	208	111	319
Running costs	:	:	267
Total infrastructure costs[4)]	:	:	586
Out of these:			
VAT [5)]	0	0	0
Non-transport related costs	0	0	0
Transport related infrastructure costs [6)]	:	:	586
	2005		
Gross capital value [2)]	*6 364*	*3 230*	*9 594*
Net capital value [2)]	*5 053*	*2 368*	*7 421*
Capital costs [3)]	*257*	*121*	*378*
Running costs	*:*	*:*	*307*
Total infrastructure costs[4)]	*:*	*:*	*685*
Out of these:			
VAT [5)]	*0*	*0*	*0*
Non-transport related costs	*0*	*0*	*0*
Transport related infrastructure costs [6)]	*:*	*:*	*685*

[1)] 1996 at 1996 prices, 1998 at 1998 prices, 2005 at 1998 prices. – [2)] Including land value. As of 31 December. – [3)] Including land costs. Calculated as average over the year. Interests were calculated with a social interest rate of 3%. – [4)] Including VAT. – [5)] VAT included in running costs and depreciation. – [6)] Excluding VAT. – : = data not available.

Source: DIW.

Total infrastructure costs amounted in 1998 to € 586 million. The respective figures for 1996 and 2005 are € 546 million and € 685 million. Related to the network length, the non-DB rail companies had in 1998 with € 0.153 million/km only half of the specific costs that occurred at DB with € 0.329 million per network kilometre. The data situation did not allow any further differentiation and no cost allocation to passenger and freight transport.

4.1.4 Other public transport infrastructure (tram, metro, trolley bus)

As discussed in chapter 3 we used a definition of public transport for infrastructure cost calculation which deviates from the term "Öffentlicher Strassenpersonenverkehr" of German transport statistics. While German transport statistics include all companies operating transport with buses, trams and similar means, metros and trolley buses, we excluded buses from estimating infrastructure costs due to the fact that infrastructure costs caused by buses are included in the road account.

Within the available investment time series it was possible to calculate the capital stock value which amounted in 1998 to € 48.7 billion (gross value) and € 38.1 billion (net value). From these values capital costs of € 2.1 billion were derived. Due to the difficulties mentioned above it was not possible to quantify the running costs of tram and metro infrastructure. For 1996 we calculated capital costs of € 2.1 billion and for 2005 of € 2.2 billion.

Table 50
Capital value and capital costs of tram and metro in Germany 1996, 1998 and 2005[1)]
– in € million –

	1996	1998	2005
Gross capital value [2)]	48 589	48 701	*54 370*
Net capital value [2)]	38 078	38 147	*40 828*
Capital costs [3)]	2 060	2 067	*2 246*
Running costs	:	:	*:*
Total infrastructure costs[4)]	:	:	*:*
Out of these:			
VAT [5)]	0	0	*0*
Non-transport related costs	0	0	*0*
Transport related infrastructure costs	:	:	*:*

1) 1996 at 1996 prices, 1998 at 1998 prices, 2005 at 1998 prices. – 2) Including land value. As of 31 December. – 3) Including land costs. Calculated as average over the year. Interests were calculated with a social interest rate of 3%. – 4) Including VAT. – 5) VAT included in running costs and depreciation – : data not available.

Source: DIW.

4.1.5 Aviation infrastructure

Under the term aviation infrastructure the following are included: the airports; the national air navigation provider (DFS); and, the provider of meteorological services (DWD German Meteorological Services). Note, that due to data problems it was not possible to estimate the capital stock and capital costs separately for airports, air control and for meteorological services. It was not possible to sort out the non-transport related investments (and running costs). This implies that in contrast to road, rail, public transport and inland waterway infrastructure the cost account of aviation is not fully comparable.

The gross capital value of aviation infrastructure amounted in 1998 to € 24.3 billion. Total infrastructure costs of € 3.5 billion split up into € 1.4 billion capital costs and € 2.1 billion for running costs. For 1996 we estimated total infrastructure costs of € 3.4 billion (€ 3.5 billion in 1998 prices) and for 2005 of € 4.7 billion. The ratio between capital costs and running costs increases slightly from 1998 to 2005. No cost allocation was carried out.

Table 51
Capital value and total infrastructure costs of aviation infrastructure in Germany 1996, 1998 and 2005
– in € million –

	1996 (at 1996 prices)	1996 (at 1998 prices)	1998	2005[1)]
Gross capital value [2)]	25 056	•	24 333	*32 076*
Net capital value [2)]	18 538	•	18 800	*24 077*
Capital costs [3)]	1 420	•	1 433	*1 793*
Running costs	1 953	•	2 055	*2 914*
Total infrastructure costs[4)]	3 373	3 475	3 488	*4 707*
Out of these:			•	••
VAT [5)]	0	•	0	*0*
Non-transport related costs	:	•	:	*:*
Transport related infrastructure costs	:	•	:	*:*

[1)] At 1998 prices. – [2)] Including land value. As of 31 December. – [3)] Including land costs. Calculated as average over the year. Interests were calculated with a social interest rate of 3%. – [4)] Including VAT. – [5)] VAT included in running costs and depreciation – : = data not available.

Source: DIW.

4.1.6 Waterborne transport infrastructure

The capital stock of inland waterways amounted in 1998 to € 41.7 billion (gross value) and € 27.3 billion (net value) which implied capital costs of € 1.4 billion. Running costs of € 835 million made about one third of total infrastructure costs including VAT and non-transport related costs. Non-transport related costs for electric power generation, flooding prevention etc. were estimated by using information on the shares of these costs on total costs of different types of waterways (canals, canalised rivers, regulated rivers) which was described in BMV (1969). After eliminating non-transport related costs and VAT we obtained total transport related infrastructure costs of € 1.2 billion. Based on the methodology described in chapter 3 we estimated for 1996 total transport related infrastructure costs of € 1 178 million and for 2005 of € 1 303 million. Due to the lack of data no cost allocation could be carried out.

Table 52
Capital value and total infrastructure costs of inland waterways in Germany 1996, 1998 and 2005
– in € million –

	1996 (at 1996 prices)	1996 (at 1998 prices)	1998[1)]	2005[1)]
Gross capital value [2)]	41 458	•	41 708	*44 210*
Net capital value [2)]	27 094	•	27 341	*28 424*
Capital costs [3)]	1 382	•	1 390	*1 459*
Running costs	782	•	835	*942*
Total infrastructure costs[4)]	2 164	•	2 225	*2 401*
Out of these: VAT [5)]	63	•	71	*75*
Non-transport related costs	923	•	952	*1 024*
Transport related infrastructure costs [6)]	1 178	1 178	1 203	*1 303*
Transport related infrastructure costs at 1998 prices				

[1)] At 1998 prices. – [2)] Including land value. As of 31 December. – [3)] Including land costs. Calculated as average over the year. Interests were calculated with a social interest rate of 3%. – [4)] Including VAT. – [5)] VAT including in running costs and depreciation. – [6)] Excluding VAT.

Source: DIW.

Port infrastructure costs on a social cost basis, both for inland waterway harbours and for seaports, belong to those cost calculations which have never been carried out before in Germany. While the estimation of the capital stock on a social cost basis and the derivation of capital costs was based on good data available at DIW, serious problems occurred with estimating the running costs of port infrastructure. We have conducted company surveys asking for this information (all public and partly publicly owned ports were written to) but it must be pointed out that the response rate was extremely low (below 10% answered). The available data is not representative and no estimation of running costs could be made.

The capital stock values and the capital costs obtained with the perpetual inventory model are reported in table 53. The gross capital stock value amounted in 1998 to € 9.1 billion for inland waterway harbours and to € 20.2 billion for seaports. The respective net values were € 6.2 billion and € 13.9 billion. From these capital stocks we derived capital costs of € 297 million (inland waterway harbours) and € 779 million (seaports).

Table 53
Capital values and infrastructure costs of inland waterway harbours and seaports in Germany 1996, 1998 and 2005[1)]
– in € million –

	Inland waterway harbours			Seaports		
	1996	1998	2005	1996	1998	2005
Gross capital value [2)]	8 974	9 083	*8 969*	20 046	20 171	*21 374*
Net capital value [2)]	6 081	6 183	*6 152*	13 800	13 905	*14 645*
Capital costs [3)]	263	297	*290*	705	779	*807*
Running costs	:	:	*:*	:	:	*:*
Total infrastructure costs[4)]	:	:	*:*	:	:	*:*
Out of these: VAT [5)]	0	0	*0*	0	0	*0*
Non-transport related costs	:	:	*:*	:	:	*:*
Transport related infrastructure costs	:	:	*:*	:	:	*:*

[1)] 1996 at 1996 prices, 1998 at 1998 prices, 2005 at 1998 prices. – [2)] Including land value. As of 31 December. – [3)] Including land costs. Calculated as average over the year. Interests were calculated with a social interest rate of 3%. – [4)] Including VAT. – [5)] VAT included in running costs and depreciation. – : = data not available.

Source: DIW.

4.2 Supplier operating costs

For the German pilot account we analysed the national rail carrier Deutsche Bahn (DB) and its transport companies: DB Reise & Touristik (long distance rail), DB Regio (regional train passenger transport) and DB Cargo (freight transport). Furthermore, non-DB rail companies (about 180 companies) and public transport companies (tram, metro, buses) were considered for this cost category.

4.2.1 National rail carrier – Deutsche Bahn AG (DB AG)

Like all other European railways Deutsche Bahn (DB AG) is obliged to separate transport and infrastructure accounts at least at the bookkeeping level. Deutsche Bahn has met this requirement and has even set up three transport companies and two infrastructure companies (for tracks and stations) as companies in their own right, however, they operate under the roof of the DB Holding. Separate balance sheets and profit/ loss statements for these companies have not been published so far. Only the turnovers, the depreciation (on a business accounting basis and with huge devaluations) and the operating results of these companies are provided in a so-called segment business report. It is obvious that this is not the information required for UNITE. We used this, however, for our own estimates of supplier operating costs. The data did not allow any further disaggregation for vehicle-related costs, service related costs, other costs and administrative costs as originally suggested in Link et al. (2000 b).

In table 54 we present the data from the aggregated profit/ loss statement of DB AG and the data available from the segment report. This data has only been available since 1998. Based on these input data and by using information available at DIW (for example: engineering studies on material and maintenance for tracks and vehicles, number of personnel per segment etc.) we estimated for 1998 supplier operating costs of € 11 603 million.[10] These costs exclude depreciation and include the track and station charges which DB Regio, DB Fernverkehr & Touristik and DB Cargo pay to DB Netz (€ 4.3 billion). For 1996 and 2005 we estimated supplier operating costs of € 10 708 million and € 12 206 million respectively. These figures should be treated with much care since they are based on unreliable input data and/or guestimates.

[10] The estimates for supplier operating costs are not presented in table format in this section but are contained in the summarising tables in chapter 5.

Table 54
Profit/ loss statement of Deutsche Bahn AG and information from the segment reports of the DB companies 1998
– in € million, 1998 prices –

Items	DB AG	Segment companies					
		DB Reise & Touristik	DB Regio	DB Cargo	DB Netz	DB Stations	DB Holding
Turnover revenues	15 348	4 172	7 328	3 541	153	184	252
Changes of stocks	-8	:	:	:	:	:	:
Others	1 764	:	:	:	:	:	:
Total revenues	2 596	:	:	:	:	:	:
Expenditures on material	6 595	:	:	:	:	:	:
Expenditures on personnel	8 389	:	:	:	:	:	:
Depreciation	1 737	259	348	169	823	73	293
Other expenditures	2 546	:	:	:	:	:	:
Revenues from profit sharing	-143	:	:	:	:	:	:
Interest revenues	-89	:	:	:	:	:	:
Operating result	201	:	:	:	:	:	:
Taxes	31	:	:	:	:	:	:
Annual result	**170**	**70**	**193**	**31**	**148**	**14**	**-285**

: = data not available.

Sources: Business report DB AG

4.2.2 Non-DB rail companies

The data situation is here even more complicated due to the following facts:

- In contrast to DB these companies are not obliged to establish separate bookkeeping for transport operations and infrastructure.
- There are two potential sources for the UNITE pilot accounts. The first one is VDV statistics. This source refers to the 180 rail companies, which form, together with the operators of trams, metros and buses, the Association of Railways and Public Transport operators (VDV). VDV publishes only an aggregated statement of the costs and revenues of its members (see table 55). The second source is a study on cost structures of public transport companies, which has been conducted on behalf of VDV, Deutscher Städtetag, Deutscher Gemeindetag (Deutscher Städtetag et al. 1999) (see table 56). Table 56 also shows the expenditures from private bus operators in Germany which operate bus services on the basis of their own line concessions. To give an indication of the importance of

these companies it has to be mentioned that they carry about 11 % of all bus passengers and operate half of the bus network in Germany. None of these sources are exactly what is needed to complete the UNITE accounts, but they give an idea of cost structures in public transport.

- The VDV figures are biased due to the fact that not all public transport companies are members. This means that these figures underreport costs and revenues.
- A disaggregation of supplier operating costs as originally suggested in Link et al. (2000 b) is considered to be over-ambitious given the normal procedures of profit/ loss statements.

Table 55 presents the aggregated figures from VDV and table 56 gives the results of the study mentioned above (Deutsche Städtetag et al. 1999).

Table 55
Expenditures of VDV companies[1)] 1996 and 1998
- in € million -

Expenditures	1996	1998
Material costs	2485	2937
Raw materials	707	901
Electricity	178	204
Diesel fuel	220	262
Services	1778	2036
Bus rental	943	1069
Personnel	4217	4932
Depreciation	895	1068
Other operating expenses	904	1090
Interests	186	36
Taxes	62	245
Total	8749	10308

[1)] Rail companies in passenger transport, metro, tram and bus operator.

Source: VDV.

4.2.3 Public transport

Ideally, supplier operating costs would have to be separately estimated for companies with tram and metro operation (or their respective business units) and for companies operating bus services (or their respective business units). Furthermore, an analysis of supplier operating costs would require a separate treatment of municipal companies with (at least partly) public ownership on the one hand and private companies on the other hand. However, the previous sections already discussed the data problems which complicate an estimation of supplier costs for public transport.

Table 56
Expenditures of public transport companies[1] in Germany 1997
– in € million, 1998 prices –

Type of expenditures	VDV companies[1]	Private bus companies[2]	Total
Material out of these: bus rental	2 928 1 048	130	3 058
Personnel	4 992	272	5 264
Capital costs[3]	1 243	144	1 387
Taxes and others	1 109	93	1 202
Total	10 272	639	10 911

[1] Rail companies, tram, metro, bus operators.– [2] Private bus companies that are non-members of VDV but are members of German bus service providers association. – [3] Interest and depreciation.

Sources: Deutscher Städtetag, Deutscher Landkreistag, Deutscher Städte- und Gemeindebund, Bundesverband Deutscher Omnibusunternehmer, Verband Deutscher Verkehrsunternehmen.

4.3 Delay costs due to congestion

The results presented for delay costs are based on the methodology outlined in chapter 3 and described in detail in Link et al. (2000 b) "The Accounts Approach". Note, that no costs could be estimated for waterborne transport since no delay statistics were collected for these modes.

4.3.1 Results per mode

4.3.1.1 Road transport

Average and total delay costs for road transport are given in table 57 for passenger transport and table 58 for freight transport.

Table 57
Total and average delay costs for road passenger transport in Germany 1998

Private Vehicles[1)]	Total additional delay costs – € million –	Average additional delay costs – €/1000 vehicle km –
Motorway	2 168	24.1
Trunk	1 069	9.3
Urban	5 056	44.1

[1)] Cars, station wagons, motorcycles and recreational vehicles.

Source: IWW.

Table 58
Total and average delay costs for road freight transport in Germany 1998

	Total additional delay costs – € million –	Average additional delay costs – €/1000 vehicle km –
LGV		
Motorway	429	37.0
Trunk	367	14.0
Urban	1 667	67.0
HGV		
Motorway	3 310	72.0
Trunk	1 028	29.0
Urban	1 000	133.0

Source: IWW.

4.3.1.2 Rail transport

Only time costs were considered for the estimation of delay costs for rail passenger and freight services. Using an average VOT of € 9.57/hour for passenger travel, the following costs were calculated for the German National Railways (Deutsche Bahn).

Table 59
Additional time costs for rail passenger transport in Germany 1998
(German National Railways only)
- in € million -

	Total additional time costs of rail passenger transport
DB AG Total	682
of which	
Highspeed passenger	653
Other passengers	20
Freight	9
Non-DB Railways	:

: = data not available.

Source: IWW.

The average costs were calculated to be € 617.3/1000 train km for all rail services. Because of the lack of delay data by type of goods train no distinction between short and long distance freight or combined transport could be made. The total costs of delays to rail freight were calculated to be € 8.71 million for German National Railways and other German rail companies.

Note, that a comparison of the total costs between passenger and freight transport for rail shows the relative unimportance of freight rail delays. This is because of the low value of time per tonne and the definition of delay.

4.3.1.3 Public transport

Delay costs in public transport were calculated by assuming that buses and tramways are affected by road congestion. No data was available for delays in public transport operating on networks separate to road transport (rapid mass transport, light rail, underground). No estimation of delay costs could be made for these modes of transport.

Table 60
Additional time costs for public transport users in Germany 1998
– in € million –

	Total additional time costs
Bus / Coach	1 286
Motorways	324
Trunk roads	270
Urban roads	692
Tramway + Trolley bus [1) 2)]	125

[1)] Values of passenger mileage of municipal companies estimated by the share of seat kilometres. – [2)] Tram excluding major parts of traffic performed on grade-separated networks.

Source: IWW.

The average additional costs for bus and trams are € 80/1000 vkm and € 72/1000 vkm respectively.

4.3.1.4 Air transport

The results for air passenger and air cargo transport are given in table 61.

Table 61
Air traffic delay results for arrivals in selected airports representing 57.9% of air traffic in Germany
- € million -

	Total additional time costs 1998	
	Passenger	Cargo
Dusseldorf	57.90	0.03
Frankfurt/Main	178.88	0.89
Munich	83.41	0.07
Total of selected airports	320.86	1.00

Source: IWW.

The average additional costs were calculated to be € 387 per arriving flight for the three major German airports studied.

4.3.2 Total and average delay costs for Germany

Detailed results of the delay cost estimation by vehicle types and network types for Germany 1998 are shown in table 62. In 1998, total delay costs for transport amounted to € 18 333 million for Germany. 95% of these costs were borne by road traffic users (including bus and coach passengers). The remaining costs were borne by rail users (3.7%), air traffic users (0.8%) and users of tram and trolley bus (0.7%).

Compared to Germany's GDP the costs of road traffic delays were roughly 0.95% in 1998. This means that compared to the average allocation of road congestion costs to GDP of 2%, which is reported in the EU Green Book on Fair and Efficient Pricing, the delay costs estimated in this study for Germany are considerably lower. However, the value of time and the definition of delay used in the green book are not known. In the UCI report (INFRAS/IWW 2000) road congestion costs were estimated to be approximately 0.5% of the GDP when based on dead-weight loss calculations. This value is similar to the time-related externalities computed by the TRENEN-II-STRAN model for Europe. The delay costs for Switzerland (Suter 2000) show similar values between 0.2% to 0.4% of GDP.

Table 62
Total delay costs for Germany in 1998 – € million –

	Additional time costs due to road congestion	Additional fuel costs due to road congestion	Additional time costs due to late arrivals in public transport	Total	Motor-ways	Trunk roads	Urban roads
Road transport	16 491	593	–	17 381	6 231	2 734	8 415
Private vehicles [1]	7 700	593	–	8 293	2 168	1 069	5 056
Buses [2]	1 287	–	–	1 287	324	270	692
Light goods vehicles [4]	2 442	21	–	2 463	429	367	1 667
Heavy goods vehicles [3]	5 062	276	–	5 338	3 310	1028	1000
Rail transport [5]	–	–	682	682	–	–	–
High speed passenger trains	–	–	653	653	–	–	–
Other passenger trains	–	–	20	20	–	–	–
Freight trains	–	–	9	9	–	–	–
Public transport with tram and trolley bus[6]	125	–	–	125	–	–	125
Aviation	–	–	147	147	–	–	–
Passenger	–	–	146	146	–	–	–
Cargo	–	–	1	1	–	–	–
Total	16 616	890	829	18 333	–	–	–

[1] Cars, station wagons, motorcycles and recreational vehicles. – [2] Including urban busses and coaches of private and municipal companies. – [3] Rigid and articulated goods vehicles with a gross weight > 3,5t. – [4] Goods vehicles / vans <3,5t, agricultural vehicles and other use vehicles. – [5] Including S-Bahn and tram on grade-separated network. – [6] Tram excluding major parts of traffic performed on grade-separated networks.

Source: IWW.

Average costs per vehicle kilometre in road transport were calculated by using PCU-kilometres for each network aggregate. In rail a unique value per kilometre by each train class was applied. In air transport average costs were divided by aircraft movement (or arrival). The detailed results are given in table 63.

Table 63
Average delay costs for Germany in 1998 by vehicle kilometre or movement

	Unit	Motorways	Trunk roads	Urban roads
Road transport				
Private vehicles[1)]	€ / 1000 vkm	24	9	44
Buses[2)]	€ / 1000 vkm	72	28	132
Light goods vehicles[4)]	€ / 1000 vkm	37	14	67
Heavy goods vehicles[3)]	€ / 1000 vkm	72	29	133
Rail Transport[5)]				
High speed passenger trains	€ / 1000 train-km	617		
Other passenger trains	€ / 1000 train-km	617		
Freight trains	€ / 1000 train-km	617		
Public Transport with tram & trolley bus[6)]	€ / 1000 vkm	72		
Aviation				
Passenger	€ / arriving flight	387		
Cargo	€ / arriving flight	387		

[1)] Cars, station wagons, motorcycles and recreational vehicles. – [2)] Including urban busses and coaches of private and municipal companies. – [3)] Rigid and articulated goods vehicles with a gross weight > 3,5t. – [4)] Goods vehicles / vans <3,5t, agricultural vehicles and other use vehicles. – [5)] Including S-Bahn and tram on grade-separated network. – [6)] Tram excluding major parts of traffic performed on grade-separated networks.

Source: IWW.

4.3.3 Results for 1996

Total delay costs for Germany 1996 amounted to € 16 907 million. This is 8% less than the delay costs calculated for 1998. The most severe increase in delay costs between 1996 and 1998 can be observed in aviation (+21%), followed by rail (+17%).

The resulting values for average costs per vehicle kilometre (road), train-km (rail), wagon-km (public transport) or aircraft movement are presented in Table 65. The data illustrates the relatively coarse delay information used, as the results show the same increases in unit costs within the market segments road, rail, public transport and aviation. In general it can be concluded, that delay costs were 3% to 10% lower in 1996 compared to 1998, whereby 3% were caused by the increase of the GDP per capita between 1996 and 1998.

Table 64
Total delay costs for Germany in 1996
- € million -

	Additional time costs due to road congestion	Additional fuel costs due to road congestion	Additional time costs due to late arrivals in public transport	Total	Comparison to 1998 (%): total network
Road transport	15 248	833	–	16 080	-7.5
Private vehicles [1]	7 269	560	–	7 829	-5.6
Buses [2]	1 211			1 211	-5.9
Light goods vehicles [4]	2 095	18	–	2 113	-14.2
Heavy goods vehicles [3]	4 673	255	–	4 927	-7.7
Rail transport [5]	–	–	584	584	-14.4
High speed passenger trains	–	–	559	559	-14.4
Other passenger trains	–	–	17	17	-15.0
Freight trains	–	–	8	8	-11.1
Public transport	121			121	-3.2
Tram & trolley bus [6]	121			121	-3.2
Metro and other [7]	0			0	0.0
Aviation	–	–	121	121	-17.7
Passenger	–	–	120	120	-17.8
Cargo	–	–	1	1	-9.9
Waterborne transport			0	0	0.0
Total	15 369	833	705	16 906	-7.8

[1] Cars, station wagons, motorcycles and recreational vehicles. - [2] Including urban busses and coaches of private and municipal companies. - [3] Rigid and articulated goods vehicles with a gross weight > 3,5t. – [4] Goods vehicles / vans <3,5t, agricultural vehicles and other use vehicles. - [5] DB only. – [6] Tram excluding major parts of traffic performed on grade-separated networks. – [7] Including S-Bahn and tram on grade-separated network.

Source: IWW.

Table 65
Average delay costs for Germany in 1996
- € million -

	Unit	Total on all types of infrastructure	Comparison to 1998 figures
Road transport			
Private vehicles [1)]	€ / 1000 vkm	22.7	-3.9%
Buses [2)]	€ / 1000 vkm	76.8	-3.9%
Light goods vehicles [4)]	€ / 1000 vkm	34.7	-3.9%
Heavy goods vehicles [3)]	€ / 1000 vkm	67.4	-3.9%
Rail transport [5)]		551.2	-10.7%
High speed passenger trains	€ / 1000 train-km	551.2	-10.7%
Other passenger trains	€ / 1000 train-km	551.2	-10.7%
Freight trains	€ / 1000 train-km	551.2	-10.7%
Public transport		69.6	-3.9%
Tram & trolley bus [6)]	€ / 1000 vkm	69.6	-3.9%
Metro and other [7)]	€ / 1000 vkm	:	:
Aviation		356	-8.7%
Passenger	€ / arriving flight	356	-8.7%
Cargo	€ / arriving flight	356	-8.7%
Waterborne transport	€ / 1000 vkm	:	:

[1)] Cars, station wagons, motorcycles and recreational vehicles. - [2)] Including urban busses and coaches of private and municipal companies. - [3)] Rigid and articulated goods vehicles with a gross weight > 3,5t. - [4)] Goods vehicles / vans <3,5t, agricultural vehicles and other use vehicles. - [5)] DB only. - [6)] Tram excluding major parts of traffic performed on grade-separated networks. – [7)] Including S-Bahn and tram on grade-separated network.

Source: IWW.

4.3.4 Forecast 2005

Table 66 shows the total delay costs which were estimated for 2005 based on the methodology and the assumptions described in chapter 3.

Table 66
Total delay costs for Germany in 2005
- € million -

	Additional time costs due to road congestion	Additional fuel costs due to road congestion	Additional time costs due to late arrivals in public transport	Total	Comparison to 1998 (%)			
					Total Network	Motor-ways	Trunk-roads	Urban roads
Road transport	*20 484*	*1102*		*21 586*	*24.2*	*21.4*	*28.7*	*31.3*
Private vehicles [1]	*9 570*	*737*		*10 307*	*24.3*	*21.8*	*30.4*	*30.5*
Buses [2]	*1 444*			*1 444*	*12.2*	*10.9*	*17.4*	*17.6*
Light goods vehicles [4]	*3 290*	*28*		*3 318*	*34.7*	*32.5*	*41.4*	*41.3*
Heavy goods vehicles [3]	*6 180*	*337*		*6 517*	*22.1*	*20.8*	*25.1*	*28.2*
Rail transport [5]			*902*	*902*	*32.3*			
High speed passenger trains			*863*	*863*	*32.2*			
Other passenger trains			*27*	*27*	*35.0*			
Freight trains			*11*	*11*	*22.2*			
Public transport	*149*			*149*	*19.2*			
Tram & trolley bus [6]	*149*			*149*	*19.2*			*19.2*
Metro and other [7]	*0*			*0*	*0.0*			
Aviation			*245*	*245*	*66.7*			
Passenger			*243*	*243*	*66.4*			
Cargo			*2*	*2*	*55.4*			
Waterborne transport			*0*	*0*	*0.0*			
Total	*20 633*	*1102*	*1 147*	*22 881*	*24.8*			

[1] Cars, station wagons, motorcycles and recreational vehicles. - [2] Including urban busses and coaches of private and municipal companies. - [3] Rigid and articulated goods vehicles with a gross weight > 3,5t. – [4] Goods vehicles / vans <3,5t, agricultural vehicles and other use vehicles. - [5] DB only. - [6] Tram excluding major parts of traffic performed on grade-separated networks. – [7] Including S-Bahn and tram on grade-separated network.

Source: IWW.

Table 67 finally presents average delay costs for 2005 broken down to passenger kilometres (in road transport) and to passenger movements (in rail and air transport) since in road transport only small changes of the average congestion probability were assumed average delay costs increase close to the growth of GDP per capita used for value transfer. The most drastic worsening of the user situation is due to air traffic as there the most severe increase in late time probabilities were forecasted.

Table 67
Average delay costs for Germany in 2005
- € million -

	Unit	Total on all types of infrastructure	Comparison to 1998 figures	Out of these: Motorways	Trunk roads	Urban roads
Road transport						
Private vehicles [1)]	€ / 1000 vkm	*27.2*	*14.9*	*12.6*	*20.6*	*20.6*
Buses [2)]	€ / 1000 vkm	*91.8*	*14.9*	*12.6*	*20.6*	*20.6*
Light goods vehicles [4)]	€ / 1000 vkm	*40.9*	*14.9*	*12.6*	*20.6*	*20.6*
Heavy goods vehicles [3)]	€ / 1000 vkm	*80.6*	*14.9*	*12.6*	*20.6*	*20.6*
Rail transport [5)]		*709.1*	*14.9*			
High speed passenger trains	€ / 1000 train-km	*709.1*	*14.9*			
Other passenger trains	€ / 1000 train-km	*709.1*	*14.9*			
Freight trains	€ / 1000 train-km	*709.1*	*14.9*			
Public transport						
Tram & trolley bus [5)]	€ / 1000 vkm	*87.4*	*20.6*			*20.6*
Metro and other [5)]	€ / 1000 vkm	*:*	*:*			
Aviation		*489*	*26.4*			
Passenger	€ / arriving flight	*489*	*26.4*			
Cargo	€ / arriving flight	*489*	*26.4*			
Waterborne transport	€ / 1000 vkm	*:*	*:*			

[1)] Cars, station wagons, motorcycles and recreational vehicles. – [2)] Including urban busses and coaches of private and municipal companies. - [3)] Rigid and articulated goods vehicles with a gross weight > 3,5t. - [4)] Goods vehicles / vans <3,5t, agricultural vehicles and other use vehicles. - [5)] Tram excluding major parts of traffic performed on grade-separated networks. - [6)] Including S-Bahn and tram on grade-separated network. [5)] DB only.

Source: IWW.

4.4 Accident costs

4.4.1 Results for 1998- total costs by category and main cost bearer

Table 68 presents total internal and external accident costs for Germany by accident mode. Total social costs of accidents, e.g. including both transport system internal and external components, amounted in 1998 to € 73 billion. Total internal accident costs were € 59 billion. 99% of these costs were due to road transport. Because internal accident costs are carried by the transport user or the community of transport users the interpretation of the results for accident costs should be based on the total external accident costs that are carried by society as a whole. Total external accident costs for Germany amounted to € 15 billion in 1998 with 99% to be allocated to road transport.

The most important cost driver is the Risk Value, which accounted in 1998 for 64% of total costs, followed by production losses (19%) and material damages (16%). The costs arising from medical treatment and administration were of minor importance.

Table 68
Total internal and external accident costs in Germany 1998 by cost category
- in € million -

	Internal costs		External costs				
	Material damages	Risk value	Administrative costs	Health costs	Production loss	Total costs 1998	Total user external costs
Road [1]	11 957	45 962	222.9	867.1	13 501.5	72 511	14 591.6
Rail	:	581	0.2	2.1	80.9	664	83.2
Public transport [2]	6	19	0.1	0.4	5.7	32	6.2
Aviation	:	176	0.1	1.2	33.7	211	34.9
Inland waterway	:	8	:	0.1	2.1	11	2.2
Maritime shipping	:	:	:	:	:	:	:
Total	11 963	46 746	223.4	870.8	13 623.8	73 429	14 718.0

[1] Passenger cars, motorcycles and goods vehicles. - [2] Tramways and trolley buses; accidents distributed between bus and other public transport by vkm. – [3] Due to data availability comprising all costs of material damages only.

Source: IWW.

As already mentioned, the risk value was responsible for 64% of total accident costs and for 80% of internal accident costs in 1998. This seemingly high ratio in fact is explained simply by the high priority society places on improved traffic safety. The value of a statistical life of around € 1.5 million per fatality used in UNITE lies at the lower end of possible values. Sensitivity tests for UNITE are € 2.5 million and € 0.75 million (Nellthorp et al. 2001).

4.4.2 Allocation of total costs to modes and types of infrastructure

The question of responsibility in the field of traffic accidents is a very complex one. Official records from traffic police and insurance companies naturally relate the definition of "responsibility" under the current national legislation framework. However, suitable data on the distribution of accident responsibilities are not available. Whilst a principle of UNITE is to avoid arbitrary cost allocation, we were not able to produce a responsibility - coverage matrix as proposed in "Accounts Approach for Accidents", Doll et al. (2000) for Germany.

Nevertheless, we allocated accident costs to road classes and vehicle types in order to meet the minimum level of disaggregation set out in "The Accounts Approach" (Link et al. 2000 b). The cost allocation was based on the following assumptions and data sources:

- We assumed the costs borne by different actors within each mode of transport as shown in Table 69 as equal to the costs caused within this mode. The distribution of costs across modes therefore is not necessary.
- In each mode, the costs which are directly borne by the users of a specific mode are respectively seen as caused by the mode. All other costs within this mode are distributed to the vehicle types by the share of vehicle-specific costs.
- For the allocation of road accident costs to road types, records of accidents, injuries and fatalities, information from the German Highway Research Institute (BASt) is used. The cost allocation key takes into consideration accident risks and traffic volumes on motorways, trunk roads and urban roads.
- In rail transport passengers and on-board staff killed or injured are allocated to passenger transport, while other staff is allocated to all types of service by train-km. A distinction between high speed passenger and conventional passenger services has not been possible.
- In aviation the efficiency-measure (1 tkm = 10 pkm) according to INFRAS/IWW (2000) has been used to subdivide costs between passenger and freight traffic.
- In waterborne transport an allocation of damages to human health or live to vehicle types is not possible. Thus only the total figures are given.

The results of this cost allocation procedure are presented in table 69 for road transport and in table 70 for the other transport modes.

Table 69
Total external accident costs in Germany 1998 – road transport
- € million -

Road accidents	Motorways	Trunk roads	Urban roads	All roads
Private vehicles [1)]	1218	7067	5799	14083
Bus / coach [2)]	7	37	36	79
LGV [3)]	16	92	64	172
HGV [3)]	23	138	96	258

[1)] Passenger cars, motorcycles, mopeds and station wagons. - [2)] Cost allocation with tram/trolley bus by vehicle kilometres. - [3)] Cost allocation between vehicle types via vehicle kilometres.

Source: IWW

Table 70
Total external accident costs in Germany 1998 – other transport modes
- € million -

	All network
Rail transport [1)]	83
Passenger traffic [2)]	71
Freight traffic	12
Public transport [2)]	6
Tram / trolley bus	6
Metro / light rail [3)]	:
Aviation	35
Passenger traffic	30
Freight traffic	5
Inland navigation	2
Maritime shipping	:

[1)] Including DB and other rail carriers. - [2)] Cost allocation with tram/trolley bus by vehicle kilometres. - [3)] Assumption: operation on separate tracks => no accident risk.

Source: IWW.

4.4.3 Average costs in 1998

Average costs were calculated based on vehicle-km (road), train-km, aircraft-km and ship-km. A breakdown to pkm or tkm was not made. The results of the average cost estimates are presented in Tables 71 and 72.

Table 71
Average accident costs in Germany 1998 – road transport
- €/1000vkm -

Road accidents	Other inter-urban roads	Trunk roads	Urban roads	All roads
Private vehicles [1)]	37.07	144.09	204.89	129.51
Bus / coach [2)]	43.32	112.00	130.50	111.05
LGV [4)]	11.13	44.75	44.75	28.18
HGV [3)]	3.93	38.01	50.49	22.82

[1)] Cars, station wagons, motorcycles and recreational vehicles. - [2)] Including urban busses and coaches of private and municipal companies. - [3)] Rigid and articulated goods vehicles with a gross weight > 3,5t. - [4)] Goods vehicles / vans <3,5t, agricultural vehicles and other use vehicles.

Source: IWW.

Table 72
Average accident costs in Germany 1998 – other transport modes
- €/1000km -

	Unit	Total network
Rail transport		
Passenger traffic	€ / 1000 train-km	651.16
Freight traffic		498.43
Public transport		
Tram / trolley bus [1)]	€ / 1000 vkm	110.86
Metro / light rail [2)]		:
Aviation		
Passenger traffic	€ / 1000 aircraft-km	450.71
Freight traffic		450.71
Inland navigation	€ / 1000 vessel-km	515.06
Maritime shipping		:

[1)] Tram excluding major parts of traffic performed on grade-separated networks. - [2)] Including S-Bahn and tram on grade-separated network.

Source: IWW.

4.4.4 Results for 1996

As we used average cost values for all cost categories, for the transfer of the accident accounts to 1996 only the inflation rate was considered. Concerning the number of physical units the respective data for 1996 was used. Total accident costs for 1996 are shown in table 73.

Table 73
Total accident costs in Germany 1996
- € million -

	Internal costs		External costs					
	Material damages	Risk value	Total external costs	Administra-tive costs	Health costs	Production loss	Total costs 1998	Relative to 1998 (%)
Road [1]	12 931	44 504	13 818	226.2	917.7	12 675	71 254	–1.7
Rail	:	591	55	0.5	2.8	52	646	–2.7
Public transport [2]	7	17	5	0.1	0.3	5	29	–9.4
Aviation	:	171	24	0.1	1.2	23	195	–7.6
Inland waterway	:	12	4	:	0.2	4	16	+45.5
Maritime shipping	:	:		:	:	:	:	:
Total	12 938	45 295	13 906	226.9	922.2	12 759	72 140	–1.7

[1] Passenger cars, motorcycles, all buses and goods vehicles. - [2] Tramways and trolley buses; accidents distributed between bus and P.T. by vkm.

Source: IWW.

In 1996 total accident costs in road transport were about 1.7% lower than the values for 1998 which is due to the lower demand for road transport. Accident rates have developed differently for different vehicle classes. Especially for road freight transport the 1996 values turn out to be much higher. However, the relatively low number of accidents in this segment is a source of statistical fluctuations.

Table 74
Average accident costs in Germany 1996 – road transport
- € / 1000 vkm -

Road accidents	Motorways	Trunk roads	Urban roads	All roads	Relative to 1998 (%)
Private vehicles	37.09	138.54	208.19	129.31	-2.8
Bus / coach	35.93	99.01	123.70	96.10	–13.5
LGV	6.41	34.31	34.31	26.55	–5.8
HGV	4.67	47.22	77.33	28.33	24.1

Source: IWW.

Table 75
Average accident costs in Germany 1996 – other transport modes
- € / 1000 vkm -

	Unit	Total network	Relative to 1998 (%)
Rail transport			
Passenger traffic	€ / 1000 train-km	632.81	–2.8
Freight traffic		484.38	–2.8
Public transport			
Tram / trolley bus	€ / 1000 vkm	95.78	–13.6
Metro / light rail		:	:
Aviation			
Passenger traffic	€ / 1000 aircraft-km	554.46	23.0
Freight traffic		601.05	33.4
Inland navigation	€ / 1000 vessel-km	801.62	56.6
Maritime shipping		:	:

Source: IWW.

4.4.5 Results for 2005

The results for total and average cost estimates for 2005 are given in table 76.

Table 76
Total accident costs in Germany 2005
- € million -

	Internal costs		External costs					
	Material damages	Risk value	Total external costs	Administrative costs	Health costs	Production loss	Total costs 1998	Relative to 1998 (%)
Road [1]	*14 196*	*54 568*	*17 324*	*264.7*	*1 029.5*	*16 029*	*86 087*	*+18.7*
Rail	*:*	*773*	*111*	*0.3*	*2.7*	*108*	*884*	*+33.1*
Public transport [2]	*7*	*22*	*7*	*0.1*	*0.4*	*6*	*36*	*+15.4*
Aviation	*:*	*267*	*53*	*0.1*	*1.8*	*51*	*320*	*+51.7*
Inland waterway	*:*	*11*	*3*	*0.0*	*0.1*	*3*	*14*	*+37.2*
Maritime shipping	*:*	*:*		*:*	*:*	*:*	*:*	*:*
Total	*14 203*	*55 641*	*17 498*	*265.2*	*1 034.5*	*16 197*	*87 341*	*+18.9*

[1] Passenger cars, motorcycles, all buses and goods vehicles. - [2] Tramways and trolley buses; accidents distributed between bus and P.T. by vkm.

Source: IWW.

In total, as in road transport, accident costs were estimated to increase by 19% from 1998 to 2005. Even if we disregard the increase in costs caused by growth in the risk value, total costs would still increase by 6.8%. For road transport this means that, the falling accident rates are not able to overcompensate the growth of road traffic volumes. Due to the high growth of the aviation market here an increase in total external accident costs of roughly 52% within the seven year time period (1998 – 2005) was estimated.

Average costs 2005 develop less than total costs, as here the traffic growth component does not weigh the results as in the total costs. For all modes other than road, the development of accident rates were considered to remain constant. The development of average costs is equal to the growth of risk value. In the road sector the growth in average costs of approximately 10% indicates the difference between growth in average income and increasing traffic safety.

Table 77
Average accident costs in Germany 2005
- € / 1000 vkm -

Road accidents	Motorways	Trunk roads	Urban roads	All roads	Relative to 1998
Private vehicles	*40.67*	*158.11*	*224.10*	*142.10*	*+9.7%*
Bus / coach	*47.53*	*139.36*	*121.85*	*121.85*	*+9.7%*
LGV	*12.21*	*49.10*	*30.92*	*30.92*	*+9.7%*
HGV	*4.31*	*41.70*	*25.04*	*25.04*	*+9.7%*
Source: IWW.					

Table 78
Average accident costs in Germany 2005 – other transport modes
- € / 1000 vkm -

	Unit	Total network	Relative to 1998 (%)
Rail transport			
Passenger traffic	€ / 1000 train-km	*752.10*	*15.5*
Freight traffic		*575.70*	*15.5*
Public transport			
Tram / trolley bus	€ / 1000 vkm	*128.04*	*+15.5*
Metro / light rail		*:*	*:*
Aviation			
Passenger traffic	€ / 1000 aircraft-km	*520.58*	*+15.5*
Freight traffic		*520.58*	*+15.5*
Inland navigation	€ / 1000 vessel-km	*594.89*	*+15.5*
Maritime shipping		*:*	
Source: IWW.			

4.5 Environmental costs

4.5.1 Results for 1998

Table 79 presents the environmental costs of transport in Germany for the year 1998. The highest share of costs, 41%, stems from the emission of air pollutants, followed by noise with 34%. Global warming is responsible for 20% of total costs, 5% are attributable to Nature, Landscape, Soil and Water pollution. Compared to the other cost categories, the costs of nuclear risks are virtually negligible, even if valued with the much higher shadow price described in the methodology section.

The sector causing the highest costs is road transport, reflecting its dominating role in transport performance. Road transport is responsible for 88% of the total transport sector costs. Air pollution is the most important costs category, for both passenger and freight transport. Costs are dominated by impacts due to primary and secondary particles, above all loss of life expectancy and increased morbidity rates. Noise, the second important cost category, is dominated by amenity losses. Further cost components here are health impacts due to ischaemic heart disease and hypertension and the subjective impairment of sleep quality. Noise exposure estimates were only available for the whole road transport sector. The resulting costs were broken down by splitting the total based on weighted vehicle kilometres. Following weights were derived from differences in measured noise emission levels in relation to passenger cars: passenger car = 1, motorcycle = 5, bus = 6, LGV = 7, HGV = 14. As the lion's share of noise exposure occurs in urban areas, the vehicle kilometres driven on urban roads were used for determining the vehicle categories' shares. The breakdown has to be regarded with caution, because noise exposure estimates and vehicle mileages stem from different sources and the procedure of splitting the total costs does not necessarily represent the vehicle categories' true share in causing noise exposure.

Total costs of rail transport are dominated by noise costs, which were broken down by splitting the total by weighted train kilometres. The weights were estimated based on data from the German Umweltbundesamt, which suggest that on average freight trains cause twice as much noise as passenger trains. The cost breakdown has to be regarded with caution, because noise exposure estimates and train mileages stem from different sources and the procedure of splitting the total costs does not necessarily represent the train categories' true share in causing noise exposure. Costs due to air pollution and global warming are comparably low due to a high share electric traction. As non-fossil power plants (nuclear: 28%, hydro: 13% – including the share of transformation from the public grid) have a considerable share in the railway electricity production, this leads to much lower emissions of air pollutants and CO_2 than traction based on fossil fuels.

Table 79
Total Environmental costs for Germany 1998
- € million -

	Air Pollution	Global Warming	Noise	Nature, Landscape, Soil and Water pollution	Nuclear Risks	Total
Road	8 410	3 849	6 245	967	.	19 472
Passenger Transport	4 460	2 681	3 003	708	.	10 852
Freight Transport	3 950	1 168	3 242	259	.	8 620
Rail	220	153	1 031	41	0.2 [2]	1 444
Passenger Transport	176	108	635	[1]	0.1 [3]	919
Freight Transport	44	45	396	[1]	0.1 [4]	484
Public Transport [5]	21	24	:	:	0.0 [6]	46
Tram & Trolley bus	10	12	:	:	0.0	22
Metro and other	11	13	:	:	0.0	24
Aviation	162	434	278	71	.	945
Airports	86	[7]	278	71	.	435
Flights	76 [8]	434 [8]	.	.	.	510
Inland Waterways	143	55	0	7	.	205
Maritime Shipping	:	:	0	:	.	:
Total	8 957	4 514	7 554	1 086	0.2	22 112

1) No split available according to UNITE principle of *non-arbitrary cost allocation*. – 2) Sensitivity value based on Umbricht and Zweifel (2000): 47. – 3) Sensitivity value based on Umbricht and Zweifel (2000): 31. – 4) Sensitivity value based on Umbricht and Zweifel (2000): 16. – 5) Only mass rapid transport, tramways and trolley buses; diesel buses included in road transport. – 6) Sensitivity value based on Umbricht and Zweifel (2000): 8. – 7) Included in flights. – 8) Based on civil aviation fuel taken in Germany.

Source: IER.

The results of public transport only include vehicles with electric traction. The costs of petrol and diesel buses are included in the road transport sector to avoid double counting. The costs of aviation are dominated by global warming. The category “flights” covers the costs due to emissions of CO_2 and indirect emissions of air pollutants (due to fuel production) based on the civil aviation fuel taken in Germany. For technical reasons CO_2 emissions at airports are included in this category. “Airports” contains costs of pollutant emissions (except CO_2) during the Landing and Take-off (LTO) cycles at 52 German airports.

The major part of the costs of inland waterway transport stems from air pollution. Noise costs are virtually negligible, as it can be assumed that the threshold of 55 dB(A) is hardly exceeded and thus population exposure is not significant.

A comparison of the costs due to road transport with the respective costs given in Infras/IWW (2000) leads to the following picture: The air pollution costs estimated in Infras/IWW (2000) are about four times higher than our estimate. A huge part of this difference is caused by the differences in the underlying road vehicle emission estimates, which are by a factor of 5 higher for PM_{10} and 1.2 higher for NO_x. The considerable difference in PM_{10} emissions stems mainly from the underlying emission factors for non-exhaust emissions (re-suspended road dust, tyre and break wear), where empirical evidence is still scarce. It has to be stated that the UNITE estimate is based on more detailed, spatially disaggregated emission modelling for Germany. Costs due to global warming differ by a factor of 6, mostly reflecting the different values per tonne of CO_2 emitted (€ 135 versus- € 20 /t CO_2). Noise costs are in the same order of magnitude. A more detailed analysis of the differences between the studies should be performed in the future.

In general it has to be noted, that the costs given in Table 79 are only the costs which are currently *quantifiable*. For some modes or cost categories no appropriate data was available. In addition, there are effects, for which currently no consistent monetary values exist (e.g. costs of ecosystem impairment due to nitrogen deposition).

Table 80 shows the environmental costs of road transport for different vehicle types. Passenger cars cause the highest total costs, followed by heavy goods vehicles.

Table 80
Environmental costs road transport Germany 1998
– Disaggregation by vehicle type
- in € million -

	Air Pollution	Global Warming	Noise	Nature, Landscape, Soil and Water pollution	Total
Motorcycles	82	34	417	8	541
Passenger Cars	4 023	2 581	2 436	687	9 727
Buses	355	66	150	13	584
Light Goods Vehicles	469	217	1 545	45	2 276
Heavy Goods Vehicles	3 481	951	1 697	215	6 344
Total	8 410	3 849	6 245	968	19 472

Source: IER/IWW.

In Table 81 the costs are split per vehicle type and road type. Noise costs are not included in Table 81, because breaking down the noise costs to road types would be too arbitrary.

Table 81
Environmental costs road transport Germany 1998 (excluding noise costs) – Disaggregation by vehicle and road type
- in € million -

	Motorways	Other Extra-Urban roads	Urban Roads
Motorcycles	20	65	38
Passenger Cars	2 223	2 579	2 490
Buses	64	112	258
Light Goods Vehicles	178	195	358
Heavy Goods Vehicles	2 518	1 133	996
Total	5 003	4 084	4 140

Note: Categories included are air pollution, global warming, nature landscape, soil and water pollution. Noise costs (total: 6245) are not included, because a split to road type is not possible.

Source: IER/IWW.

The average costs per vehicle km are given in Table 82. With the exception of rail transport, costs were given per vehicle category only, because the different vehicle types are too different to be aggregated. Because the values are presented in vehicle kilometres, vehicles with a high capacity (ships, trains) show a much higher value than vehicles with a low capacity (LGV, HGV).

Table 82
Average environmental costs for Germany 1998
- in € / 1000 vehicle-km -

	Air Pollution	Global Warming	Noise	Nature, Landscape, Soil and Water pollution	Nuclear Risks	Total
Road						
Motorcycles	5.40	2.19	27.2	1.44	.	36.24
Passenger Cars	7.70	4.91	4.6	2.37	.	19.57
Buses	96.40	18.01	40.8	7.74	.	162.92
Light Goods Vehicles	16.10	7.46	53.1	3.61	.	80.28
Heavy Goods Vehicles	71.80	19.60	35.0	5.63	.	131.96
Rail						
Passenger Transport	256	156	922	[1]	0.21	1 334
Freight Transport	203	207	1841	[1]	0.36	2 251
Public Transport						
Tram & Trolley bus	40.76	46.01	:	:	0.07	86.84
Metro and other	30.28	34.18	:	:	0.05	64.51
Aviation	539.04	1 446.36	927.88	235.95	.	3 149.23
Inland Waterways	2 681.2	1026.79	0	129.36	.	3 837.37
Maritime Shipping	:	:	0	:	.	:

[1] No split available according to UNITE principle of *non-arbitrary cost allocation*.

Source: IER/IWW.

4.5.2 Account years 1996 and 2005

Table 83 shows the costs for the 1996 account. Changes compared to the account year 1998 are only small, as the key parameters for environmental costs only changed little within the two years. For road transport and aviation, costs were lower than 1998, reflecting lower mileage/aircraft activities in 1996. For rail transport, costs due to air pollution were higher in 1996, reflecting progress in emission reduction from 1996 to 1998. Costs due to public transport remain constant, which implies slightly higher emissions in 1996 which is compensated by the change in valuation. In inland waterway transport the air pollution costs declined considerably from 1996 to 1998, among other factors caused by the decreasing sulphur content of the fuel used.

Table 83
Environmental costs for Germany 1996
- in € million -

	Air Pollution	Global Warming	Noise	Nature, Landscape, Soil and Water pollution	Nuclear Risks	Total
Road	8 125	3 712	5 977	950	.	18 764
Passenger Transport	4 337	2 634	2 820	695	.	10 486
Freight Transport	3 788	1 078	3 157	255	.	8 278
Rail	252	150	930	41	0.2	1 374
Passenger Transport	201	107	574	1)	0.1	883
Freight Transport	51	43	356	1)	0.1	451
Public Transport 2)	21	25	:	:	0.0	46
Tram & Trolley bus	11	13	:	:	0.0	24
Metro and other	10	12	:	:	0.0	22
Aviation	151	406	260	70	.	887
Airports	80	3)	260	70	.	410
Flights	71 4)	406 4)	.	.	.	477
Inland Waterways	199	52	0	7	.	258
Maritime Shipping	:	:	0	:	.	:
Total	8 748	4 345	7 167	1 067	0.2	21 329

1) No split available according to UNITE principle of *non-arbitrary cost allocation*. – 2) Only mass rapid transport, tramways and trolley buses; diesel buses included in road transport. – 3) Included in *flights*. – 4) Based on civil aviation fuel taken in Germany.

Source: IER/IWW.

The results for 2005 are presented in table 84. Total costs increase by 8% compared to 1998. A forecasted reduction in road air pollution costs due to declining pollutant emissions is compensated by increasing costs of global warming and noise. The most significant increase in costs occurs for aviation. The tremendous increase in activities more than compensates the expected reductions in specific emissions, leading to an increase of total costs of almost 50%. The development for the modes rail, public transport and inland waterways has to be interpreted cautiously, because specific emissions from electricity production, diesel trains and inland waterway vessels were assumed to be constant.

Table 84
Environmental costs for Germany 2005
- in € million -

	Air Pollution	Global Warming	Noise	Nature, Landscape, Soil and Water pollution	Nuclear Risks	Total
Road	*7 030*	*4 555*	*7 825*	*1 119*	*.*	*20 529*
Passenger Transport	*3 782*	*3 129*	*3 691*	*819*	*.*	*11 421*
Freight Transport	*3 249*	*1 425*	*4 135*	*300*	*.*	*9 108*
Rail	*200*	*179*	*1 159*	*48*	*0.3*	*1 586*
Passenger Transport	*150*	*125*	*725*	[1]	*0.2*	*1 000*
Freight Transport	*50*	*54*	*434*	[1]	*0.1*	*538*
Public Transport [2]	*25*	*28*	*:*	*:*	*0.0*	*54*
Tram & Trolley bus	*9*	*10*	*:*	*:*	*0.0*	*19*
Metro and other	*16*	*18*	*:*	*:*	*0.0*	*34*
Aviation	*239*	*692*	*384*	*82*	*.*	*1 397*
Airports	*118*	[3]	*384*	*82*	*.*	*584*
Flights	*121*[4]	*692* [4]	*.*	*.*	*.*	*813*
Inland Waterways	*184*	*70*	*0*	*8*	*.*	*262*
Maritime Shipping	*:*	*:*	*0*	*:*	*.*	*:*
Total	*7 678*	*5 524*	*9 368*	*1 257*	*0.3*	*23 828*

[1] No split available according to UNITE principle of *non-arbitrary cost allocation*. – [2] Only mass rapid transport, tramways and trolley buses; diesel buses included in road transport. – [3] Included in *flights*. – [4] Based on civil aviation fuel taken in Germany.

Source: IER/IWW.

4.6 Taxes, charges, subsidies

This section reports on the transport related taxes and charges which can be compared with the related costs. Furthermore, as far as the available data did allow to do so, subsidies were quantified.

4.6.1 Road transport

Table 85 shows the revenues related to road infrastructure costs for 1996, 1998 and 2005. Revenues from vehicle taxes, fuel taxes and the Euro-Vignette amounted in 1998 to € 37.2 billion. If VAT to be paid on fuel tax is considered too, revenues amounted to € 41.7 billion. Compared to 1996 revenues increased by 3%. For 2005 we estimated total revenues of € 50.9 billion (excluding VAT) and € 57.2 billion (including VAT), which represents an increase from 1998 to 2005 by more than one third. This is clearly an effect of the next steps of fuel tax increases as foreseen in the ecological tax reform. Furthermore, the introduction of the distance-related HGV tax from 2002 onwards contributes to this increase. The fuel tax revenues are in all account years the main contributor to total revenues. In 1996 and 1998 fuel tax revenues had a share of approximately 78% in total revenues, annual circulation tax contributed approximately 21% and the Euro-Vignette revenues made only 1% of total revenues. For 2005 the share of revenues from the distance-related HGV tax will almost remain constant and the revenues from the annual circulation tax will drop to 19%. For the allocation method used in this table please refer to chapter 3.6.2.1.

Table 85 [1)]
Road transport revenues[2)] in Germany 1996, 1998 and 2005
- € million –

	All roads	Motorways	Other Federal Roads	Other Roads
	1996			
Motorcycles[3)]	340	60	72	208
Passenger Cars[4)]	27 648	7 473	6 202	13 973
Buses	368	58	83	227
Light Goods Vehicles[5)]	1 294	323	237	733
Heavy Goods Vehicles[6)]	5 949	3064	842	2 042
Special Vehicles	424	12	80	332
Total	**36 023**	**10 990**	**7 516**	**17 515**
Structure of Revenues:	36 023	10 990	7 516	17 515
Annual Circulation Tax	7 027	1 235	1 068	4 723
Fuel Tax	28 588	9 348	6 449	12 791
Eco Tax	-	-	-	-
Vignette	407	407	-	-
	1998			
Motor Cycles[3)]	413	73	83	257
Passenger Cars[4)]	28 256	7 855	6 264	14 138
Buses	373	62	85	227
Light Goods Vehicles[5)]	1 457	344	266	847
Heavy Goods Vehicles[6)]	6 211	3 467	1 145	1 599
Special Vehicles	441	25	83	333
Total	**37 151**	**11 826**	**7 926**	**17 401**
Structure of Revenues:	37 151	11 826	7 926	17 401
Annual Circulation Tax	7 757	1 363	1 179	5 214
Fuel Tax	28 983	10 051	6 746	12 186
Eco Tax				
Vignette	411	411	-	-
Additional information: VAT on fuel tax and eco tax	4 565	1 583	1 063	1 919
	2005			
Motor Cycles[3)]	*575*	*108*	*117*	*351*
Passenger Cars[4)]	*36 526*	*10 218*	*8 133*	*18 175*
Buses	*505*	*84*	*115*	*306*
Light Goods Vehicles[5)]	*2 231*	*534*	*410*	*1287*
Heavy Goods Vehicles[6)]	*10 478*	*6 553*	*1 663*	*2 263*
Special Vehicles	*602*	*31*	*113*	*458*
Total	*50 917*	*17 528*	*10 551*	*22 839*
Structure of Revenues:	*50 917*	*17 528*	*10 550*	*22 839*
Annual Circulation Tax	*9561*	*1683*	*1 453*	*6 425*
Fuel Tax	*28 937*	*10 101*	*6 696*	*12 139*
Eco Tax	*10 501*	*3 825*	*2 401*	*4 275*
Road pricing	*1919*	*1919*	-	-

[1)] See 3.6.2.1 for allocation methods. – [2)] Excluding military and agricultural Vehicles. - [3)] Including mopeds. - [4)] Including recreation vehicles. - [5)] Up to 3,5 t GVW. - [6)] Over 3,5 t max GVW.

Sources: BAG, BMF, Calculations of DIW.

4.6.2 Rail transport – Deutsche Bahn

Table 86 shows the revenues from track access charges, from station charges and from tariff revenues in passenger and freight transport. For 1998 DB has reported a total of almost € 3.9 billion and from station charges of € 693 million. It was not possible to estimate the revenues from station charges in 1996.

Furthermore, the tariff revenues of DB (which correspond to the supplier operating costs) amounted to € 8.1 billion in 1996 and € 8.6 billion in 1998 (excluding subsidies and VAT). An estimate for 2005 was not feasible due to the fact that the forecasted transport performance mixed DB and non DB companies up to an aggregate. Note, however, that DB has presented a new tariff system which is expected to yield revenues in long-distance passenger transport of about € 3.1 billion p. a. in the next years.

The revenues from fuel tax paid for Diesel consumption in the rail sector were calculated based on information on energy consumption. They amounted in 1998 to € 217 million (excluding VAT). VAT of € 34 million can be added to this value.

Subsidies to DB are granted for several purposes. First of all, the financial measures taken within the railway reform process 1994 have to be mentioned which amounted in total to € 149 billion and contained:

- outstanding debts of the two former rail companies DB and DR (€ 36 billion),
- additional costs of material and personnel arising from the outmoded technology used at the East German DR (€ 26 billion),
- costs of "catching up" investments for the East German DR and expenses arising from DR's ecological legacies (€ 17 billion),
- obligations concerning civil servants employed by DB (€ 29 billion),
- adjustment of the opening balance sheet of DB AG (€ 41 billion).

The figures given here are total figures, an allocation to single years is only partly possible.

Table 86
Revenues from taxes, charges and tariffs in rail transport – Deutsche Bahn AG
– € million –

Type of revenue/ type of transport	Track access charges	station charges	Tariff revenues[1)]	fuel tax	VAT on fuel tax
			– 1996 –		
Regional passenger transport	1958	:	1722	173	26
Long-distance passenger transport	900	:	2735	28	4
Freight transport	762	:	3673	35	5
Total	3620	:	8130	236	35
			– 1998 –		
Regional passenger transport	:	:	2516	159	25
Long-distance passenger transport	:	:	2712	26	4
Freight transport	:	:	3386	32	5
Total	**3873**	**693**	**8614**	**217**	**34**
			– 2005 –		
Regional passenger transport	*:*	*:*	*:*	*:*	*:*
Long-distance passenger transport	*:*	*:*	*:*	*:*	*:*
Freight transport	*:*	*:*	*:*	*:*	*:*
Total[2)]	***4090***	***780***	***:***	***213***	***34***

[1)] Excluding subsidies and VAT. [2)] No breakdown to transport types possible.

Sources: Deutsche Bahn AG, Calculations of DIW.

Table 87 summarises the subsidies paid to DB. Basis for the figures in this table was an analysis of the Federal budget plans whereby only those payments were considered which are not already included at the cost side. We did not estimate subsidies for 2005.

Table 87
Subsidies for DB 1996 and 1998
– in € million –

Items	1998	1996
Interest payments for debts before 1994	-	2 341
Payments for administrative costs of Bundeseisenbahnvermögen	4 928	5 113
Payments for pensions	252	199
Payments for health insurance costs of civil servants of former Bundesbahn	-	-
Payments for compensating additional personnel costs of former Reichsbahn due to the out-moded technology	1 189	1 603
Payments for excessive costs of level crossings	44	77
Payments for ecological burdens and additional material expenses of former Reichsbahn	752	1 038
Payments for civil defence purposes at DB	10	-
Debt payments	-	153
Total	**7 175**	**10 524**

Sources: Federal budget plans for fiscal years 1998 and 2000 with reported figures for fiscal years 1996 and 1998.

In 1998, € 4 244 million in subsidies in the form of compensation for concessionary fares were paid to the DB. In 1996, this form of compensation amounted to € 3 815 million.

4.6.3 Non-DB railways

As discussed in chapter 3 it was not possible to obtain reliable information on track access charges paid for using tracks of non-DB railways since the response rate of the company survey conducted by VDV was much too low. We mention here that the small number of companies which responded reported track revenues of € 35.6 million. We do not report this figure in the account due to the reasons mentioned above.

Tariff revenues as the corresponding item to the supplier operating costs were taken from BMVBW/DIW (2000). They amounted to € 424 million (1996) and € 419 million (1998) respectively. These figures include subsidies paid for reduced tariffs for certain social groups. For the same reasons mentioned in section 4.6.2 it was not possible to forecast tariff revenues of non-DB rail companies.

Revenues from fuel taxes paid for Diesel traction were calculated out of energy consumption figures given in BMVBW/DIW (2000) and amounted to € 17 million (1998) and € 24 million (1996 excluding VAT). For 2005 estimated that non-DB companies will pay about € 31 million at fuel taxes.

It was not possible to quantify subsidies paid to non-DB railways. Due to the fact that they are partly in the ownership of federal states and municipalities, this would have required an analysis of all respective public budget plans.

Table 88
Revenues from taxes, charges and tariff revenues in rail transport
– non DB-rail companies –
– in € million –

Type of revenue/ type of transport	Tariff revenues [1)]	Fuel tax	Out of these: Eco tax	VAT on fuel tax
1996				
Passenger transport	189	:	0	:
Freight transport	235	:	0	:
Total	**424**	**24**	**0**	**4**
1998				
Passenger transport	199	:	0	:
Freight transport	220	:	0	:
Total	**419**	**17**	**0**	**3**
2005				
Passenger transport	*:*	*:*	*:*	*:*
Freight transport	*:*	*:*	*:*	*:*
Total	*:*	***31***	***10***	***5***

[1)] Including subsidies
Sources: VDV, BMVBW/ DIW.

4.6.4 Public transport excluding rail

Taxes and charges which could be directly allocated to infrastructure use do not exist in public transport. For tariff revenues and at least parts of subsidies, the federal Statistical Office provides a good data base. Due to lack of data on energy consumption as a separate figure for public transport excluding rail it was not possible to estimate revenues of the state from fuel taxation. However, it should be borne in mind that the road account contains the fuel tax paid by buses, most of this item referring to public transport.

The only subsidies reported for public transport are compensation payments for reduced tariffs or transport types with free tickets. Infrastructure subsidies are already considered at the cost side like in all other modes due to the principle of including all investments independent of their origin and/ or financial source. Subsidies paid for the municipal companies for running costs, for debts etc. were not estimated since this would have required to analyse all respective financial flows in all municipal budgets.

Table 89 summarises the revenues (including subsidies for concessionary fares) for public transport excluding rail. Total tariff revenues amounted to € 8429 million in 1996 and to € 8884 million in 1998. For 2005 we estimated revenues of € 8800 million, e.g. slightly declining revenues due to the fact that the official transport forecast yielded a slightly declining transport performance for this mode.

Table 89
Tariff revenues and subsidies of public transport (excluding rail) [1)]
– in € million –

Type of revenue	1996	1998
Tariff revenues from scheduled transport	3 993	4 215
Tariff revenues from special forms of scheduled transport [2)]	160	141
Subsidies for compensating losses due to reduced tariffs [3)]	1 485	1 622
Revenues from charter transport	1 443	1 488
Revenues from school buses with free tickets	442	420
Revenues from transport on behalf of other transport companies	907	999
Total	**8 430**	**8 885**

[1)] Excluding VAT. Transports with buses, tram, metro. Municipal and private companies, including taxis and car rental.
[2)] For example: buses to workplace where other passengers are excluded, school buses with (reduced) tariffs to be paid.
[3)] Reduced or free tickets for school children, apprentices, students, disabled persons, pensioners etc.

Sources: Federal Statistical Office, calculations of DIW

4.6.5 Aviation

Table 90 shows the revenues of airports, of German National Air Control (DFS) and those of the aviation related meteorological services of DWD. Total aviation related revenues amounted to € 3937 million in 1998 and to € 3859 million in 1996. For 2005 we estimated revenues of € 5 803 million. Analysing the structure of revenues we can observe for 1998, the core year of accounts, the following:

Table 90
Revenues and subsidies of aviation infrastructure in Germany 1996 and 1998
– in € million –

Type of revenue	1996	1998	*2005*
1. Airports			
Start and landing fees	909	918	*:*
Out of these:			
Fixed part	544	471	*:*
Variable part	365	448	*:*
Parking fees for aircrafts	21	39	*:*
Revenues from ground services[1)]	1007	1022	*:*
Revenues from renting and leasing[2)]	372	373	*:*
Turnover charges including concession charges	230	272	*:*
Other turnovers[3)]	218	334	*:*
Other revenues[4)]	169	162	*:*
Total airport revenues	2925	3121	*4690*
2. National Air Control (DFS)			
Navigation charges for aircraft approach	423	233	*:*
En-route navigation charges	251	409	*:*
Compensation payments from the federal government[5)]	67	64	*:*
Other revenues	131	62	*:*
Total revenues DFS	872	768	*1065*
3. German Meteorological Services (DWD)	63	48	*50*
Total revenues	**3860**	**3937**	***5805***

[1)] Including freight and trucking fees. - [2)] Including long-term aircraft parking, renting of buildings etc. – [3)] Revenues from own retailing, restaurants, guided tours etc. - [4)] Revenues from interests. - [5)] For military flights, flights on sight approaching rules, flights which are exempted from navigation charges, payments for the affiliation in Maastricht.

Sources: ADV, DFS, DWD.

- In 1998, the German airports earned about € 3.1 billion. The largest part of this amount were revenues received for ground services and trucking services (one third of all revenues) and the start and landing fees which amounted to about 29 % of all airport revenues. The remaining revenues refer to renting, leasing and long-term aircraft parking, to turnover charges including concessions of non-aviation related business and to other revenues.
- German Air Control received in 1998 about € 0.8 billion. More than half of these revenues were earned by en-route navigation charges and one third by navigation charges to be paid

for aircraft approach to airports. A smaller amount of € 64 million was received from the federal government for compensation for flights which are exempt from paying navigation charges.

- German Meteorological Services (DWD) earned € 48 million for weather forecast and other meteorological services in relation to aviation in 1998.

Subsidies for infrastructure financing are – as in all modes – considered at the cost side. Subsidies for compensation payments are shown separately in table 90. No tax on kerosene is charged in Germany for commercial aviation, this can be considered to be an indirect subsidy to the aviation sector and the revenue loss is estimated for 1998.

4.6.6 Inland waterways

Revenues of inland waterborne transport that relate directly to infrastructure costs are first of all infrastructure user charges such as canal charges, waterway charges, pilotage charges and charges, fees and other payments at inland waterway harbours. Inland waterborne transport is exempted from paying fuel tax which can be considered as an indirect subsidy. Revenues of companies operating waterborne transport were not estimated since in the UNITE conventions it was agreed to estimate supplier operating costs (and the respective revenues) for rail and public transport only.

The infrastructure user charges of inland waterways were obtained from the Federal Ministry of Transport. They amounted to € 75 million in 1998 and € 76 million in 1996. However, in these totals no revenues from charges for pilotage are included. For 2005 we estimated revenues from infrastructure user charges of € 85 million. In contrast to waterways no data on revenues of inland waterway harbours were available.

4.6.7 Maritime shipping

Revenues in maritime shipping that relate directly to infrastructure costs are charges, fees and other payments at seaports and pilotage charges, as far as they do not belong to such coastal areas which are still defined as inland waterways. The data situation concerning revenues of seaports is the same as for inland waterway harbours. The last available figure (1990, West Germany only) presents total revenues (including VAT) of € 1 370 million. We were consequently not able to report any figure on these revenues in the German pilot accounts.

Revenues of operators in maritime shipping were not estimated since in the UNITE conventions it was agreed to estimate supplier operating costs (and the respective revenues) for rail and public transport only.

5 Summary of results for Germany

5.1 Road transport

Table 91 presents the costs and revenues of German road transport in 1996, 1998 and 2005. In 1998, the core year of the pilot accounts, by far the largest cost block were accident costs. Total social accident costs amounted to € 72.5 billion, out of these were 20% (€ 14.6 billion) 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 core and additional environmental costs with almost € 20 billion. Congestion costs which refer in the UNITE accounts to costs of delay (e.g. time and fuel costs) and not to the deadweight welfare loss of congestion were at € 17.4 billion, 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, with € 411 million, only 1% of all road transport related taxes and charges were directly raised for covering infrastructure costs. Note, however, that the charging and taxation regimes 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 will increase at € 1918 million in 2005, this is four times higher than in 1998. Total road transport related revenues will increase by more than one third. This effect will mainly be caused by the eco tax raised together with the fuel tax on fuel consumption. This tax was introduced in 1999 and increases yearly until a maximum of € 0.15 per litre is reached in 2003.

Table 91
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)] An Eco tax has been raised on fuel consumption since 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.

Sources: DIW, IER, IWW.

The following tables are summarised from chapter 4 and are intended to provide additional information for the road account.

Table 92
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	0.0112	0.0258	0.0985	0.0455	0.2070
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.

Sources: DIW, IER, IWW.

Table 93
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)]		**1 013.4**	**3 727.9**	**17 143.8**	**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.

Sources: DIW, IER, IWW.

Table 94
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	1 264
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)]	**10 467** [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.

Sources: DIW, IER, IWW.

Table 95
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.

Sources: DIW, IER, IWW.

Table 96
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.

Sources: DIW, IER, IWW.

5.2 Rail transport – National rail carrier DB

As can be seen from table 97 the largest cost blocks in the rail account for DB are infrastructure and supplier operating costs which are both in the same order of magnitude (€ 12.6 billion and € 11.6 billion respectively). More than one third of the supplier operating costs are track and station charges paid to DB Netz. Environmental costs are with € 1.4 billion the highest block of the remaining cost categories. Note that also non-DB rail carriers are included in the figures for environmental costs, accident costs and congestion costs since the data situation did not allow a separation between 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). The expected cost reduction programmes will lead to an only moderate increase of supplier operating costs by 5% while the necessary infrastructure investments (both replacements and new investments) will be responsible for an increase of infrastructure costs by 11%.

Total rail transport related revenues (excluding subsidies except subsidies for concessionary fares which can be seen as a payment of services) amounted in 1998 to € 17.7 billion. User tariffs including subsidies for concessionary fares amounted to € 12.9 billion. Total supplier operating costs, including access charges, were estimated to be € 11.6 billion. Infrastructure user charges consisting of rail track access charges and station charges were € 4.6 billion. This revenue category relates directly to infrastructure costs. 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 DB network in 1994 also a change towards direct user charges was introduced.

Due to the extremely high level 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.

Table 97
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	:	:	*:*
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 raised since 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.

Sources: DIW, IER, IWW.

The following tables provide additional information for the national rail account summarised from chapter 4.

Table 98
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	6.45	25.12
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.

Sources: DIW, IER, IWW.

Table 99
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.

Sources: DIW, IER, IWW.

5.3 Rail transport – Rail Companies other than National Rail (non-DB companies)

It was not possible to compile a complete rail account for non-DB companies due to serious data problems. An interpretation of results is limited to infrastructure costs, revenues from user tariffs, the fuel and eco tax and VAT separately since an inclusion in the DB account would bias the results for DB. Due to the fact that most of the cells in the non-DB account are empty we consider this rather as additional information. Future work should focus on closing the gaps here.

Infrastructure costs of non-DB companies amounted in 1998 to € 586 million which is related to the network length but show only half of the costs per km that occurred at DB Netz. For 2005 an increase by 17% was estimated. The introduction of the eco tax and the assumption that in future non-DB companies will win more competitive tenders of regional passenger services than DB will lead to an increase of fuel and eco taxes to be paid by non-DB companies by about 82%.

5.4 Public transport with tram, metro and trolley bus

As for the non-DB railways it was not possible to develop a complete pilot account. Table 101 shows that in particular the categories infrastructure costs, supplier operating costs and noise costs could not be quantified due to methodological difficulties and/or data problems. Note furthermore, that buses are included in the road account.

As to be expected, 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 be € 125 million in 1998 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 of this component of infrastructure costs by 9% was forecast.

Table 100
German rail account for non-DB rail companies 1996, 1998 and 2005
- € million at 1998 prices –

Costs **Core information**	**1996**	**1998**	***2005***
Infrastructure Costs	569	586	*685*
Fixed	:	:	*:*
Variable	:	:	*:*
Services			
Supplier operating costs [5]	:	:	*:*
Accident costs (user external)[6]	:	:	*:*
Environmental costs[6]	:	:	*:*
Air pollution			
Global warming			
Noise			
Additional information			
Congestion costs[7]	:	:	*:*
Accident costs (user internal)[6]	:	:	*:*
Environmental costs[6]	:	:	*:*
Nature and landscape, soil and water pollution[8]			
Nuclear risk[8]			
Revenues			
Directly related to Infrastructure Costs			
Track charges[1]	:	:	*:*
Fixed	:	:	*:*
Variable	:	:	*:*
Station charges[1]	:	:	*:*
Directly related to Supplier Operating Costs			
Subsidies for concessionary fares	424	419	*:*
User Tariffs[4] [5]			
Other transport specific revenues			
Fuel tax	24	17	*21*
Eco tax[2]	0	0	*10*
VAT[3]	4	3	*5*
Subsidies[9]	:	:	*:*
Non-transport related revenues of rail companies	:	:	*:*

[1] Track access charges received by other than non-DB companies for the use of non-DB networks. – [2] Eco tax raised since 1999 and collected together with fuel tax. – [3] VAT levied on fuel and eco tax. – [4] Compensation payments for concessionary fares, other subsidies and VAT are excluded– [5] Included within these costs and revenues are rail track and station charges of € 112 million for 1996 (excluding station charges due to lack of data), €337 million for 1998 and estimate of €363 for 2005. – [6] Figures are included in the National Rail account. [7] Expressed as delay costs. Figures are included in the National Rail account. – [8] 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. Totals are included in the National Rail account. – [9] – 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.

Sources: DIW, IER, IWW.

Table 101
German public transport account for 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 (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 (internal)[2]	24	26	*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[2]	:	:	*:*
Eco tax[2]	:	:	*:*
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. Eco tax and VAT on eco tax for electric traction of tram and metro operation not available. – [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.

Sources: DIW, IER, IWW.

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. The tables 101 - 103 show the total costs for the three UNITE account years and a summary of allocated costs for the main account year 1998.

Table 102
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.

Sources: DIW, IER, IWW.

Table 103
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

Sources: DIW, IER, IWW.

5.5 Aviation

By far the largest cost block in 1998 for the air transport account were infrastructure costs which amounted to € 3.5 billion (see table 104). Total core and additional environmental costs represented € 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 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 € 4 billion in 1998. It is expected that they will increase up to 2005 by 47% to € 5.8 billion. This will mainly be caused by an increased number of passengers carried.

According to the conventions set for the UNITE accounts indirect subsidies can be added as additional information. Indirect subsidies play a major role in the aviation sector. Aviation is exempted from paying kerosene tax and from paying VAT on the ticket price of international flights. According to a DIW study on subsidies in the aviation sector for the German aircraft group Lufthansa, (see DIW 2001) the tax loss due to the lack of kerosene taxation amounted in 1998 to € 2262 million (calculated using a weighted average tax rate in the EU countries of 0.39 €/litre) and the VAT loss to € 252 million.
In the following tables the total costs and revenues for the three UNITE years and further information summarised from chapter 4 for the base year 1998 are presented.

Table 104
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 raised since 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: DIW, IER, IWW.

Table 105
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.

Sources: DIW, IER, IWW.

Table 106
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	:	:	:
Environmental costs[1)]			
Nature, landscape, soil and water pollution	:	:	71
Nuclear risk	•	•	•
Total II	:	:	**365**
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.

Sources: DIW, IER, IWW.

5.6 Inland waterways

Infrastructure costs play the major role in inland waterway transport. This can be seen in table 107, although we were not able to estimate the infrastructure costs of inland waterway harbours due to the lack of data on infrastructure running costs. The available figures (total infrastructure costs of € 1203 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. 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 the waterways 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 € 1203 million. Note, that similar to air transport no fuel taxes have to be paid which has to be considered as an indirect subsidy. For fuel tanked within Germany an estimation of revenue loss could be made.

Table 107
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 (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[4]	:	:	*:*
Accident costs (internal)	:	:	*:*
From this: risk value	12	8	*11*
Environmental costs			
Nature and landscape, soil and water pollution[5]	7	7	*8*
Nuclear risk[5]			
Revenues			
Directly allocatable			
Charges for infrastructure usage[1]	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[2]	0	0	*0*
VAT[3]	0	0	*0*
Subsidies [5]	12	15	*:*
Non-transport related revenues of ports	:	:	*:*

[1] Excluding charges for pilotage due to lack of data. – [2] Eco tax raised since 1999 and collected together with fuel tax. – [3] VAT levied on fuel and eco tax. – [4] Expressed as delay costs. – [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.

Source: DIW, IER, IWW.

5.7 Maritime shipping

Maritime shipping is the only mode were we were not at all able to compile any figure on costs and revenues except for infrastructure capital costs. The gross and net capital values and capital costs are given in table 53. This reflects the very poor data situation within this transport mode. 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. The following summary tables are provided as additional information for the shipping accounts.

Table 108
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.

Sources: DIW, IER, IWW.

Table 109
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.

Sources: DIW, IER, IWW.

6 Conclusions

In this annex report we have presented the results on costs and revenues of all transport modes for Germany in 1996, 1998 and 2005. Summarising up, it was possible to estimate the majority of the categories described in Link et al. (2000 b):

- 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 and air transport only. 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 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.

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 for Germany and also considering the remaining gaps in the German pilot accounts 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).

For the German transport policy this is an important issue in the ongoing policy debate on the level of the planned HGV charges. Here it can contribute to the question whether the general charge level for HGV and the charge levels between vehicle classes are properly defined.

However, the pilot accounts cannot be used to assess equity between individual users or user groups defined by income classes.

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 the planned German HGV charging scheme, not only in a national context but moreover 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 (2000b). Although the accounts are comprehensive they can not be considered to be all inclusive. This leads to the conclusions for future work.

6.2 Open questions and future improvements

There are still gaps in the German pilot accounts. 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 and for aviation. At this stage we can draw conclusions for future work:

- 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.

- Data problems also 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). These companies do not have a separate bookkeeping for infrastructure and operation and they usually do not provide separate figures for buses, trams, metros. Furthermore, in Germany they are organised within VDV (Association of public transport companies) together with rail passenger and rail freight companies. The statistical sources provided by VDV therefore embraces all these companies together. This latter problem is a specific German one, while the other problems will probably also occur for the next tranches of UNITE accounts.

- 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.

- Further data problems concern inland waterway transport where it was not possible to estimate infrastructure and supplier operating costs as well as revenues of inland waterway harbours. The response rate of questionnaires was too low for estimates. 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.

- The main methodological problems occurred when estimating supplier operating costs, caused by the above mentioned data problem in the rail and public transport sector in Germany.

- 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 expense.

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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 accidential 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).
CORINAIR	Programme to establish an inventory of emissions of air pollutants in Europe. It was initiated by the European Environment Agency Task Force and was part of CORINE (COoRdination d'Information Environmentale) work programme set up by the European Council of Ministers in 1985. End of 1994 the EEA's European Topic Centre on Air Emissions (ETC/AEM) took over the CORINAIR programme.
Earmarking	Direct interlinkages between the financial source and the financial purpose, in order to secure financial resources. In practice, specific funds are used therefore (e.g. earmarking road pricing revenues and financing of road infrastructure or environmental measures).
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 tons.
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.

NUTS — Nomenclature of territorial units for statistics; level 0 = countries, level III = départements, Kreise, etc. (depending on country considered).

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.

Passenger car unit — (= PCU) PCU is used in order to standardise vehicles in relation to a passenger car. Speed and lengths differentials are most common.

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 - a 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.

Survival function Survival functions are used in rather refined perpetual inventory models. The survival function g (i) is based on the assumption that the service lives of assets within an investment vintage are dispersed around the mean. g (i) explains then which share of investments within an investment-vintage still exists in the capital stock after i years. The survival function is characterised by a downwards slope of shares between 100 % (in the first year of investment) and 0 % (after exceeding the maximal lifetime of all assets in the investment vintage).

Synthetic method One of the two main methods to value the existing road network (see also: perpetual inventory method). The synthetic method values the road network by estimating what it would cost to replace the road network with assets of equivalent quality. The method therefore involves measuring the existing physical assets, in terms of road length of particular types, bridges, etc, and then multiplying these measures of physical assets by unit replacement costs, such as the cost of constructing a motorway with the same physical characteristics as the existing one.

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 state (or reveal) 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 statistical 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 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.

YOLL Year of life lost

Abbreviations

BASt	German Highway Research Institute
bill.	billion
BMVBW	German Ministry of Transport, Building and Housing
CO_2	Carbon dioxide
COI	Cost of illness
dB(A)	Decibel, weighted with the *A*-filter. Logarithmic unit of sound pressure level.
DB	German National Railways = Deutsche Bahn
EMEP	European Monitoring and Evaluation Programme
FSO	Swiss federal statistical office
GDP	Gross Domestic Product
GDV	German Association of Insurance Companies
GIS	Geographical Information System
GVF	Service for transport studies (Switzerland)
GVW	Gross vehicle weight (weight of the vehicle itself and the weight of the payload)
HGV	Heavy goods vehicles (goods vehicles with a maximum GVW equal or more than 3,5 tonnes)
Kph	Kilometres per hour
kWh	Kilowatt hour
LAeq	Energy equivalent noise level
LGV	Light goods vehicles (goods vehicles with a maximum GVW less than 3,5 tonnes)
LTO	Landing and take-off cycle
mill.	Million
MWh	Megawatt hour
n.a.	No data available
NMHC	Hydrocarbon
NMVOC	Non-methane volatile organic compounds
NOx	Nitrogen oxides (mix of NO and NO_2)
NUTS	Nomenclature of territorial units for statistics; level 0 = countries, level III = départements, Kreise, etc. (depending on country considered)

PCU	Passenger car unit
PIM	Perpetual Inventory Model
PM_{10}	Fine particles with a diameter of 10 µm and less
$PM_{2.5}$	Fine particles with a diameter of 2.5 µm and less
PPP	Purchasing power parity
PT	Public transport
SOC	Supplier operating costs
SO_2	Sulphur dioxide
SRWP	Steady reduction of working power
UPT	Urban public transport
VDV	German Association of Railways and Public Transport Operators
v-hours	Vehicle hours
v-km	Vehicle kilometres
VOC	Volatile organic compounds
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