Environmental and Social Transport Costs: a case study of Ireland

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ABSTRACT

The aim of the EU funded UNITE research project was to provide information about the costs, benefits and revenues of all transport modes including environmental and social costs. The project involved compiling accounts for 18 countries across Europe with each country having its own set of accounts in such a format that comparisons, where possible, could be made. The paper focuses on the latter two sets of costs i.e. environmental and social for Ireland. The account presented here is a pilot account (rather than an ideal account) i.e. the actual, feasible accounts given the available data. The costs are reported and documented at the current level of transport demand for the reference year 1998 but data for 1996 and projections for 2005 are also included where data and historical trends allow. The paper concludes with some comparisons between transport costs in Ireland and some of the other European countries examined in the UNITE project. The accident costs in Ireland (€50/capita) lower than those for Denmark (€120/capita), Netherlands (€80/capita) and about the same as Spain (€50/capita), are considerably less than those in Austria (€160/capita) and larger than those of France (€20/capita) and the UK (€25). Noise costs are €100/capita and are close to those of France, Spain and the UK. They are higher than those of Netherlands (€20/capita) and Austria (€40/capita).

BACKGROUND

The pilot accounts compiled in the UNITE project (*1*) attempt to show the general relationship between costs of transport and the revenues from transport pricing and charging. The aims and role of the pilot accounts are discussed in detail in Link et al (*2*). The accounts are aimed at providing the methodological and empirical basis for in-depth policy analysis rather than as a guide for immediate policy actions such as setting prices and charges or shutting-down transport services in order to achieve cost coverage. They compare social costs at 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 (*1*). They consider the country-specific situation and the existing institutional frameworks. The pilot accounts show the level of costs and charges as they were in 1998 as well as in 1996 and extrapolated for 2005 where data and historical trends allow.

In the European Commission's White Paper "Fair payment for infrastructure use" (*3),* 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 estimates. The loss of lives and the reduction of health and prosperity through transport accidents are of major concern. 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. The external part of accident costs, defined here as accident costs imposed by transport users on the rest of society, is included but total accident costs, however, include a substantial proportion of costs imposed by one user on others and these are included as well where possible.

A wide range of transport related environmental impacts and effects are considered under environmental costs. Included in this cost category are: air pollution, global warming and noise. However, they do not include the environmental costs incurred during the manufacturing of vehicles. All calculations for air pollution and noise with the EcoSense model running at the Institute of Energy Economics and the Rational Use of Energy of the University of Stuttgart. The model was developed within the series of ExternE Projects on "External Costs of Energy" funded by the European Commission (*4).*

Transport taxes and charges are exceptionally heterogeneous throughout Europe. 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 also considered. The need to maintain free and undistorted competition is recognised as being one of the basic principles upon which the European Union (EU) is built. State aid or subsidies are considered to distort free competition and eventually cause inefficiency.

INPUT DATA

Table 1 contains the most important basic economic data used in the cost estimations (*5*) and Table 2 shows a summary of the available base data for the different modes for 1998 (*1*). For the purposes of the paper the main focus will be on road and rail modes although in the case of rail sometimes data is non existent and in those cases no results for rail will be presented in the paper. The car is the predominant mode of transport making up to 71% of all million v.kms travelled in 1998, light and heavy goods vehicles make up 26%, buses about 1% and the remainder motorcycles. A 16% increase in passenger transport from 1998 to 2005 and a

reduction in rail freight of 23% between 1998 and 2005 are used for the predictions in line with current trends.

Congestion Costs

The Value of Time (VOT) per passenger-hour are taken from the UNITE valuation paper (*6*), are purchasing power parity (PPP)-adjusted and converted into factor costs (commuting and leisure values only). According to the valuation paper (*6*) it was assumed that VOT grow over time in line with real incomes (elasticity of 1.0 to the country's real GDP per capita). Table 3 shows the values used for estimation of Irish congestion costs. In the case of rail, only information on aggregate punctuality of the train services was available so estimates of congestion costs in this case could not be made.

Accident Costs

The methodology and steps to calculate the costs of transport accidents is described in Link et al. (*2*) and in more detail in Doll et al. (*7*). In these documents, comprehensive lists of data requirements are stated. For the assessment of total accident costs, input data concerning several cost blocks is required to be collected. Table 4 summarises the main cost blocks that add up to the total costs of traffic accidents and it also includes the value assigned to a statistical life and the assumptions made about injuries.

The number of road accidents is published annually by the National Roads Authority (NRA) in their yearly Road Accident Facts (RAF) (*8*) and reports at a level of detail which shows the numbers killed, numbers injured, age group, gender, road user type and area type (location of accident – urban/rural). However, there does not appear to be agreement between the levels of accidents reported by the NRA and insurance industry data (*9*). The official data includes reporting by the police force (Gardai) and hospital admissions while industry data is based on the needs of individual insurance companies to meet claims. A research study looking at hospital admissions which is currently underway is likely to generate possibilities in providing estimates on accidents but this work is not yet complete.

A study conducted for the National Safety Council (*9*) conducted an examination of road accidents in Ireland using existing available data in Ireland and translation of UK costs to Irish conditions. Another study (*10*) conducted for the Department of Public Enterprise on the environmental impact of Irish transport growth of related sustainable policies and measures makes estimates of accidents costs for some modes. These two studies are used as the basis of estimation of accident costs.

The number of fatalities and injuries caused by rail accidents are available from Irish Rail (IR). The statistics contain detailed information about the different type of accidents (e.g. accidents during shunting, involved categories of persons (employees, passengers and third parties), accidents on level crossings). However, the distinction between freight and passengers trains is not made.

Environmental costs

The environmental cost category contains different types of costs: air pollution, global warming and noise. Estimates could not be made for nature, landscape or for nuclear risk for Ireland. For quantifying the costs due to airborne pollutants the *Impact Pathway Approach,* the methodology developed in the ExternE project series (*4*) has been applied. It comprises the steps; emission estimation, dispersion and chemical conversion modelling, calculation of physical impacts, and 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 emission inventory, Europe-wide impacts are calculated and subtracted from impacts resulting from a reference inventory without these emissions. This procedure using a reference inventory is required,

because of air chemistry processes where "background" emissions play an important role. Besides emission data, the distribution of the population over space is the second central input for the calculations of the most important costs of air pollution, i.e. the health costs. This type of exposure data is not available for Ireland.

In the case of Ireland, estimates of emissions are made by the Environmental Protection Agency (*11*) using an energy balance model for fuel used in all road vehicles. Table 5 shows the emissions estimate for road transport using the energy balance for 1998 along with particulate matter estimates. Some estimates for rail and air transport are presented in the study commissioned by the Department of Public Enterprise (*10*). For the global warming calculations, the input data for the calculation of the costs of CO_2 are made using fuel consumption data and from information on energy consumption and the electricity production mix (rail).

Insufficient data is available to quantify the proportion of the population that is exposed to different levels of noise accurately. Tinch (*12*) estimated levels for a range of EU countries. In the case of Ireland he estimated that 0.8, 0.59, 0.38, 0.22, 0.07 and 0.02 million people were exposed to road noise levels of 50-55, 55-60, 60-65, 65-70, 70-75, and 75+ dB(A) respectively and that 0.15, 0.11, 0.07, 0.03, 0.01 and 0.01 million people were exposed to the same levels of rail noise.

METHODOLOGY

Congestion Costs

In order to estimate congestion costs on the entire network, a series of simplifying assumptions were required. For its travel time estimates, the NRA uses a simulation model which treats a year on the basis of 250 working days. The model has five traffic conditions – traffic is at average level (median), days on which traffic is moderately light, moderately busy days, extremely busy days and extremely light days. The 250 days are divided as follows by the NRA:

Median: 80 days
Moderately light: 80 days
Moderately busy: 80 days
Extremely busy: 5 days
Extremely light: 5 days

One of the difficulties when concentrating only on 250 working days is that weekend travel is excluded. Significant delays can be experienced on Sunday evenings particularly on the main routes to Dublin. The other point is that there can be considerable fluctuations within any one day and this may generate sizeable errors in any estimate of congestion costs based on this breakdown of traffic. However, in the absence of detailed delay studies, the data available was used with a series of assumptions to estimate congestion costs on the road network.

The first assumption made was the level of delay on any one of the particular types of day. It was assumed that for extremely busy days the average delay in the bigger towns was 2.78 mins using data on a number of towns from the NRA and in the case of the others 0.14 minutes. It was assumed on moderately light days and on extremely light days that there was no delay. On moderately busy days it was assumed that the delay was 50% that experienced on extremely busy days and in the case of the median days, it was assumed there would be some delay on those days also, of the order of 25% or the extremely busy days.

The values of time used in the calculation are presented earlier. For the purposes of this calculation it was assumed that 0.2 of traffic on the network is business related, 0.6 is commuting and 0.2 is leisure traffic (*13*). To estimate the additional fuel costs due to

congestion the same rate used in the German UNITE accounts is used here i.e. that a vehicle consumes 0.05 litres/km more in congested conditions. It should be noted that the delay costs estimated here are rough and significant errors may be associated with them.

Insufficient data was available to conduct congestion delay estimates for rail in Ireland.

Accident Costs

Two issues concerning the calculation of the accident costs deserve some further methodological discussion in this section (*1*):

– the consequences of the victim perspective of UNITE with regard to cost allocation

– the distinction between system-internal and -external costs

UNITE follows, in the case of accident costs, the "victims perspective" (monitoring perspective). Another important methodological aspect is the distinction between internal and external costs with regard to the risk value, i.e. the willingness-to-pay (WTP) for avoiding death casualties or injuries caused by traffic accidents. Looking at the order of magnitude of this "cost block", this distinction crucially influences the total level of the external accident costs. In the theoretical part of the UNITE project (*14*) it is mentioned that this distinction depends on the risk awareness of the individuals participating in transport.

Under this perspective of the transport system, the risk value (WTP-value) is an internal cost block because it refers to actors of the transport system. Only the grief and suffer of the relatives would be transport system external. However, in Doll et al. (*7*) it is made clear that due to data and information problems it is not possible within UNITE to separate this part of the WTP-value from the part referring to the victim of the traffic accident itself. The risk value is not internalised because the understanding taken is that internalisation is cost allocation according to the "polluter-pays-principle" which is not the case here. The external cost part is limited to those transfer payments from the social security to persons involved in accidents that are not covered by payments of the auto liability insurances (i.e. transport system internal insurances) to the social security. The victims perspective used in the UNITE project has advantages with regard to data collection (the information about the causer of accidents is in many countries not immediately available) but it has considerable disadvantages when it comes to cost allocation and the distinction between internal and external cost parts that is very relevant for pricing.

The total number of reported accidents is available for the year 1998 for road transpor**t.** In the case of rail transpor**t,** data over several years is used to estimate an equivalent number of accidents per year. In the case of road, data is available for the distribution of the accidents to the different vehicle categories and according to the severity of the accidents.

Environmental Costs

In the case of road transport, the total emissions of most air pollutants increased in Ireland matching a growth in traffic. Unlike other countries though e.g. Switzerland, the presence of 'cleaner cars' does not appear to have initiated a decrease in emissions from the road sector. Ireland experienced increased economic activity during the period under consideration and it is thought that this has had an effect on the higher levels of demand for road transport which may mask any improvements as a result of clean cars. Modest increases are used in projections to 2005.

In the case of rail transport, a report commissioned for the Department of Public Enterprise (*10*) gave some estimates of emissions for 1996 but few further estimates or measurements have been made.

Noise

Noise estimates could not be found for any modes. Given the lack of data on this topic and the difficulty in predicting changes given the non-linearity of the relationship between traffic growth and noise levels, it is proposed to use the set of estimates by Tinch presented earlier.

RESULTS

Congestion Costs

Table 6 shows the results for congestion costs for road transport for 1998. As can be seen, the calculation is sensitive to the average trip length used in the calculation. No estimates are made for 1996 and 2005 given the many assumptions that had to be made for 1998 and the difficulties in making such calculations without more data.

Accident Costs

Table 7 shows the total social accident costs for 1998, i.e. the sum of transport system internal and external accident costs for the transport mode. In the case of roads, estimates of all costs are given in Bacon (*9*). In the case of rail, a value for preventing a fatality of 2.66 million euro was calculated by IRMS (*15*). The social accident costs amount to almost € 1.4 billion per year. Similar estimates for 1996 and 2005 can be made with total social accident costs of € 1.3 billion and € 1.7 billion respectively.

Table 7 also shows the external part of the social accident costs, presented in italics. As discussed earlier, the difference between internal and external is large because the cost block "risk costs" is considered as transport system internal with the exception of uncovered transfer payments of social security. External accident costs in 1998 amounted to € 240 million and for 1996 and 2005 totals of € 226 and € 289 were found.

Vehicle specific statements cannot be made for the external costs under the victims perspective chosen in UNITE because of the problem of arbitrary cost allocation. Therefore, the vehicle specific figures given in Table 8 refer to the total social accident costs. Table 8 shows that relatively high social costs are associated with victims in the category of unprotected road users (i.e. pedestrians and cyclists) and in the "dangerous" category - motorcycle. In absolute terms, the social costs in the passengers car category dominate. The costs of accidents in urban areas is 42% of total costs.

Environmental costs

The costs of air pollution for 1998 for road transport are presented in Table 9. The costs were computed by Bickel (*4*). The total costs in 1998 were found to be € 478 million. This is 85% of the total costs associated with road, rail and air emissions (*1*). The air pollution costs for emissions associated with rail transport are presented in Table 10 for 1996 (1996 because of lack of data for 1998). Given that there was only a marginal increase in the number of train kms between 1996 and 1998 and that estimates rather than measurements are being used in the calculations, the costs associated with rail transport in 1996 are assumed to be similar for 1998. Costs associated with diesel trains are also presented but this is likely to be an underestimate because the costs associated with fuel production are not included. The pollution costs associated with production of the electricity used are not included and therefore the estimates are likely to be lower than actual. Global warming costs due to road transport were found to be € 165 million compared with € 2 million for rail.

The results for costs of noise exposure using the ExternE method based on the exposure rates suggested by Tinch (*12*) are shown in Table 11. The total costs for road were €352 million compared with €29 million for rail.

COMPARISON WITH OTHER COUNTRIES AND CONCLUDING REMARKS

In 1998 in Ireland, 20% of the total core costs (all costs examined in UNITE) of road transport amounting to €1.3 billion were infrastructure costs (for national roads only – main roads). The percentage of total costs pertaining to accidents was 18%. The environmental costs show the following breakdown: 26% of core costs were noise costs, 23% of core costs were air pollution costs and 12% of core costs were global warming costs. The total core costs make up approximately 1.73% of the Irish GDP for 1998 and were equal to approximately €362 per citizen. Internal accident costs were 1.85% of the Irish GDP or €387 per citizen and delay costs were 0.52% of the GDP or approximately €109 per person in Ireland. Revenues relating to road transport totalled €2.4 billion in 1998, 51% of these revenues come from fuel tax, 32% from registration tax and 16% from circulation tax. The remaining 1% are revenues from variable infrastructure usage charges (*1*).

For the comparison and interpretation of country differences total costs were related to indicators such as GDP and population. In Figure 1, the total core costs (including all costs examined by UNITE, not just environmental and social) for road are expressed as % of GDP. A similar set of results in € per capita are presented in Figure 2. The accident costs in Ireland (€50/capita) lower than those for Denmark (€120/capita), Netherlands (€80/capita) and about the same as Spain (€50/capita), are considerably less than those in Austria (€160/capita) and larger than those of France (€20/capita) and the UK (€25). Noise costs are €100/capita and are close to those of France, Spain and the UK. They are higher than those of Netherlands (€20/capita) and Austria (€40/capita).

In 1998, the data basis for the estimation of Irish rail costs and revenues was not complete. Only the infrastructure costs relating to signalling, operation and depreciation could calculated. No data regarding the external costs of accidents was available. The available core costs calculated amounted to €316 million (making up 0.41% of GDP or approximately €86 per person). Environmental costs were 12% of core costs (air pollution 3%, global warming 1% and noise costs 9%). Infrastructure costs made up only 7% of the core costs. The low infrastructure costs and missing accident costs cause the percentage of costs attributed to environmental costs to be disproportionately high. The costs of rail transport must be considered to be a low representation of the actual costs. This is a result of poor data for this mode.

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Table 1 Basic economic and structural data for Ireland (*6, 7*)

	unit	1996	1998
Land area	sqkm	70 273	70 273
Population	1 000	3 626	3 680
Population density	inhabitants/sqkm	51.6	52.4
Population employed	1 000	1 643	1 825
Employment Rate	%	45.3	49.5
GDP	€ billion	58	77
GDP per capita	€ million	0.015	0.02
GDP growth rate (change to previous year)	% (in prices of 1995)	7.7	8.6
Consumer price index	1996 = 100	100	103

Table 2 Basic transport related indicators for Ireland 1998 per mode (*1*)

Indicator	Unit	Road	Rail	Public transport[4]	Aviation	Inland waterway navigation[6]	Maritime shipping	Total[10]
Transport performance								
Passengers carried	Mill.	[2]	32 29[a]	•	14.8[b]	•	•	
Vehicle-km	Mill. Veh.km	38150	15.5	•	0.5[9]	•	•	
Goods transported	Mill. t		2.9[2][c]	•	0.2[b]	•	190[4]	
Tonne-km	mill. tkm	5.9	0.5[2][c]	•	[3]	•	[3]	
Network length	1000 km	97[d]	2.8[c]	•	•	•	•	
Employees	1000		4.9[e]	•	2.2[5][b]	•	•	
Gross investments[2]	€ mill.	498[1][c]	231[1][c]	•	95.7[b]	•	•	
Gross capital stock[3]	€ mill.	3 052	15[7][e]	•	97[5]	•	14[8][f]	
Accidents								
Number of injuries	Casualties	7 831	3	•	10	•	•	7 844
Number of fatalities	Casualties	408	0	•	2	•	•	410
Environment								
Direct transport emissions								
CO_2	Mill. t	8.3	0.1	•	1.9	•	•	10.3
PM	1 000 t	3.6	0.01	•		•	•	
NO_x	1 000 t	52.8	1.2	•	5.2	•	•	59.2
SO_2	1 000 t	7.9	0.02	•	0.06	•	•	8.0
NMVOC	1 000 t	65.7	0.01	•	3.0	•	•	68.7

[1] 1997 values [2] not available, [3] 1999 values, [4] metro, tram and trolley buses (no such services existed in Ireland in 1998), [5] airports only, [6] Inland waterways in Ireland are for recreational purposes only – data excluded here, [7] railway lines and works, [8] Dublin port only [9] aircraft movements, [10] In most cases, data are lacking or units are different, making it difficult to arrive at totals. Where it is possible to calculate totals, they are presented.

Source: [a] (*6*), [b] (*7*), [c] (*8*), [d] (*9*), [e] (*10*), [f] (*11*)

Table 3 VOT-Values for Ireland - PPP-adjusted, (*6*), in € per hour, 1998 prices (*1*)

	1996			1998			2005		
	Business	**Commuting**	**Leisure**	**Business**	**Commuting**	**Leisure**	**Business**	**Commuting**	**Leisure**
Car	31.99	9.14	6.09	32.98	9.42	6.28	35.03	10.01	6.67
Inter-urban rail	31.99	9.75	7.16	32.98	10.05	7.38	35.03	10.67	7.84
Coach	31.99	9.14	6.09	32.98	9.42	6.28	35.03	10.01	6.67
Air	43.42	15.23	15.23	44.76	15.71	15.71	47.53	16.68	16.68
Urban bus/tramway	31.99	9.14	4.87	32.98	9.42	5.03	35.03	10.01	5.34

Table 4 Input data for the valuation of the road accidents *(1)*

Cost category	Data sources, main input data	Level of disaggre-gation	Quality of data, level of uncertainty
Material damages	Insurance industry data	Aggregate estimates - not much detail	Sufficient disaggregation not available
Administrative costs	Total payment for motor insurance to the Department of Enterprise, Trade and Employment.	Little disaggregation between cost category	Sufficient disaggregation not available
Medical costs	Data not available - transfer from UK costs to Irish conditions used.	Average values.	Estimate
Production losses	Irish data from the CSO and the NRA on age profile and GNP per capita .	Average values	Estimate
Risk value (Value of Statistical Life VOSL)	Source: Valuation conventions of UNITE (Nellthorp, 2001) VOSL: 1.5 mill. € Adjustments: - Income, adjustment factor: 1.0877 - Factor costs, adjustment factor: 0.0 VOSL after adjustment: 1.63€ Value for injuries in % of VOSL: - Severe permanent: 32% - Severe temporary: 4% - Light: 1%	- -	An Irish study contains an estimate of 0.857 mill. € / fatality (Bacon, 1999)

Table 5 Emission of air pollutants and particulate matter from road transport, in t/a, 1998 (*1*)

AIR POLLUTANTS									
Sector	**PM**	**SO_2**	**NO_x**	**NMVOC**	**CH_4**	**CO**	**CO_2**	**N_2O**	**NH_3**
Passenger Cars		**3470**	**33458**	**58130**	**1961**	**215582**	**4767413**	**658**	**1034**
Gasoline		2525	30929	57532	1928	212835	4018551	609	1029
Diesel	730	945	2446	562	31	2565	741652	49	5
LPG		0	83	36	2	182	7210	0	0
Light Duty Vehicles		**2657**	**6849**	**3637**	**85**	**17377**	**2127714**	**121**	**8**
Gasoline <3.5t		55	555	1327	40	8736	87001	2	1
Diesel <3.5t	1987	2602	6294	2310	45	8641	2040713	119	7
Heavy Duty Vehicles		**1176**	**7440**	**1797**	**51**	**3549**	**923743**	**54**	**6**
Gasoline >3.5t		3	58	35	1	457	4290	0	0
Diesel	642	1173	7382	1762	50	3092	919453	54	6
Buses		**535**	**5010**	**544**	**56**	**1350**	**419569**	**14**	**2**
Urban Busses	127	273	2899	273	31	846	214419	6	1
Coaches	112	262	2111	271	25	504	205150	8	1
Mopeds & Motorcycles		**28**	**72**	**1609**	**81**	**11123**	**44457**	**1**	**1**
Mopeds		5	3	915	10	1476	7832	0	0
Motorcycles		23	69	694	71	9647	36625	1	1
Grand Totals:	**3598**	**7866**	**52829**	**65717**	**2234**	**248981**	**8282896**	**848**	**1051**

PARTICULATES			
	Hot	**Cold Start**	**Total**
Passenger Cars	**543**	**187**	**730**
Diesel <2.0 l	480	165	645
Diesel >2.0 l	63	22	85
Light Duty Vehicles	**1569**	**418**	**1987**
Diesel <3.5 t	1569	418	1987
Heavy Duty Vehicles	**881**		**881**
Diesel 3.5 - 7.5 t	107		107
Diesel 7.5 - 18 t	535		535
Diesel 16 - 32 t	0		0
Diesel > 32 t	0		0
Urban Buses	127		127
Coaches	112		112
Total	**2993**	**605**	**3598**

Table 6. Road Congestion Costs 1998 in million €, 1998 prices (*1*)

Average trip length assumed (km)	Total Veh.kms /year (mill)	Delay (mill hrs)	Cost of delay (mill €)	Cost (€/1000km)	Fuel costs in congested conditions (€)	Fuel costs /1000km (€/1000km)	Avge user costs €/1000km
70	38150.00	8.55	115.45	3.03	10.42	0.27	3.30
40	38150.00	27.24	367.84	9.64	33.20	0.87	10.51

Table 7. Social costs and transport system external costs of transport accidents, in million €, 1998 (*1*)

	Output Loss	Human (WTP) Costs	Medical Expenses	Damage to Property	Insurance Administration	Profess'l Services	Police Costs	Total of social costs	Total of system external costs
Fatality	*44*	747	*3*	1	7	*6*	*1*	755	*53*
Serious Injury	*34*	406	*22*	6	43	*51*	*0*	455	*106*
Slight Injury	*21*	171	*10*	33	10	*50*	*0*	214	*81*
Total	*99*	1323	*34*	41	60	*107*	*1*	1425	*240*

Note: social costs are in normal font whereas transport system external costs are in italics

Table 8. Social accident costs of road transport 1998 – detailed results per road type, in million € *(1)*

	Output Loss	Human (WTP) Costs	Medical Expenses	Damage to property	Insurance Admin	Professional Services	Police Costs	Total
Pedestrian								
Inter-urban	5.29	84.47	0.78	0.70	1.64	2.15	0.08	95.12
Urban	13.05	181.46	4.26	4.34	7.74	12.53	0.19	223.58
Pedal cyclists								
Inter-urban	0.83	12.32	0.18	0.26	0.31	0.58	0.01	14.50
Urban	3.13	41.28	1.02	1.63	1.68	3.53	0.05	52.30
Motor cyclists								
Inter-urban	3.63	53.97	0.87	0.87	1.64	2.52	0.05	63.55
Urban	5.34	64.67	2.54	2.75	4.42	7.67	0.08	87.46
Car users								
Inter-urban	41.62	568.90	13.50	16.51	23.74	42.18	0.62	707.07
Urban	19.03	225.37	8.95	11.37	15.07	28.55	0.29	308.63
PSV users								
Inter-urban	0.91	13.08	0.22	0.32	0.38	0.72	0.01	15.64
Urban	0.24	2.36	0.13	0.22	0.20	0.46	0.00	3.61
GV								
Inter-urban	4.15	54.52	1.57	1.81	2.75	4.82	0.06	69.68
Urban	1.62	19.66	0.74	0.87	1.28	2.31	0.02	26.50
Other								
Inter-urban	1.03	14.14	0.36	0.36	0.65	1.04	0.01	17.59
Urban	0.33	4.15	0.14	0.15	0.25	0.43	0.00	5.45

Table 9. Cost of air pollution from roads sector for Ireland for 1998 in million € (*1)*

	$PM_{2.5}$	SO_2	NO_x	NMVOC	CH_4	CO	CO_2	N_2O	Total
Passenger Cars	**21.8**	**6.7**	**90.1**	**36.2**	**0.8**	**0.0**	**95.3**	**4.1**	**255.0**
Gasoline	0.0	4.8	83.3	35.8	0.8	0.0	80.4	3.8	208.9
Diesel	21.8	1.8	6.6	0.3	0.0	0.0	14.8	0.3	45.7
LPG	0.0	0.0	0.2	0.0	0.0	0.0	0.1	0.0	0.4
Light Duty Vehicles	**59.4**	**5.1**	**18.4**	**2.3**	**0.0**	**0.0**	**42.6**	**0.8**	**128.5**
Gasoline <3.5t	0.0	0.1	1.5	0.8	0.0	0.0	1.7	0.0	4.2
Diesel <3.5t	59.4	5.0	16.9	1.4	0.0	0.0	40.8	0.7	124.3
Heavy Duty Vehicles	**19.2**	**2.3**	**20.0**	**1.1**	**0.0**	**0.0**	**18.5**	**0.3**	**61.4**
Gasoline >3.5t	0.0	0.0	0.2	0.0	0.0	0.0	0.1	0.0	0.3
Diesel	19.2	2.2	19.9	1.1	0.0	0.0	18.4	0.3	61.1
Buses	**7.1**	**1.0**	**13.5**	**0.3**	**0.0**	**0.0**	**8.4**	**0.1**	**30.5**
Urban Busses	3.8	0.5	7.8	0.2	0.0	0.0	4.3	0.0	16.6
Coaches	3.3	0.5	5.7	0.2	0.0	0.0	4.1	0.0	13.9
Mopeds & Motorcycles	**0.0**	**0.1**	**0.2**	**1.0**	**0.0**	**0.0**	**0.9**	**0.0**	**2.2**
Mopeds	0.0	0.0	0.0	0.6	0.0	0.0	0.2	0.0	0.7
Motorcycles	0.0	0.0	0.2	0.4	0.0	0.0	0.7	0.0	1.4
Grand Totals:	**107.5**	**15.1**	**142.2**	**40.9**	**0.9**	**0.1**	**165.7**	**5.3**	**477.6**

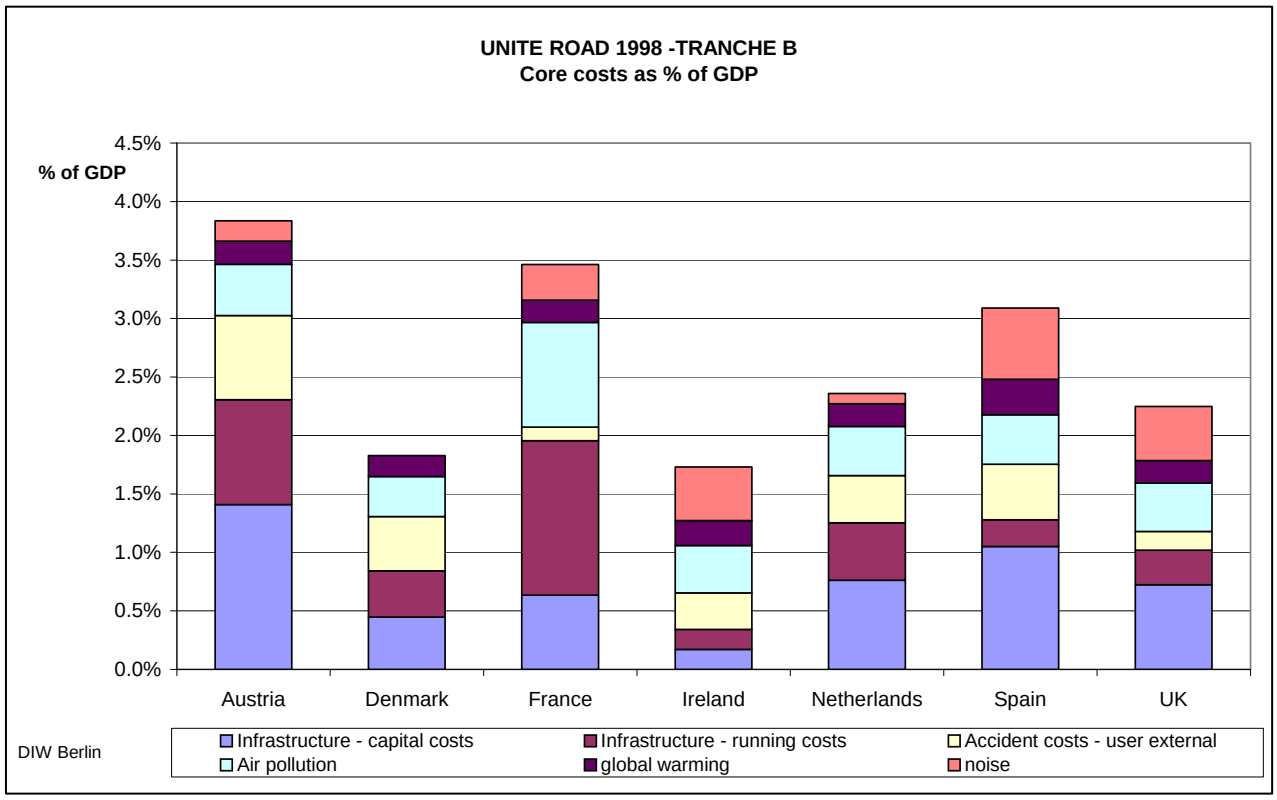
Table 10. Cost of emissions from rail (diesel and electric traction) for 1996 in million € in 1998 prices (*1*)

	Air pollution (excl. GHG)		GHG (direct)		Air pollution + CO2	
	Total [million €]	Average [€ / Train-km]	Total [million €]	Average [€ / Train-km]	Total [million €]	Average [€ / Train-km]
DIESEL TRACTION						
Passenger	5.2	0.6	1.6	0.2	6.9	0.8
Freight	2.5	0.6	0.8	0.2	3.3	0.8
Total	7.7	0.6	2.4	0.2	10.2	0.8
ELECTRIC TRACTION						
Passenger Trains	0.24	0.12	0.29	0.15	0.53	0.27
Freight Trains	-	-	-	-	-	-
Total	0.24	0.12	0.29	0.15	0.53	0.27

Table 11. Noise costs of road and rail for 1996 in million € for road and rail, in 1998 prices (*1*).

	1996		1998		2005	
	Road	**Rail**	**Road**	**Rail**	**Road**	**Rail**
Myocardial infarction	9	1	9	1	10	1
Angina pectoris	0	0	0	0	0	0
Hypertension	0	0	0	0	0	0
Sleep disturbance	18	2	19	2	20	2
Amenity losses	305	24	324	26	343	27
Total	332	27	352	29	373	31

Figure 1 Core costs of road transport for Austria, Denmark, France, Ireland, Netherlands, Spain and UK as % of GDP (*1*)



Note: UNITE focused on three tranches of countries based on the quality of available data. Ireland was in the middle group of the three - Tranche B.

Figure 2 Core costs of road transport for Austria, Denmark, France, Ireland, Netherlands, Spain and UK in € per capita *(1)*