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The socio-economic impacts of road pricing

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Executive summary

The use of road user charges has increased in Europe. Charges have been imposed in order to finance road management and/or to regulate demand. At the same time, practical experience has provided information about the impacts of road pricing. The objective of this study is to prepare a concise and easy-to-read survey of the impacts of road pricing. Objectives, impacts on equity, and acceptability of road pricing have also been addressed because these questions are connected to the impacts of pricing.

In addition to conducting a survey of the literature, the working method included the application of the causal chain method. The impacts of road pricing are presented graphically as causal chains which proceed from state changes caused by pricing (e.g. a change in kilometre costs) to impacts on the welfare of road users or the rest of society (e.g. the habitability of residential areas or the availability of labour). Some of the causal chains are very straightforward, while others are very complicated. The study does not, however, present estimates of the magnitudes of impacts; impacts are instead illustrated using a set of practical examples.

The two primary objectives of road pricing are usually to finance road management and/or regulate demand for road traffic. In those cases where financing is the main objective, an attempt is made to set fees in such a way that income targets are met. The regulation of road traffic is effective when road users pay all the costs they generate, including externalities (the costs of congestion, emissions, and noise to other parties; accidents causing damage and injury to other parties).

The lack of funding for road construction, maintenance, and operation has led to the more widespread use of road user charges in Europe. Pricing can focus on individual links (toll roads) or parts of the network (e.g. user charges on highways in Germany and Austria). On toll roads, charges are collected from all vehicles. However, when only parts of the road network are priced, pricing is usually restricted to heavy goods vehicles. In the latter case, vehicles that cause greater pollution can be charged higher fees in order to reduce emissions.

In addition to the need for funding, road pricing is an effective way of regulating demand for road traffic in congested urban areas. A reduction in demand for traffic results in time savings for road users and increased predictability of travel times. A reduction in traffic also improves the habitability of the urban environment and reduces urban sprawl. On the other hand, the higher price of the travelled route forces a proportion of users to switch to a different means of transportation or to forego making the trip altogether. The congestion fees in Stockholm and London are good examples of successful demand regulation. However, the congestion charges are only one part of a larger package as a substantial amount of funding is also allocated to the promotion of public transport.

Distance-based network charges and cordon tolls are the most effective ways of producing the desired regulatory effects. In the case of distance-based charges, the level of the fee collected per kilometre can be set according to a certain factor such as the size of the vehicle, the emissions produced, or the time of day the trip is made. The same applies to cordon tolls around cities. In this case, however, the most important factor affecting the level of the costs generated is the time of day the trip is made. Thus, a higher fee is charged during congested times of day.

It is often claimed that road pricing simply improves the position of the well-off and worsens the position of the less well-off. However, studies on this issue have produced conflicting results and show that road pricing can be either regressive or progressive. Impacts on equity vary from case to case, and the targeting of impacts should be carefully evaluated at the planning stage.

Road users usually oppose road pricing because it is felt to be an additional cost burden on top of the taxes they are already paying. Businesses also usually oppose road pricing because it means higher transportation costs, which can prevent some customers from conducting business, in consequence of which they do not buy goods and services, and demand drops. The opinions of political decision-makers often reflect the opinions of citizens and businesses, but politicians also see road user charges as an attractive funding method. The pricing systems that have been implemented have shown, however, that the acceptability of road pricing usually increases after it has been introduced. The reason for this is that citizens experience the direct benefits of pricing first hand or benefit from subsequent investments that were made possible by the income generated by the charges.

Tolling station in France

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1 Introduction

Road pricing has been studied extensively by the European Commission over the last 15 years. The results of these studies have been directly reflected in the EU's traffic policies and ultimately in the directives enacted. It is reasonable to say that research has been one factor influencing the spread of the practical application of road pricing in Europe, although the effect of the development of technical solutions for collecting charges has been significant.

Simplifying the matter, we can say that there are two main motives for road pricing, namely the funding of road management and the regulation of demand for road traffic. Cordon tolls around cities are an example of the latter and toll roads are an example of the former. That being said, cordon tolls around cities can also be used to obtain funding and toll roads can also be used to regulate demand. Nevertheless, road pricing has many other impacts, some of which are direct impacts on road users, the road manager, and the rest of society. These impacts can be determined fairly easily. Other impacts only emerge in the long term as a result of a complicated chain of causes and impacts. The mere description of the causal mechanisms of these impacts is challenging, not to mention the difficulties involved in measuring the impacts.

The need to describe the socio-economic impacts of road pricing was acknowledged in CEDR's first strategic plan. The objective of this study is to respond to this need and describe the socio-economic impacts of road pricing in a simple and graphic way. The method used is causal chains. According to this method, impacts are traced from state changes resulting from measures to impacts that can be measured. The intention of this study is not to present estimates regarding the amount of the impacts. Practical examples are presented alongside the causal chains, which help to provide a concrete example of the causal-chain analysis.

The impacts of road pricing are materially connected to pricing objectives, the impacts of pricing on equity, and the acceptability of pricing to citizens, companies, and political decision-makers. The objectives set for road pricing often concern desired impacts. By comparing the objectives with the forecast/realised impacts, it is possible to evaluate the efficiency of pricing. Equity is about distributing impacts between various economic actors. The impacts on equity can be undesirable if the pricing places stress on a group that is already in a weaker position. Equity, other expected impacts, and impacts that are experienced after road pricing is introduced are some of the numerous factors affecting the acceptability of road pricing.

Chapter 2 of the report describes the objectives of road pricing, starting with the basis of the economic theory of pricing. Chapter 3 describes the main features of the EU's traffic policy on road pricing and provides a general description of the use of road pricing in Europe. Chapter 4 is the heart of the report and presents the causal chains of road pricing along with practical examples. The causal chains reveal that pricing has diverse impacts and help explain the formation of the impacts. Chapter 5 describes equity issues connected to road pricing. This issue is closely related to the acceptability of pricing because the introduction of road pricing always results in winners and losers. Chapter 6 takes up the issue of acceptability and its link to the impacts of pricing. Chapter 7 summarises the conclusions of the report.

2 Objectives of road pricing

The reasons for introducing road pricing (RP) can be divided into two main categories: funding and regulation (see, for example, PIARC 2008).

The most obvious objective of funding is to generate more financial resources for the maintenance, operation, and development of either the road network or a single road project (e.g. toll roads and tunnels). However, RP has only provided a partial solution to the problem of road funding; almost all over the world, the lion's share of road funding comes from public budgets. In view of the fact that it is not easy to allocate the costs of road use directly to road users, roads have traditionally been seen as public goods.

Although regulation is a much more diffuse goal, it normally relates to the management of road traffic demand. RP is one way of reducing traffic in order to ensure more efficient use of existing capacity and to postpone the construction of new road capacity. Reduced traffic will also have a number of other positive impacts such as decreased emissions and, in the case of urban congestion charges, an improved living environment for city inhabitants.

It is important to note that funding may be a supplementary goal of regulation and vice versa. Additional charges that are set in order to generate funding increase the price of road trips. This could result in some individuals, who are not able to meet these higher costs, being priced out of the system. If charges are set with a view to managing demand, the system will generate net revenue, which could be used to develop the road network or public transport.

From the point of view of economic theory, the rationale behind RP rests primarily on the fact that the marginal cost of a road trip is often higher than the direct cost perceived by the driver/operator, as some costs (the external costs) are transferred to other agents (to other drivers in the form of congestion, to those living near roads in the form of noise and pollution, or to society in general in the form of the costs of accidents and certain types of pollution). As a result, decisions about road trips made by individuals are biased, as the comparison between costs and benefits does not include all costs involved. This leads to a sub-optimal allocation of resources.

In principle, in order to ensure the correct allocation of resources, a pricing system should reflect, in a transparent way, all the costs incurred as a result of any decision with economic implications. Therefore, the aim of any RP scheme should be to incorporate all external costs so that an individual making a decision about a road trip can meet all the costs involved. This could be regarded as the fundamental objective of any RP scheme.

Following this logic, the income generated by an RP scheme should also be used to cover the external costs generated and, therefore, paid to those suffering their consequences. Again, such a scheme would be impossible to implement, so alternative expenditure channels can be established in order to compensate for those costs. The decision to spend the generated income in certain channels could reinforce the objectives of the scheme. For instance, an RP scheme that seeks to reduce private traffic could use the income generated to improve public transport.

The following table summarises the objectives and potential impacts of existing road pricing systems, as well as others that could be feasible in the near future.

Table 1: The objectives and potential impacts of existing road pricing systems

OBJECTIVE	RP SCHEME	USE OF REVENUE	FULFILMENT OF OBJECTIVES	OTHER IMPACTS
To pay for the infrastructure	BOT[1] concession with tolls	Direct financing of the infrastructure and its operation	100% coverage of infrastructure costs	• Diversion of traffic to non-tolled roads[2,3]
	Time-based vignette	Direct financing of network operator	Partial contribution to network costs	• Not fully related to real infrastructure use
	Charging system based on real route travelled	Direct financing of network operator	Contribution to network costs[4]	• Technology-dependent (GPS and Galileo) • Base allowing any RP mechanism • Privacy concerns
To reduce traffic levels in sensitive areas	Congestion Charge	Financing of public transport	Proportional to fee level	• Compound effect of pricing plus public transport[2]
		Financing of environmental policies	Diminishing efficiency as market gets used to charge over time	• Risk of distortions through the choice of environmental policies[2]
To generate revenue	Fuel tax	Public budget	Highly efficient revenue generator	• Efficient system for incorporating CO_2 • User-taxpayer transfer distortions • Lacks deterrent effect on traffic
To limit greenhouse gas emissions	Carbon emissions trading schemes	Emission allowances traded on the open market vs. carbon tax	Effective price mechanism[5]	• Inductive effect on R&D of carbon reduction technologies • Unit price of allowance related to the number given out free of charge

EXPLANATION OF NOTES:
1) Build-Operate-Transfer
2) If the toll is implemented on existing road
3) Regressive effect: the most cost-sensitive motorists can be priced out of the system while those who are able to afford the charge benefit from lower congestion.
4) If generalised, it could become the backbone of a new road financing system, as well as allowing for a generalised road pricing system based on marginal costs.
5) Depending on the number of users

3 Road pricing in Europe

3.1 The position of the European Commission

The policy developed by the Commission for infrastructure pricing can be summarised as follows:

- For each form of transport, taxes and fees must be flexible pursuant to the level of pollution and degradation, the length of time of the journey, and the depreciation of the infrastructures.

- It is important that the 'polluter pays principle' is applied and that clear fiscal advantages are provided to road users in order to achieve the objectives set to reduce congestion, fight pollution, reach a balance between the types of transport, and to eliminate links between an increase in transport and economic growth.

- It is legitimate to make transport users pay, as this contributes to an improvement in the use of the capacity of the infrastructures in place.

- Equally, the articles 12 and 18 of the Treaty establishing the European Community on non-discrimination of road users have been fully complied with.

The Commission supports the concept that intelligent pricing favours partner development between the public and private sectors as well as a more open market. Indeed, the fees collected for the use of infrastructures constitute a direct source of revenue for the partners in their management of the infrastructures.

Apart from the guidelines specified in the White Paper of 2001 on the European transport policy, which examines in detail how to use fees to manage the cost of traffic jams and environmental costs, the Commission reinforced its policy on the subject in the White Paper of 1998 entitled *Fair payment for infrastructure use: a phased approach to a common transport infrastructure charging framework in the EU*.

Since the publication of the White Paper in 1998, the European institutions have adopted several directives concerning the pricing of transport infrastructures such as:

- Directive 1999/62/EC (June 1999) on the charging of heavy goods vehicles for the use of certain roads (known as the 'Eurovignette Directive').
- Directive 2006/38/EC (May 2006) which amends the 'Eurovignette Directive' in order to implement a new community framework for charges for the use of road infrastructures by heavy goods vehicles, setting some common and updated principles for the calculation of tolls and user charges.

- On 8 July 2008, the Commission adopted a package called 'Greening Transport', which contained a communication on 'Strategy for the internalisation of external costs' and a new proposal for revising Directive 1999/62/EC on the charging of heavy goods vehicles for the use of infrastructure.

- This proposal seeks to establish a framework which enables member states to calculate and vary tolls according to air and noise pollution from traffic emissions and peak-hour congestion levels, and steers transport towards sustainability by ensuring that the transport prices better reflect the real cost of transport to society. The methodology used to quantify external costs in based on the so-called IMPACT study (see annex 1).

3.2 Main pricing instruments

Throughout the report, the term ‘road pricing’ is used to mean both road user taxes and road user charges. When a more specific distinction is needed, road pricing is divided to ‘taxes’ and ‘charges’. In practice, there are many pricing methods, ranging from simple vehicle taxes to complex tolling systems. There follows a list including brief descriptions and examples.

- **Vehicle taxes** are fixed taxes that are levied on the purchase and ownership of vehicles. Taxes levied on the purchase of a vehicle may also be called excise taxes. Vehicle taxes are levied all over Europe, and normally the revenue collected is allocated directly to the state’s general budget.
- **Fuel taxes** are variable taxes that are levied on the sale of fuels. Fuel taxes may also be called excise taxes. Like vehicle taxes, fuel taxes are also levied all over Europe, and normally the revenue collected is transferred to the state budget. An exception is Switzerland, where half of the fuel tax revenue is earmarked for funding road management. Estonia also allocates part of its fuel tax revenue directly to road management.
- **Vignettes** are semi-fixed taxes that are levied on the right to use a road network, or parts of it, for a fixed time period (day, week, month, or year). Different kinds of vignettes are implemented in many European countries (e.g. time-based vignettes for all vehicles in Austria and the Eurovignette on motorways for HGVs in Belgium, the Netherlands, Luxemburg, Denmark, and Sweden).
- **Distance-based network charges** are collected on any trip made on roads. The charges may vary according to route, time of day, or type of vehicle. Distance-based charges are levied on HGVs and are collected either on motorways only (e.g. Germany) or on the whole network (e.g. Switzerland). The level of charges differs, e.g. according to EURO-class emission standards or total weight of the vehicle. The most extensive pricing system is being planned in the Netherlands, where a decision has been made to implement a distance-based charging system, initially for HGVs in 2011 and eventually for all vehicles in 2016 at the latest.
- **Link tolls** are collected for the right to use a particular link (e.g. single motorway) or a set of links (e.g. motorway system). Link tolls can be time-based (like vignettes) or distance-based. There is a long tradition of link tolling in Europe. Almost half of the motorway network in Italy is subject to link tolling. Other countries that apply link tolling are France, Spain, and Portugal.

A link toll collection point in Spain (Carriles vía T en la AP4. Aumar)

- **Cordon tolls** give road users the right to enter a particular area of the network. Cordon tolls can also be called congestion charges if they incorporate variable pricing that seeks to cut peak traffic. Norway has pioneered the establishment of cordon tolls with seven cities currently imposing cordon tolls. Other more recent examples of the successful implementation of cordon tolls are London and Stockholm.

A cordon toll in Norway (Oslo)

- **Point tolls** are collected for the right to use a particular facility (e.g. a tunnel, bridge, or ferry). These tolls are in use almost all over Europe.
- **Parking fees** are collected for managing urban parking spaces and for covering the cost of allocating scarce space to parking. Parking fees are also in common use throughout Europe.

Distance-based network charges, link and cordon tolls, and electronic vignettes all need suitable collection technology that enables tolls to be collected with a minimum impact on traffic flow, without violating the privacy of users, and with minimum running, maintenance, and investment costs. The leading technical solutions for road pricing in Europe are microwave- and satellite positioning-based pricing systems.

The general consensus is that the existence of suitable technology is not now an obstacle to efficient road pricing. Current technology has made it possible to set the objectives of road pricing first and subsequently to select the most efficient technology to achieve the given objectives with minimum investment, maintenance, and other system costs. The most sophisticated systems must be flexible enough to be able to adjust the toll price according to the time of day, the type of vehicle, or the distance travelled.

European motorway toll collection point in Spain (Playas de peaje de Europistas)

4 Socio-economic impact chains of road pricing

4.1 Road pricing and different policy levels

Road pricing (RP) serves a large range of policy targets both at a general policy level and within the road sector (Figure 1). Due to the long fiscal history of vehicle and fuel taxes, it is argued that the major role of RP has been, and still is, strongly related to general policy making. Lately, the role of vehicle and fuel taxes in environmental policy has moved up the agenda.

The link between vehicle and fuel taxes and transport policy has been fairly broad. Taxes have not provided clear behavioural signals for promoting efficiency in the transport system and only a few countries (e.g. Switzerland) have created a link between the taxes collected and the financing of the road sector through the earmarking of funds.

The use of road pricing instruments has become popular in transport policy since 1960s. There are many examples of tolled motorways and motorway systems, cordon tolls, and point tolls. The reasons for this development lie primarily in the need for new tools for project finance and traffic management. The role of the latter has become more significant during the last decade.

Due to the diverse roles of road pricing instruments in policy-making, the socio-economic impacts of each instrument or combination of instruments have an effect on society. Changes in road pricing usually impact on the economy and the behaviour of every household and firm.

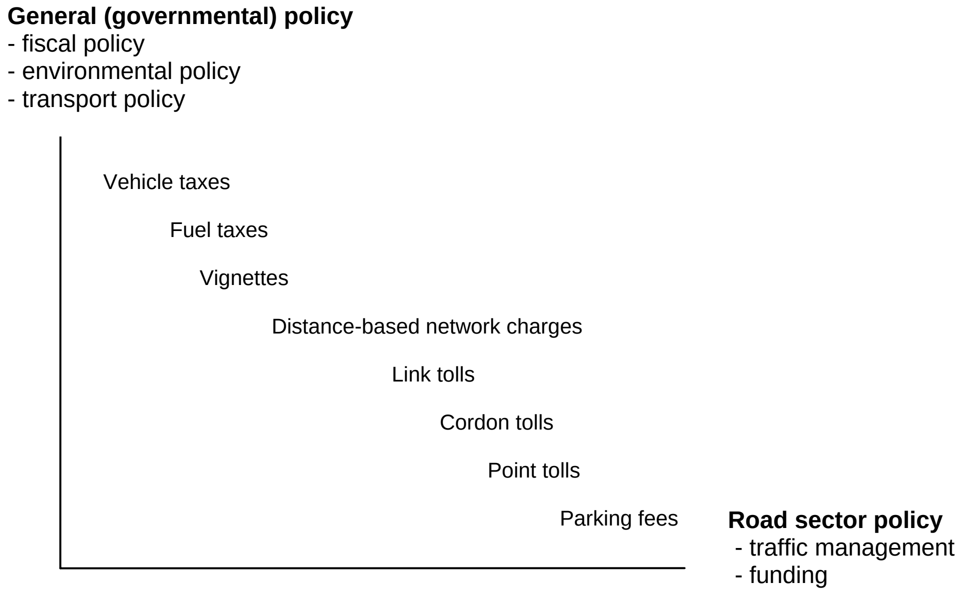

Figure 1: Use of road pricing instruments for different policy purposes

In this chapter, simplified (non-exhaustive) illustrations of the impacts of road pricing are presented using causal impact chains and impact mapping. Impact mapping is a generic approach to assessing the impacts of road management decisions. It was developed by thematic experts in Finland under the supervision of the Finnish Road Administration[1].

The idea behind the impact chain approach is to divide strategy-level impacts into more concrete and limited impacts that can be defined in more detail and, in this way, split up into partial impacts. In the case of some impacts, this is very easy. With others, however, the splitting up process creates impact chains that are fragmented at different levels and, as a result of interdependencies, go around in a loop. Nevertheless, this top-down conceptualisation, which starts with impacts, helps to clarify objectives concerning road management and creates the preconditions for measuring impacts.

In this presentation, the bottom-up approach is implemented by starting with RP measures. In this method, both the change in state that results directly from the measure (also called the output) and the impacts that follow from it in logical progression are presented. The impact chains presented here have been created by the authors. Because some impact chains can be very long and complicated, they have been simplified.

Moreover, case studies are presented on a number of pricing instruments and pricing cases. In the case studies presented here, the focus is on the instruments and instrument features that are designed to have an impact on the function of the transport system or society at large. However, no weighting is given to the significance of the impacts, nor is the success of the pricing analysed in relation to its targets.

The case studies used as examples include:

- the German kilometre-based road tax on heavy goods vehicles
- the Swiss kilometre charge on heavy goods vehicles
- the Austrian tolled motorway system
- the M6 toll in Birmingham
- the cordon toll trial in Stockholm
- the central London congestion charge
- the Humber Bridge
- the Öresund fixed link
- French, Greek, and Norwegian toll roads
- the Finnish and Swedish taxation systems.

Although most road pricing instruments exist for fiscal reasons, impacts relating to fiscal taxation at state budget level are not examined here. The socio-economic impacts of fiscal instruments are very broad and similar to the impacts of other consumption taxation (excise taxes, valued added tax).

The impacts of carbon tax policies, the design of the ‘Vignette Directive’, and features of traffic insurance systems are also discussed.

[1] For further descriptions of the methodology, see Goebel & Metsäranta 2007 or Hokkanen & Goebel 2007.

4.2 Impact chains

4.2.1 General economic perspective

According to economic assessments, road pricing directly affects the travel costs of households and the freight costs of firms (Figure 2). This has further impacts on a number of factors including the volume of travel, consumption, production by companies, employment, and, ultimately, GNP (Gross National Product).

However, road pricing should ultimately aim to solve problems relating to the functionality of the transport system and reduce negative externalities on society. This is achieved by the impacts created by price signals (changes in the immediate out-of-pocket cost of mobility) in terms of the way people and companies travel and transport goods.

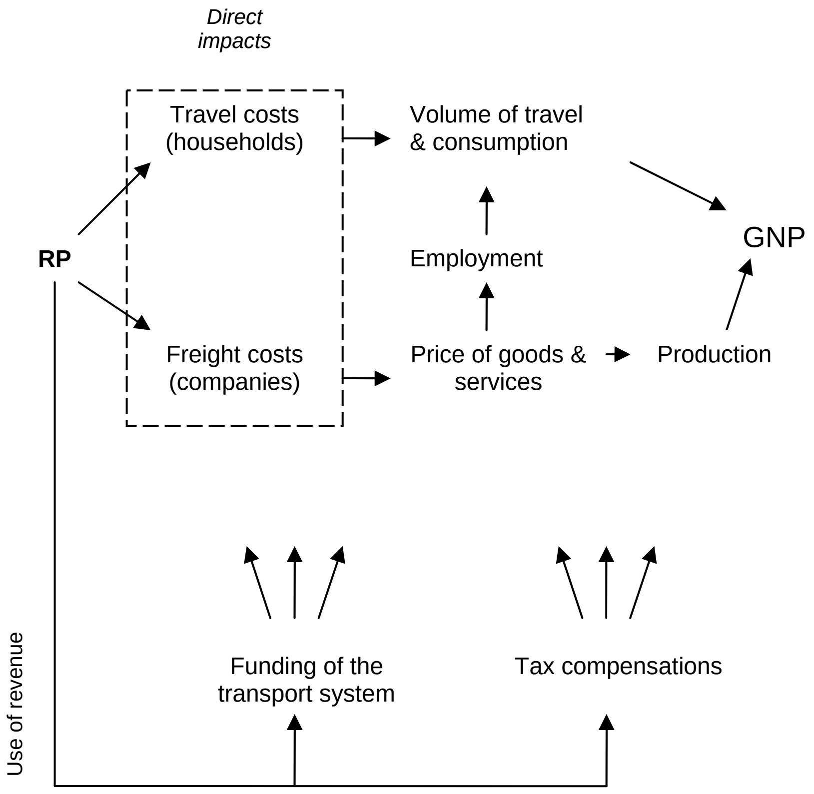

Figure 2: Impacts of road pricing (general economic perspective)

Road pricing is often initially seen in the light of its immediate negative impact on the out-of-pocket costs of mobility. However, there are many ways in which road pricing compensates for direct cost impacts. These include:

- better traffic flow due to reduced (peak) traffic
- investment in improvements in the transport system
- compensations within the road pricing regime (vehicle and fuel taxes) and/or the general (income) tax regime
- improved quality of life in built environments
- reduction in the socio-economic burden caused by externalities.

The diverse impact chains that accompany changes in road pricing are presented in the next section in more detail. As road pricing involves the simultaneous use of several pricing instruments, i.e. more or less fixed taxes and more or less variable charges, the overall impact is considered in terms of impact chains.

Distinctions should be made between road pricing (RP) of a more general nature (vehicle and fuel taxes and vignettes) and road pricing of a more specific nature (distance-based charges as well as link, cordon, and point tolls). The former are termed ‘taxes’ and the latter ‘charges’.

It must be noted that in this presentation, charges are assumed to introduce new behavioural impacts and new revenue, whereas taxes are more often part of the existing system and the associated revenue usually flows to the general state budget. Charges can therefore also be considered as earmarked revenue.

4.2.2 Accessibility

The term ‘accessibility’ refers here to the cost and how well traffic links and parts of the network allow unrestricted travel and freight deliveries. In traffic modelling, accessibility has a different name: generalized cost. Users of the road network consider the combination of pecuniary costs and quality features (e.g. functionality of a link or network and convenience of travel) of the trip in the travel choices they make. Then one considers a) the cost of travel and freight, b) the functionality of transport links, and c) the convenience of travel under the title of accessibility.

A: Cost of travel and freight

The direct economic impact of new road pricing is a rise in travel and freight costs (Figure 3). The cost of using passenger cars and the cost of operating buses and goods vehicles changes at least on some links or parts of the network.

Vehicle taxes and vignettes have a more or less fixed cost impact on mobility (no relation to the amount of road use). Fuel taxes affect the fuel cost of trips and deliveries according to fuel consumption. In turn, charges impact on the cost of travel and freight directly in relation to the number and length of trips and deliveries made on charged routes. This affects the volume of trips and deliveries or the routing of trips and deliveries. If charging is scaled according to the time of day and/or by the characteristics of vehicles, they will also have an impact on the timing of travel and deliveries and the characteristics of the vehicles used.

The rise in travel and freight costs can be compensated for within the road pricing system and/or through improvements in the functionality of road links. When new pricing is imposed, existing taxes and charges can be reduced and/or revenue can be allocated to fund the transport system (e.g. maintenance, investments, and the supply of public transport).

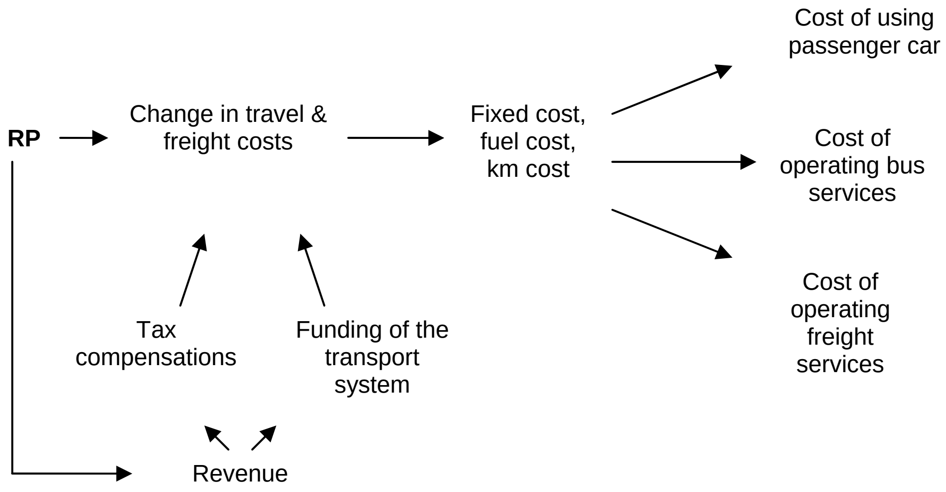

Figure 3: Impacts of road pricing on travel and transportation costs

Case study: the German road tax for heavy goods vehicles; the cost of freight and compensations

In January 2005, the German distance-based road tax directly raised the cost of freight for each kilometre hauled on the German motorway network.[2] Originally the average tax on the different vehicle types was 0.12 €/km. Evidence shows that the impacts on the cost of freight differ between freight industries inside and outside Germany. In some cases, forwarding companies added the tax directly to customer prices; in others, there has been no traceable effect.

Originally, German authorities predicted that the toll would raise transportation costs by 7–9%, which would increase consumer prices in Germany by 0.15%. However, after the first year of operation, there were no traceable increases in freight charges or consumer prices (Kossak, 2006). Economic estimations suggest similar outcomes, although minor impacts may occur in specific production sectors (Doll & Schaffer, 2007).

As an example of how the German road tax impacted on companies outside Germany, a Finnish forwarding company announced that supplementary prices will become valid as of January 2005. For shipments from Finland to Germany, the supplementary price was 0.15–0.90 €/100 kg or 20–140 €/full trailer, depending on the exact destination. For shipments to other destinations in Europe (haulage on German motorways), the supplementary price was 0.30–0.70 €/100 kg or 60–130 €/full trailer.

[2] www.toll-collect.de

Particularly in Germany, the payment of compensation to haulage industries was the subject of debate prior to the implementation of the road tax (Doll & Schade, 2005). There were plans to compensate some of the cost increase (estimated total of €600 million) by refunding fuel taxes to German haulage companies. However, this was ruled out as an industrial subsidy by EU laws. As a result, the originally intended levels of the kilometre charges were adjusted downward. The remaining compensation measures targeted at German haulage companies included a reduction in motor vehicle taxes for HGVs and the Innovation Programme, which provides incentives for purchasing cleaner HGVs.

A significant regenerating economic impact can occur if road charges and taxes provide an impulse for improving the productivity of freight operations. In Germany, for example, the number of trips by empty heavy goods vehicles have fallen by 15% since the introduction of the road tax (Short, 2007).

B: Functionality of transport links

Since road pricing has an impact on travel behaviour and freight patterns, it affects the functionality of transport links (Figure 4). Charges (distance-based charges as well as link, cordon, and point tolls) affect the volume and timing of travel and freight as well as the modal split of travel on local networks.

Functionality improvements take place if congestion or stop-and-go traffic during peak hours are reduced. As the flow of traffic improves, travel times and vehicle operating costs reduce, thereby outweighing the cost impact of charges. Also, travel times become more predictable and travel planning is easier. The risk of traffic disruptions reduces. In the case of bus and freight services, there may also be an impact on fleet rotation, which results in an improvement in productivity (a smaller fleet and group of drivers can deliver the same or larger volume of services).

In the long run, functionality impacts may be larger if pricing revenue is allocated to investments for increasing the road capacity and/or provision of public transport.

Taxes are not efficient tools for improving the functionality of transport links since they have an impact on the cost of road use in a very blunt manner regardless of the location and time of road use. Consequently, the behavioural impacts of taxes on travel and freight are less clear for problematic transport links or cordons.

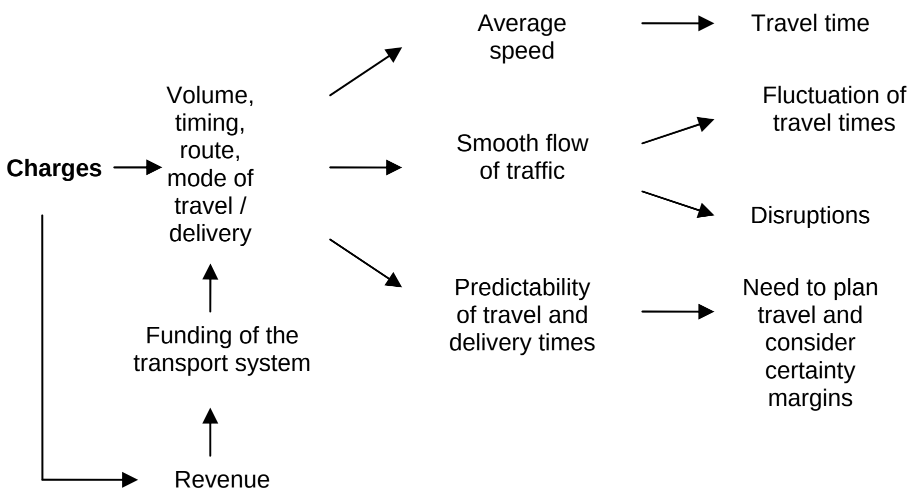

Figure 4: Impacts of road pricing on functionality

Case study: the Swiss road tolls for heavy goods vehicles

One of the main motives behind the Swiss road toll on heavy goods vehicles was to induce a change in the modal share from road to rail (Balmer, 2006). This was expected to reduce the constantly increasing number of foreign heavy goods vehicles travelling along alpine routes. A change in the modal share would improve conditions for local traffic and reduce the burden on communities and the environment.

The charge per kilometre was set at a relatively high level. As the charge imposed depends on the maximum permissible weight of the vehicle and trailer, it provides an economic incentive for hauling full loads. At the same time, national regulations were changed so that the maximum weight limits for driving on Swiss roads were raised from 20 t to 40 t.

Immediately after the introduction of the kilometre charge in 2001, the vehicle kilometres of heavy goods vehicles on Swiss roads dropped; this trend continued in 2002. The reduction in vehicle kilometres from 2000 to 2002 was approximately 7–8%. Since then, vehicle kilometres have gradually increased.

According to a Swiss analysis, the reduction in vehicle kilometres was caused by a combination of three equal factors: changes in economic activity, a change in the weight limit of vehicles, and the charging system. Although there was a downward shift in vehicle kilometres, the volume of goods (t) transported via Swiss roads has increased. This is mainly due to the rise in maximum vehicle weights. It was also noted that the number of trips made by empty HGVs or HGVs carrying small loads have reduced. However, one of the main original targets, i.e. a shift from road to rail, has not been met.

Case study: the M6 motorway

The privately operated M6 motorway in Birmingham was built in order to relieve congestion on one of the busiest roads in Europe.[3] The old M6 was carrying twice the load of traffic intended by its original design. In 2003, the old M6 was used by 144,000 vehicles per day, with its peak use at 10,000 vehicles per hour during the working day. The average speed fell to 30 km/h and travelling a distance of 43 kilometres could take up to 80 minutes.

Due to the smoother flow of traffic, travel times have been cut for those using the new tolled section by up to 45 minutes. The new tolled M6 has attracted 50,000 daily users. The impact on the whole M6 corridor is not clear, since overall traffic levels have risen. The old M6 is still used by more than 100,000 vehicles per day. The new tolled M6 has not attracted heavy goods vehicles as expected. Nevertheless, the old M6 and other links have benefited from some of the traffic using the new motorway.

Case study: the central London congestion charge

The central London congestion charge introduced in February 2003 had a very quick and significant impact on traffic volumes within the charging zone (Mori, 2004; Transport for London, 2007a and 2007b). The number of passenger cars and minicabs entering central London during the charging hours (Monday to Friday 0700–1830) fell by 30% almost instantly. There was also a drop in the number of vans. Conversely, the number of taxis, buses, coaches, and bicycles rose, indicating a change in the transport mode supported by an increase in the supply of bus services. The number of lorries and other goods vehicles remained almost unchanged.

Traffic rapidly adopted new patterns; these have been shown to be consistent. The overall drop in the number of vehicles entering the charging zone was 16% in 2006. The reduction in total circulation within the charging zone (measured in vehicle kilometres) was 14% between 2002 and 2006.

Daily time savings due to improved traffic flows are estimated at approximately 32,000 vehicle hours at the charge rate of £5. With the £8 rate, time savings are likely to increase to an estimated 37,000 vehicle hours per day. In Britain, improvements in travel time reliability are estimated to equal 30% of the value of travel time savings within congested zones and routes.

The expected rise in traffic volumes on the inner ring road (the most likely route for diverting traffic) has proven to be insignificant. Total vehicle kilometres on the ring road rose from 0.65 million in 2002 to only 0.66 million in 2006.

[3] www.m6toll.co.uk and www.m6toll.co.uk and www.cfit.gov.uk/map/pdf/europe-uk-m6.pdf

Case study: the cordon toll trial in Stockholm

The cordon toll trial in Stockholm started in August 2005 and ended in July 2006 (City of Stockholm, 2006a and 2006c). In August 2007, the congestion charge was introduced on a permanent basis.

The purpose of the trial was to cut the number of car trips during morning and evening rush hour traffic in the inner-city segment by 10–15%. The actual reduction was even higher, namely 22% or almost 100,000 fewer trips over the cordon border every day (Trivector, 2006). When measured in vehicle kilometres, inner-city traffic fell by 15%.

The number of trips made dropped more on the border of the cordon and less on the roads inside the cordon. It was suggested that perhaps the people living and operating all day inside the cordon could use their cars more due to improved traffic flow. Nevertheless, the most significant travel time savings where accounted for inside the cordon.

Travel times for motor traffic fell both in and outside the inner city. On approach roads, queue times were reduced by as much as a third during the morning rush hour and by half in the evening rush hour. Furthermore, the reliability of travel times improved significantly. Overall, the trial substantially improved accessibility.

The number of trips decreased on a larger part of the network than was expected, i.e. also on roads further away from the cordon. This was a positive outcome since it was feared that diverting traffic could cause problems further away from the cordon.

The Stockholm trial included investments in expanding the supply of public transport services. The expectation was that use of existing public transport services would increase. The results, however, were mixed. As expected, the use of public transport did increase by several per cent, although the new services did not attract car users to the extent expected. Nevertheless, the functionality of public transport remained unchanged despite the fact that usage increased.

C: Convenience of travel

Convenience of travel is a subjective impact closely related to functionality since it concerns how car users experience their travel conditional to traffic circumstances (Figure 5). It is assumed, that people feel better if driving is less exhausting, e.g. frequent changes in traffic flow are more strenuous for drivers than driving in a smooth flow at a constant speed.

In the case of charges (especially tolls that cut peak traffic), the discomfort due to poor functionality reduces and travel experiences improve. Positive attributes of the travel environment (e.g. roadside scenery and the built environment) are also more likely to be noticed. It is obvious that fixed taxes cannot deliver these benefits since they are not effective in addressing locally problematic traffic situations.

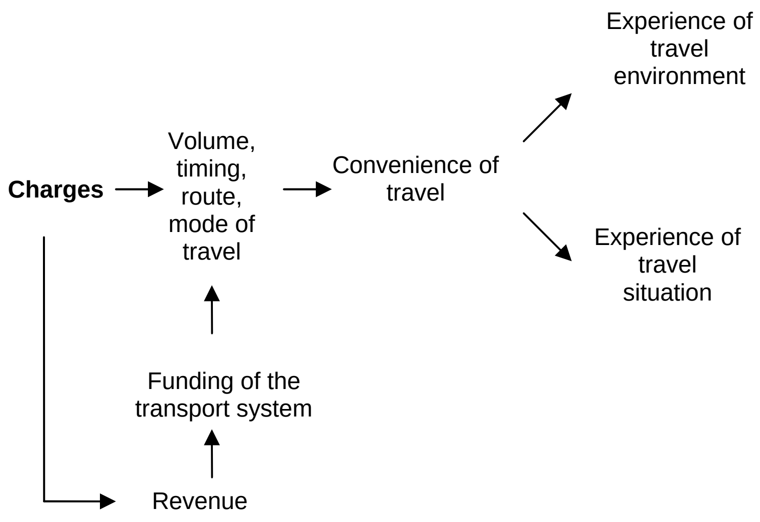

Figure 5: Impacts of road pricing on travel convenience

4.2.3 Traffic safety

The term ‘traffic safety’ refers here to accident risks and their realisation (accidents) on road links or networks.

Road pricing can have both positive and negative impacts on traffic safety (see e.g. Elvik & Vaa, 2004 and Eenink et al, 2007). Accident risks can be reduced if road pricing reduces overall traffic flows, or flows on risky road links or at risky times of the day (Figure 6). In addition, mode choices can affect accident risks. The results of Eenink et al (2007), which are based on model calculations in the Netherlands, suggest that a general reduction in car travel due to comprehensive road pricing may have significant positive safety impacts (13% less fatalities in their case). On the other hand, drawbacks may also occur. Some drivers may avoid tolls by using un-tolled, higher risk routes. In addition, rising average speeds may result in more serious accidents even if the overall number of (less serious) collisions decreases. Eenink et al (2007) also point out that vehicle occupancy rises as a result of pricing, which will lead to more casualties per individual accident.

Traffic safety usually improves when new high-quality infrastructures (e.g. motorways) replace existing poorly functioning links in the network. If the investments are financed by charges, a link between road pricing and traffic safety is created.

On a more general level, specific features in vehicle taxes may promote the purchase and use of safer cars. This, however, does not necessarily reduce the risk of accidents as such, although it does mitigate the severity of injuries. It must be noted, however, that the bonus-malus system of traffic insurance and the penalties imposed by traffic law are currently the primary forms of traffic regulation that have behavioural impacts in terms of safety.

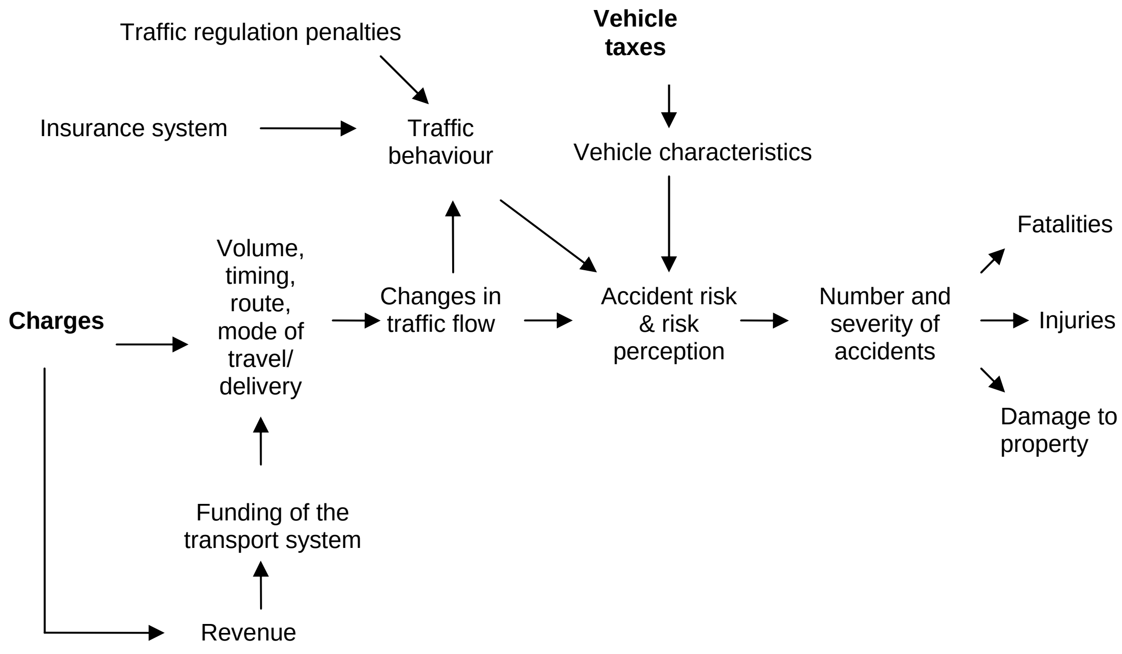

Figure 6: Impacts of road pricing on traffic safety

Case study: the cordon toll trial in Stockholm

The safety impacts of the Stockholm trial have been analysed on the basis of changes in general risk ratios (City of Stockholm, 2006c). The decrease in traffic volumes suggests that personal injury accidents should have dropped by 9–18%. However, the rise in average speeds outweighs some of the reduction in risk. A cautious estimate is that the number of personal injury accidents reduced by 5–10% (40 to 70 annual accidents) within the congestion tax area. In the inner city, a third of the parties benefiting from safety improvements consist of pedestrians and cyclists.

Case study: the central London congestion charge

London has experienced consistent and substantial declines in the number of reported personal injury road traffic accidents in recent years. Within the charging zone, an 'excess' trend, equivalent to between 40 and 70 additional collisions 'saved' per year, has been noted (Transport for London, 2007a and 2007b). However, there is data that suggests a slight rise in pedestrian accidents due to increased pedestrian mobility.

Case study: toll motorways

Toll roads are built to the highest standards with respect to the functionality of traffic and traffic safety. Kauf (2006) presents two examples on the safety record of European tolled motorways.

In 2004, French concession roads carried 13.3% of all traffic (vehicle kilometres) on the road network, while only 3.4% of fatalities occurred on concession roads. On motorways (tolled or not), only 2.4 fatalities occur per billion vehicle kilometres, while the indicator for main roads is 10.8. Similar results are presented for the tolled Athens ring road (Attiki Odos Motorway) in comparison to other Greek roads.

The Attiki Odos motorway, Greece

Toll motorways may also have adverse impacts on traffic safety if a high volume of traffic switches to lower class roads in order to avoid paying tolls. For example, a study in Norway found that the existence of un-tolled alternative routes lowers the use of tolled high-quality motorways (Elvik & Vaa, 2004). Since alternative routes are usually of lower quality, accident risks are higher, and the overall safety impacts on the network are not necessarily as positive as expected.

4.2.4 Environment

The term ‘environment’ refers here to the atmosphere, exhaust emissions, and noise from traffic.

All road pricing instruments have an impact on the overall volume and characteristics of transport (Figure 7). General taxes increase the cost of travel and freight, which restricts demand and fuel consumption. Empirically, however, it would seem that travel and freight demand is rather inelastic. General taxes can also have an impact on the types of vehicles that are purchased and used. This, however, requires that the tax instruments carry clear messages regarding factors such as energy consumption and the emission levels of vehicles.

The main environmental potential of charges (regarding emissions and noise) is their ability to relieve congestion and improve the smoothness of traffic. Improvements in traffic flow reduce emissions and noise. Mode choices in favour of public transport, walking, and cycling offset exhaust fumes and noise. The scaling of charges can also encourage the purchase of cleaner cars, although normative control already has a dominant impact on the development of vehicle technologies and, ultimately, on the types of car available on the market.

Reducing emissions and noise levels, which are harmful to health, improves the quality of life significantly and reduces associated damage costs. Exposure to pollutants is known to cause a number of health problems (e.g. respiratory problems and heart disease). There is also evidence of the negative impact of constant exposure to high levels of noise on health.

Reducing carbon dioxide has a global impact since greenhouse gasses are believed to change the climate and environment, which will have a massive impact on living conditions and economic production.

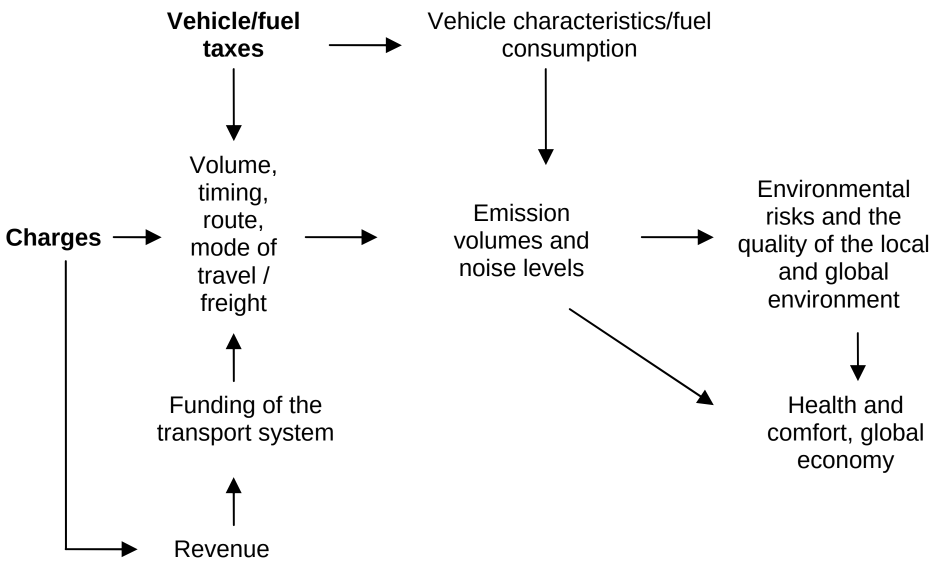

Figure 7: Impacts of road pricing on the environment (atmosphere)

Case study: the cordon toll trial in Stockholm

As a result of the reduction in traffic, the Stockholm trial cut the volume of carbon dioxide emissions from cars in the inner city by about 14% (City of Stockholm, 2006b). In the inner city, the contribution of cars to particle concentrations reduced by a tenth. A reduction in emissions was also experienced to a lesser extent at county level (i.e. beyond the charging zone).

The health benefits of the reduction in emissions (particles) were calculated to be in the range of 5 to 300 life years, depending on the methodology of assessment. It should be noted that the reduction in emissions occurred in an area where population density is high, which is a key factor regarding the significance of reduction in emissions.

The changes in traffic volumes were not sufficient to lower perceived noise levels to a clearly noticeable degree. However, intuition would imply that less traffic equals lower average noise levels. The results indicate that at some locations, fewer people considered traffic noise to be disturbing.

Case study: fuel taxes

Fuel taxes are often referred to as environmental (or energy) taxes that are strongly linked to carbon dioxide and climate policy. These references raise expectations of the associated impacts. In reality, the legislative tax basis in most countries is not literally related to CO_2, although some countries (e.g. Denmark, Finland, the Netherlands, Norway, and Sweden) apply a partial carbon content principle when setting fuel taxes.

Intuitively speaking, higher fuel taxes should restrict traffic volumes since they have a direct impact on the cost of motoring.[4] As a result, fuel taxes should have an impact on the volumes of travel and freight, as well as modal shares. In addition, fuel consumption should decrease, thereby reducing emission volumes.

However, the evidence is mixed. Although tax rates have constantly increased, road traffic volumes still seem to rise. The fuel efficiency of engines has improved. However, due to increased car travel and the popularity of bigger cars, total fuel consumption has not reduced. It may be that energy taxes have not risen in proportion to the increase in income and purchasing power.

In some countries, fuel taxation is used to promote new biofuels, with the aim of reducing the dependency on mineral oils and generating a market for fuels that are neutral with respect to climate policy. In Sweden, for example, biofuels are exempt from energy taxes. Other related measures for promoting biofuels include exemption from the Stockholm cordon tax, free parking in some cities, and direct government incentives for purchasing vehicles that use alternative fuels.

[4] In the European Union, the level of fuel taxes ranges between 0.27–0.68 €/litre for petrol (unleaded) and 0.22–0.69 €/litre for diesel. After a transition period, new member states must raise minimum taxes to 0.36 €/litre for petrol and 0.30 €/litre for diesel. The level of fuel taxes also elevates the share of value added tax in the consumer price of fuels.

Case study: road taxes and vignettes

Environmental emissions targets are pursued by scaling taxes or charges according to the characteristics of vehicles. Higher taxes or charges are levied on vehicles that emit larger volumes of pollutants; lower taxes or charges are levied on cleaner vehicles. The average level of taxes or charges is set in relation to the prevailing technology with respect to emissions. This enhances the renewal of vehicles in circulation and the development of more environmentally friendly technology.

Environmental scaling usually covers pollutants that are subject to the EURO norms on emissions.[5] The so-called ‘Vignette Directives’ (1999/62 and 2006/38) regulate the levying of charges on heavy goods vehicles according to this particular scale (table 2). It should be noted that this is an example of how normative and economic instruments can be combined to create a policy tool.

The ‘Vignette Directives’ provide guidance on the pricing of international road transport. In practice, however, they set a general framework for environmental scaling of road taxes and charges levied on heavy goods vehicles. Examples of this type of scaling include the German road tax for heavy goods vehicles and the Swiss toll for heavy goods vehicles.

Table 2: Maximum amount of annual charges, to be applied by June 10 2008 (Directive 2006/38)

Emissions category	maximum three axles, EUR	minimum four axles, EUR
EURO 0	1 332	2 233
EURO I	1 158	1 933
EURO II	1 008	1 681
EURO III	876	1 461
EURO IV-	797	1 329

4.2.5 Community structure

The term ‘community structure’ refers here to the size and density of a community with respect to the location of housing, services, and workplaces.

Community structure relates to the complicated (and long) impact chain of how vehicle and fuel taxes and charges impact on the costs of travel and freight, which in turn have an impact on location choices for housing, firms, and services (Figure 8). The often dominant role of community planning should also be noted. Cooperation between community planning and road pricing can deliver increased benefits, for instance when they work together to combat urban sprawl.

[5] The EURO norms control the emission levels of carbon monoxide, nitrogen oxides, hydrocarbons, and particles.

The thinking is that if the cost of travel and freight is high, people react by seeking jobs and services closer to home (or seek homes closer to jobs and services), and firms seek locations closer to partners and customers. As a result, the size and density of communities develop respectively. The drawback of this scheme is the intensive urbanisation of recent decades and the development of huge urban areas like London or Paris where the traffic is clogged by congestion.

Charges can have specific impacts on community structure. Tolled cordons, links, and points may create selective location choices. Tolls have an impact on the interaction between the structure that exists inside and outside the tolled areas or beyond tolled links or points.

Firms consider tolled cordons, links, and points when assessing customer flows or seeking employees. Households consider them when assessing where to live. Charges do not necessarily form adverse barriers if they support successful development of viable communities (e.g. congestion relief, reduction of environmental damage, and funding of the transport system).

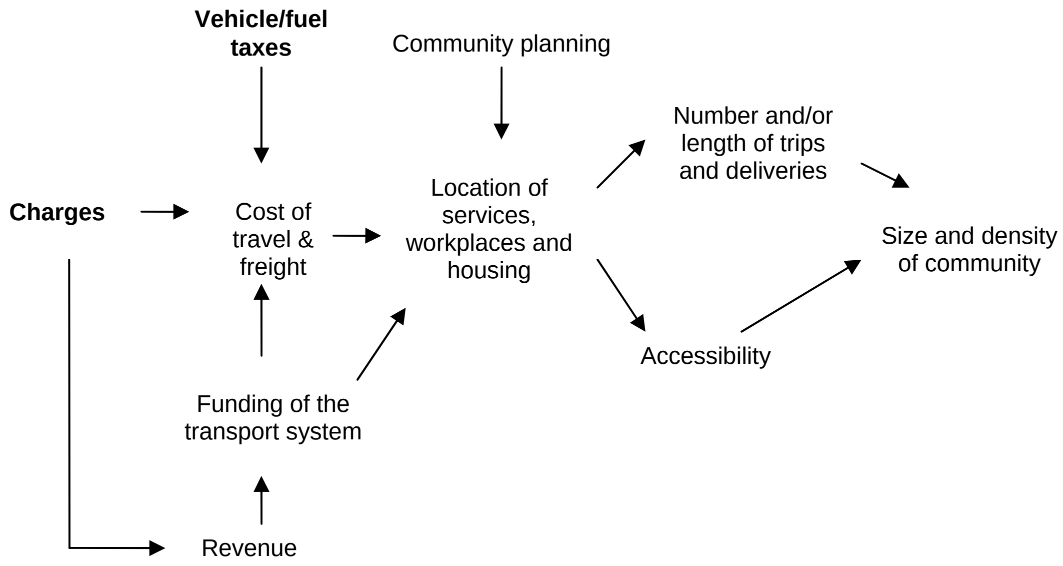

Figure 8: Impacts of road pricing on community structure

Case study: the cordon toll trial in Stockholm

The Stockholm trial's impact on the business community was investigated in several sectoral studies. Results show that the short trial period had only minor impacts on commerce and other business sectors. Sales of various types of consumer goods and special products developed during the trial period at a similar pace to elsewhere. House prices were also unaffected by the trial. It was concluded that all impacts disappeared among other causes of fluctuations in the business sector. If the results of the trial remain consistent in the long run, it can be concluded that congestion charges do not necessarily imply major changes in consumption patterns. This could mean, for example, that the location of services remains unchanged.

Case study: the central London congestion charge

Quddus et al. (2007a) examined the impacts of the central London congestion charge on the retail sector. Overall, retail sales in central London were not affected. The result is based on studies of the monthly central London retail sales index (in 2003 and 2004). The index covers sales both within the charging area and in some areas beyond the charging area. However, individual stores did experience changes in sales and a further case study was performed.

Quddus et al. (2007a and 2007b) present a detailed econometric analysis of the impacts of the congestion charge on the retail trade by focusing on the weekly sales of one of the biggest retail stores in central London (John Lewis on Oxford Street). The analysis period covered four years, three of which were prior to the congestion charge and one year thereafter.

Compared to the projected sales development, the congestion charge reduced sales by 5.5–8.2% during the year after the introduction of the congestion charge. Other factors affecting sales that can be isolated were kept constant. The drop in sales took place during late January 2003, just before the introduction of the charge in February, and remained consistent throughout the period analysed. This shows that congestion charging can have an impact on some retail sectors at least in the short term.

In the longer term, the impact may be very different once businesses and customers adapt to the changes in the operating environment. There are studies that indicate positive economic developments in urban zones that have been calmed by e.g. traffic restrictions. The calming of areas can make them increasingly attractive for businesses that serve pedestrian customers as well as customers using public transport.

4.2.6 Quality of the living environment

The term ‘quality of the living environment’ refers to the subjective attributes of urban communities.

Changes in the quality of the living environment are outcomes of many impact chains (Figure 9). The active use of charges (urban pricing) and their associated revenue can have an impact on several quality attributes in communities.

If charges (e.g. cordon tolls) cut excessive car traffic and the need to build more road, street, and parking capacity, space can be devoted to green areas or walking districts. Revenue can also be used to invest in diverting roads and public transport facilities.

Less car traffic means changes in the everyday townscape with less disturbance and visual intrusion. Cultural habitats (e.g. old buildings, squares, and parts of cities and towns) can be maintained more easily and are easier to access. Space can be devoted, for example, to outdoor activities, sports, and cultural activities. The living environment is considered safer if the opportunities for pedestrian mobility are better and there is a reduced risk of accidents.

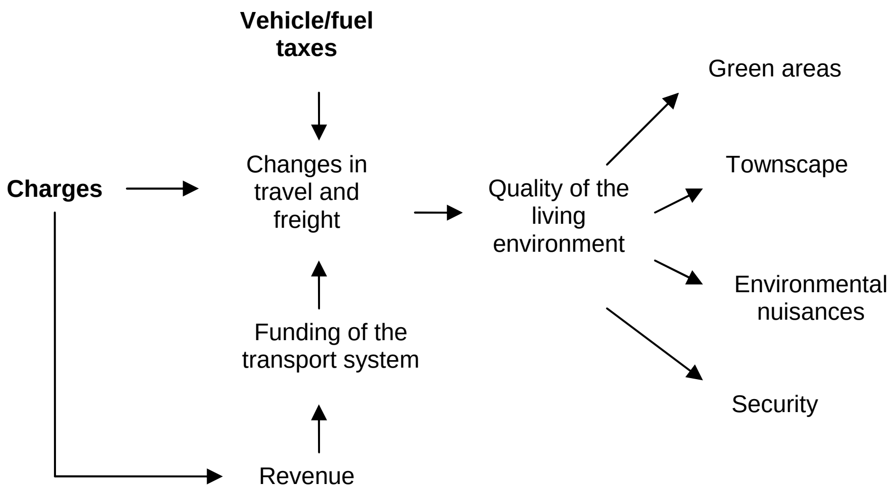

Figure 9: Impacts of road pricing on the quality of the living environment

Case study: the cordon toll trial in Stockholm

The evaluation of the Stockholm trial states that it is difficult to find a clear definition of what is meant by a change in the urban environment (City of Stockholm, 2007c). Quality issues are highly complex and subjective. No subjective measurements were made, so the evaluation of changes in the quality of the city environment was justified indirectly by using data on the changes that were clearly measured, i.e. the pace of traffic, air quality, and accessibility by car. Because positive changes were noted for all the defined attributes, it can be argued that the quality of the living environment probably improved during the trial.

4.2.7 Regional development

The term 'regional development' mainly refers here to the role of road links and networks supporting the economic status of a region and the households living and firms operating in that region.

Road pricing and the use of the associated revenue can influence regional development by changing the comparative advantage of locations (Figure 10). This is also known as accessibility. Different activities (housing and businesses) are likely to experience the changes from different standpoints. For example, in the case of an urban congestion charge, it might mean a better living environment for city inhabitants, but at the same time less economic activity in the city centre. This is an example of conflicting policy goals.

In a globally competitive economy, accessibility can be a key success factor and decisive in terms of a region being able to succeed in attracting more industrial investments than others. Ultimately these investments create economic well-being for firms and households.

The performance of road links and networks, however, is never the single cause because professional labour, innovation, and stable societies, for example, constitute the fundamental underlying factors. Nevertheless, when other factors are equal between competing regions, the role of accessibility can be significant.

Today, the mobility of labour is an increasingly important factor for firms. If traffic connections improve, enterprises can attract labour from a larger area. Skilled workers find longer distances are not such a barrier when travelling to work even beyond regional borders.

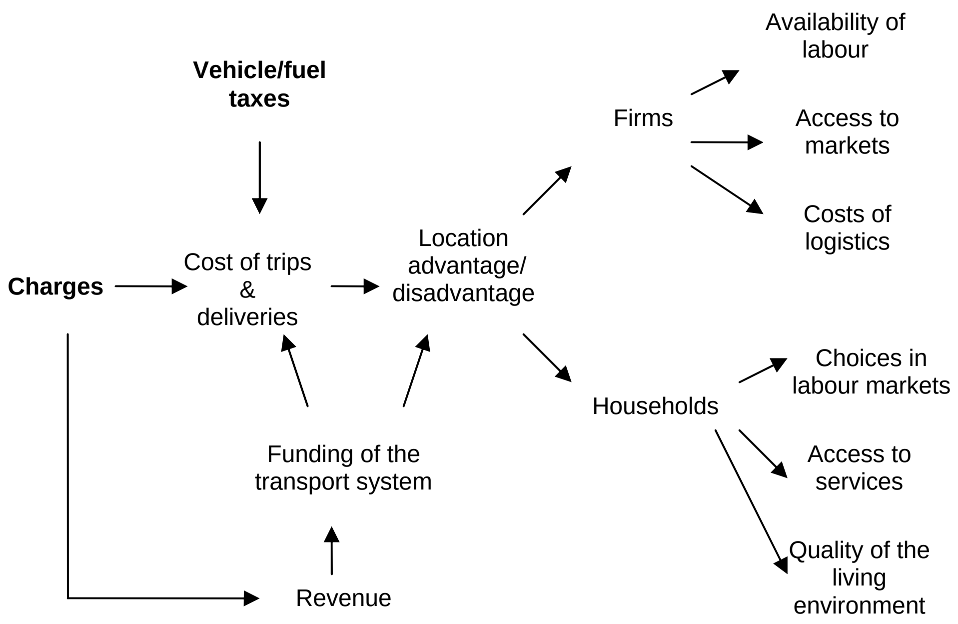

Figure 10: Impacts of road pricing on regional development

Case study: the Oresund fixed link

The Oresund tunnel and bridge linking Denmark and Sweden with road and rail connections has had significant impacts on the region since it opened in 2000. The impacts are not the direct results of pricing as such, but the construction of new infrastructure that allows increased interaction between two economically strong regions. Nevertheless, the link is financed by user charges from road vehicles and trains. It might not have been constructed in the absence of such a financial solution.

It should also be noted that the connections prior to the construction of the link were solely based on ferry services, which are also priced. Now, the alternative transport options compete with one another. The pricing of the fixed link differs for different user groups. The cost of regular use is lower; regular users are the group that is essential for regional development.

In 2006, an average of almost 16,000 road vehicles crossed the bridge per day (the total in 2006 was some 5.8 million vehicles), 90% of which were passenger cars.[6] The majority of passenger car traffic is commuter traffic between Malmö and Copenhagen and the surrounding regions. An increasing number of daily commuters also use the fixed coach and train link. There were 7.8 million train passengers between the two cities in 2005.

[6] http://osb.oeresundsbron.dk

The fixed link has led to a major integration of the Oresund region (Greater Copenhagen and Malmö/Southern Skåne) in the employment market, as well as in the areas of housing, business, shopping, and leisure activities. In addition, accessibility to airports has improved on both sides of the link. Nowadays, distribution to Southern Skåne may take place from distribution centres in the Copenhagen region.

Lower housing costs and lower vehicle taxation have resulted in Danes moving to Southern Skåne (4,300 people moved in 2006) and commuting from there to work in Denmark. Higher wages on the Danish side have attracted Swedes, who commute to work using the fixed link. The majority of fixed link users live in Sweden. Copenhagen's cosmopolitan lifestyle acts as a strong attraction for shopping and urban leisure activities within the Oresund region.

Case study: the Humber Bridge

The Humber Bridge across the Humber Estuary on the eastern coast of England (the city region of Kingston upon Hull) was opened in 1981 (Steer Davis Gleave, 2004). The toll bridge is an internal link within the Humber Trade Zone, which drives economic development in the estuary. Ports and associated economic activities are an important part of the region's future strategies. Evidently the construction of the bridge increased opportunities for local interaction, since over 6 million vehicles use it per year. The former ferry connections served only a fraction of the number of vehicles crossing the estuary today.

The level of tolls collected from users have been criticised for being high compared to major bridge tolls in the UK. The tolls are high due to the escalated financial costs of the bridge, which was built with government loans. It has been argued that the toll holds back economic development in the region. As it is the only estuarial crossing in the region, the toll bridge is even considered a barrier to economic potential.

In 2004, a study was conducted to investigate whether abolishing the toll would remove the supposed barrier and create jobs in the region. The study concluded that it would not. The unpaid loans on the bridge (costing several million pounds per annum) would have to be paid by the government. This money could create more jobs if injected into the region for alternative uses. Furthermore, it was observed that the benefits of abolishing the toll would quickly spread beyond the estuary region and diminish local benefits.

4.2.8 Funding

The term 'funding' refers here to how road projects and the public transport systems, the general road budget, and development of the transport system are funded.

In most countries, road funding primarily relies on the state budget, which is, to a varying degree, supported by taxes collected from the road sector (Figure 11). However, tax revenue from the road sector is earmarked for road funding in only a few countries.

This situation is changing as charges are increasingly used to fund roads. In some cases, the funding of individual projects relies completely on revenue from charging (e.g. tolled motorway links, bridges, and tunnels).

The popularity of financially independent road investments and/or earmarking tax/charge revenue for road sector budgets impacts on sectoral decision-making as well as overall public budgeting. Independent finance allows flexible decisions to be made on taking road projects forward, instead of political negotiations for funding from the public budget.

It is important to understand that in the case of road pricing, funding and demand management may sometimes be opposing objectives. For example, if demand management is the main objective, it may be efficient to implement a pricing scheme, despite the high investment and running costs involved, if the scheme has the desired impacts on traffic demand and the amount of externalities. Similarly, if the maximisation of revenue is the main objective of road pricing, it might be appropriate to set a price level that is so low that the impacts on traffic demand are remote.

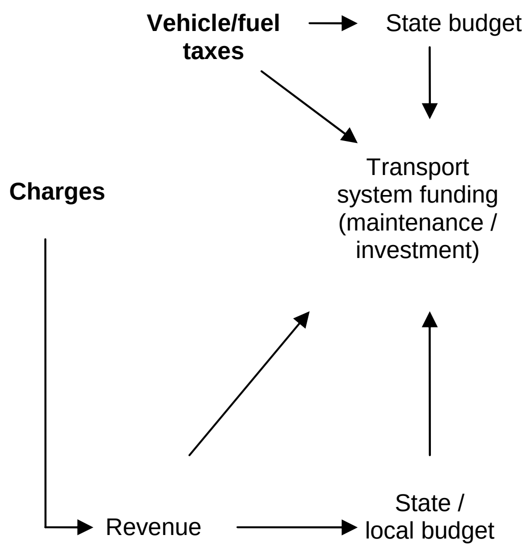

Figure 11: Impacts of road pricing on road finance

Case study: the role of taxes collected from transport in Finnish state finances

Finnish excise taxes collected from transport include the vehicle tax (on the purchase of passenger cars, vans, and motorcycles), circulation taxes (on the use of passenger cars, vans, and heavy goods vehicles) and energy taxes on transport fuels (petrol, diesel, and alternative fuels).

In 2004, for example, vehicle taxes amounted to €1.2 billion, circulation taxes €0.6 billion, and energy taxes on transport fuels €2.1 billion. The total, approximately €4 billion, made up 11% of the state budget for 2004 (€37.4 billion). At the same time, the total budget for road management amounted to €0.67 billion.

Case study: the Oresund fixed link

The Oresund fixed link is fully financed by revenue from user charges. The owner consortium, which consists of Danish and Swedish partners, provided the original capital required, DKK 19.6 billion (at 2000 levels). The current expectation is that full repayment will take place by 2033. The outcome is dependent on traffic volumes and charging levels. The volume of traffic using the link during its first years of operation has increased more than was forecast; repayment is ahead of schedule.

Case study: the German road tax on heavy goods vehicles

In Germany, the distribution of revenue from heavy goods vehicles that have to pay road taxes was a serious issue in the debate between the government and state representatives (Doll & Schade, 2005). The projected revenue flow amounts to several billion Euros per year.

Firstly, the income from the tax covers the operating costs of the toll system (Toll Collect), which account for approximately 20% of the revenue collected. Political consensus on allocating the remaining revenue was reached as follows: the federal road network (mainly motorways) is to receive 50%, the federal rail network 38%, and inland waterways 12%. A special state-owned infrastructure financing society (the VIFG) was established for the allocation of revenues to particular infrastructure investment projects.

Case study: Austrian motorway tolls

Austrian motorways and expressways are operated by one state-owned company, ASFINAG (Schwarz-Herda, 2005). Fixed toll stickers (vignettes) are collected from vehicles with a gross maximum weight of up to 3.5 tonnes. Electronically collected distance-based charges are collected from vehicles with a gross maximum weight of over 3.5 tonnes. The main goal in collecting the tolls is to finance the operation of and investment in the Austrian motorway system. According to ASFINAG's annual report (2006), total proceeds from the sticker toll and distance-based toll stood at €1.25 billion in 2006.

4.2.9 Instrument-impact matrix

In Table 3, the potential impact of RP instruments are presented in a matrix based on the judgement of the authors. It should be noted that the level of taxes or charges, as well as their design with respect to variability (e.g. time of day, type of vehicle), are important for attaining the expected impacts.

According to economic theory, only a correctly set price carries an effective signal and brings about behavioural impacts. In other words, even the application of the best instrument for a particular situation will produce inadequate results if the price setting is incorrect.

In practice, it is difficult to generalise the magnitude of impacts since pricing instruments can be applied at local, regional, or national level and with more or less high charge levels. In addition, the simultaneous use of several instruments may imply greater or fewer contradictory joint impacts.

Table 3: Road pricing instrument-impact matrix

	Accessi-bility	Traffic Safety	Environ-ment	Community structure	Quality of the living environment	Regional develop-ment	Funding
Vehicle taxes		•	•				••
Fuel taxes	•	•	•	•	•	•	•••
Vignettes	•		•			•	••
Distance-based network charges	••	••	••	••	•	•••	••
Link tolls	•••	••	•	••	•	•	•
Cordon tolls	•••	••	•••	•••	•••	•••	••
Point tolls	•••		•	••	•	••	•
Parking fees	••		•	•	••		•

••• strong impact, •• moderate impact, • small impact, (blank) very little or no impact

Motorway toll collection point in Spain (Playas de peaje de la Autopista de San Juan. Aumar)

5 Equity of road pricing

Road pricing can contribute to the implementation of projects that promote substantial economic growth or it can be an efficient way of managing traffic demand. However, treating the subject as a matter of economic efficiency only can seriously jeopardise the implementation of RP schemes. Equity—or distributional impacts, as it is often called—is frequently regarded as one of the main obstacles to achieving public acceptance of road pricing proposals. 'Equity could be defined as the fair distribution of impacts across the whole population, so that everyone takes home a share of both the benefits and the disadvantages' (CURACAO, 2007, p. 8). In other words, road pricing should provide benefits to all social groups in society without resulting in the social exclusion of vulnerable and less affluent groups. A lack of access to transport, for example because of high charges, can therefore have negative equity impacts. Although the topic attracts huge interest, there has been relatively little empirical research on equity impacts. Most of the academic focus has been on the equity impact of congestion charging and less on the equity impact of other pricing methods. Examples of congestion charging schemes are, however, few and far between.

When assessing the equity impact of potential road pricing schemes, it is important to have an overview of those who are most likely to benefit from the scheme and those who are likely to loose out. The use of revenue and the scheme design is essential to the mitigation of potentially unfavourable equity impacts.

5.1 Who wins and who loses?

Road pricing can increase the cost of travel by car but will also bring about benefits such as new roads, time savings, a reduction in accidents/pollution etc. There will, therefore, be both winners and losers throughout the transport system. Traditionally, road pricing at peak periods and in urban areas has affected those on an above-average income, often middle-aged white men (DfT, 2006). It is important to remember that travel practices vary between different social groups. National travel surveys from different countries (Denstadli et al., 2005; DfT, 2007) illustrate what previous studies have shown: high income groups travel more and longer; pedestrians and cyclists have, on average, low incomes. On the other hand, not all car owners are wealthy. Recent British research indicates that an increasing share (the latest figures show a 39% ratio) of the poorest households in the UK have access to a car, an increase from 26% in 1985/86 (DfT, 2007). The old view that a car is a luxury item might, therefore, be misleading.

However, with an increasing range of schemes in different geographical areas and with different aims, the results are likely to vary considerably, which means that it is becoming increasingly important to give consideration to equity issues.

Theoretical studies based on estimates using transport models can give indications as to what the impacts of road pricing might be. Santos and Rojey (2004) have shown, using data from three British cities, that road pricing does not have to be regressive (i.e. take a larger percentage of income from the poor than the rich) and they argue that it is a myth that the distributional impact of road pricing has to be unfavourable. Similar model calculations from Oslo have revealed that road pricing does not have to lead to reduced mobility for low income groups and that the end result might actually be improved income distribution (Fridstrøm et al., 2000). The same conclusion was reached by Small (1983) for the distributional impacts of a busy expressway in San Francisco.

Stockholm is an interesting case because extensive evaluations were carried out both before and after the implementation of the congestion tax trial (which was later made permanent). Estimates prior to implementation indicated that the charge would mainly affect men, high-income groups, and residents of central Stockholm. Model estimates also showed that high-income groups would pay 2-3 times more than low-income groups and that the use of the revenue would benefit the latter (Eliasson and Mattson, 2006). During the trial, a travel survey, which was based on trips made, was carried out. This confirmed previous estimates and showed that the congestion tax mainly affected wealthy men in central parts of the city. Households with children and households with two adults were among those who paid more than the average motorist.

Gómez-Ibáñez (1992) provides the following overview of the likely winners and losers of road pricing:

Table 4: Winners and losers of road pricing schemes

Winners	Losers
• Motorists who value time • Public transport passengers who experience shorter travel times and service improvements • Receivers of net revenues	• Motorists who do not value time and have no alternative modes of travel • Motorists who change destination • Residents in areas that experience increased traffic

Minken (2005) provides a similar classification and divides the groups affected by road pricing into four categories: (1) those who keep driving after charges are introduced and who value time more than the charge (winners), (2) those who keep driving after charges are introduced but who do not value time more than the charge (losers), (3) those who change their mode of travel (losers), and (4) those who did not use a car before the charge was introduced and will not use one afterwards (these people can be both winners and losers). Minken claims that travellers as a group will lose out as a result of road pricing since groups (2) and (3) are nearly always larger than groups (1) and (4). However, the end result will depend on how the revenue is used.

According to the studies mentioned above, it would appear that road pricing can have negative impacts on several groups of travellers even if different studies show different results. Equity implications are sensitive to the scheme's specification and the location of workplaces and residential areas, car ownership, and travel patterns in different cities. Stakeholders in some areas could thus be affected differently from stakeholders in other areas. The degree of inequity may vary significantly from scheme to scheme.

5.2 Use of the revenue

The use of revenue is a useful starting point for a study of the distributional impacts of road pricing on different geographical areas. The importance of the use of the revenue generated was emphasised as early as the Smeed report. However, it was also recognised that distributional impacts could not be gauged in full before the use of the revenue was known: 'The way in which different groups of people were affected would depend largely upon the manner in which the revenue from the pricing system was used. It is clearly outside the terms of reference to suggest how the revenue should be used. We can only point out, therefore, that the consequences of road pricing, like those of any other charge or tax, cannot be fully assessed until the answer to this question is known' (Ministry of Transport, 1964, p. 38).

Road pricing can clearly provide huge net revenues that can be redistributed to different groups in society. This can be done in different ways. Both Goodwin (1989) and Small (1992) have advocated a tripartition of the revenue: one part for general tax cuts or cuts in car taxes, one part for public transport improvements, and one part for road investments. They claim that such a division could even improve the distribution of income between different groups in society.

The trial in Stockholm proposed the following alternatives for using net revenues: (1) equal return, i.e. the same amount redistributed to everyone; (2) a reduction in public transport fares; and (3) a reduction in county income tax. Based on these alternatives, it was found that if the objective is to achieve a more equal income distribution, the revenue should be used to reduce the price of public transport. The groups that would benefit from reduced public transport fares include young people, those on a low income, single people, women, and residents of the inner suburbs (Transek, 2006).

On the other hand, even if public transport is improved and prices reduced, some vulnerable groups might have difficulties making use of it because of disabilities or insufficient service density. For some, the car will sometimes be the only alternative. The question is, therefore, how to mitigate adverse equity impacts on those who are less well off and who still rely on using a car? A simple way of protecting at-risk groups that rely on the use of a car is to provide exemptions for them (Bonsall and Kelly, 2005). This might, however, be administratively challenging and will most certainly reduce the effectiveness and the profitability of the scheme. Another way is to provide discounts or price caps in order to ensure that the average monthly bill does not become too large.

5.3 Scheme design

The scheme design will have implications on the performance of the road pricing scheme. Decisions relating to the design will have implications on the economic performance, acceptability, and equity of the scheme. A successful scheme design should therefore take into account key distributional and economic impacts. From an equity perspective, important issues to consider include the location, time of day, level of charge, and discounts and exemptions[7]. As mentioned in section 5.2, the latter can be used as a means of protecting vulnerable groups.

With respect to Norwegian toll cordons, three main measures have been introduced to reduce opposition to potential equity impacts:

- exemptions for disabled drivers;
- a ‘one-hour rule’: drivers are only charged once per hour regardless of how many times they pass the cordon;
- a maximum limit of chargeable crossings per month (usually in the order of 60–75).

In addition, discounts of up to 50% have been offered to those paying the tolls electronically from a pre-paid account. The various exemptions and discounts were mainly introduced to enhance acceptability, but there was also an equity argument based on the idea that the total monthly cost should not be excessive, even for those crossing the cordon frequently, such as taxies.

6 Acceptability of road pricing

6.1 Factors affecting acceptability

The various forms of road pricing often encounter opposition from citizens and politicians. The opposition is greatest in those cases where the plan is to implement road pricing on an existing network in order to restrict demand. The acceptability of tolls that are being imposed to raise funds for the construction or operation of new roads is much higher. This is the case despite the fact that when congestion is a problem, there are clear justifications for congestion pricing from an economic theory perspective.

Much research has been conducted into the acceptability of road pricing. The objective of the research has been to identify the factors affecting acceptability and to find ways of guiding public opinion and politicians to achieve acceptability.

The acceptability of different methods of managing demand for urban traffic is presented in Figure 12. Improving public transport and park-and-ride investments supporting the use of public transport have the greatest support. Of all pricing alternatives, cordon pricing around cities meets with the least opposition. However 84% oppose this alternative too. Distance-based pricing is opposed by 91% of respondents.

[7] For an overview of scheme design issues, see Sumalee et al. (2005).

Figure 12: Acceptability of different traffic demand management measures (Schade 2001)

Public acceptance of road pricing is the central factor when it comes to acceptability. It has been observed that the following factors affect the public acceptability of road pricing (European Commission 2003):

- **Problem perception**: the acceptability of road pricing increases if citizens notice the problems that the collection of fees aims to address. Motorists who travel in congested conditions are an exception, however, as they usually oppose pricing even if congestion is reduced. If citizens are worried about the state of the environment and traffic safety, the acceptability of road pricing is greater.

- **The perceived effectiveness of the proposed measures**: the greater the belief of the citizens in the pricing system's efficiency in achieving its objectives, the greater the acceptability of the system. Pricing implemented on highways is much more acceptable than the pricing of urban traffic. The reason for this is the complexity of the urban environment and the resulting difficulty in estimating the impacts of pricing. On highways, it is easier to see the connection between toll financing and investments.

- **Knowledge about policy alternatives**: Generally speaking, citizens are less aware of pricing than other means of influencing traffic demand. A suspicion of new things reduces the acceptability of road pricing.

- **Equity/fairness**: the equitable distribution of impacts between different interest groups increases acceptability. Targeting the use of collected funds is a key factor in acceptability.

- **System characteristics**: many studies have indicated that the acceptability of complicated systems is lower, such as systems based on time or congestion. On the other hand, according to Ubbels and Verhoef (2005), the complexity of the pricing systems has no effect on acceptability and decision-makers should not be satisfied with simple flat rates due to acceptability factors.

- **Social norms and pressure**: if there is social pressure to accept prices, the willingness of individuals to accept road pricing also increases.

In addition to public acceptability, the attitude of businesses has an effect on the acceptability of road pricing. Businesses oppose road pricing almost without exception, seeing the fees as a factor that hinders customers and transport. Companies in the area covered by the fees feel that their competitive situation will deteriorate compared to those companies for whom fees charged on customers and transport have no effect. Nevertheless, there is evidence to show that congestion tolls in cities benefit companies due to the reduction in congestion (European Commission 2007).

Ultimately, the introduction of road pricing requires the approval of political decision-makers. The attitudes of politicians are strongly influenced by the effect of their own actions on their popularity and, consequently, their chances of being re-elected. It is difficult for a single politician to receive merit for the introduction of road pricing (Ken Livingstone, the former mayor of London, is an exception to this rule) and politicians are inclined to support actions that directly benefit road users, such as new road projects. At local level, questions of equity can also become central and it can be difficult to justify the positive impacts of pricing to voters because they are far too abstract (European Commission 2003).

6.2 Factors that increase acceptability

The acceptability of road pricing can be examined through ex-ante and ex-post evaluations of the implementation of the pricing scheme. Indeed, acceptability usually increases after introduction. On the basis of Norwegian studies, Kjerkreit and Odeck (2005) conclude that the acceptability of road tolls increases when road users start to benefit from better roads built using the proceeds of the tolls. The use of the funds collected using tolls is a central factor with respect to acceptability. According to Ubbels and Verhoef (2005), Dutch road users feel that the preferred targets for the use of the various proceeds from road use tolls are the abolition of existing car taxation, reducing fuel taxes and new road investments. The crediting of the funds to the state’s general budget overwhelmingly received the least support.

The acceptability of the pricing of urban traffic can be increased by the introduction of so-called ‘package solutions’ in which the targets that receive funds are used to benefit many different parties. In the study by Jones (1991), 57% of respondents opposed congestion tolls to reduce urban congestion (30% supported them). However, the opposition turned into a support level of 57% (34% opposed) when respondents were told that the proceeds would go towards improving the quality and lowering the price of public transport, reducing accidents, and improving the conditions for pedestrians and cyclists. It is significant that acceptability was achieved even though the package did not include road investments that directly benefit road users.

Odeck and Brathen (2002) have studied the ex-ante and ex-post acceptability of urban tolls in Bergen, Oslo, and Trondheim (see Figure 13). In all three cities, the attitudes of citizens toward the tolls were less negative one year after introduction. In Bergen, attitudes were affected by the small size of the toll charged and the use of the funds for infrastructure projects that were found to be useful. In Trondheim, there was a campaign to promote the toll system among citizens by describing the infrastructure projects made possible by the funds collected. Conversely, attitudes in Oslo did not change as clearly because the once-off fee was twice as large as in Bergen and the introduction of the tolls was not supported by campaigns describing the positive impacts.

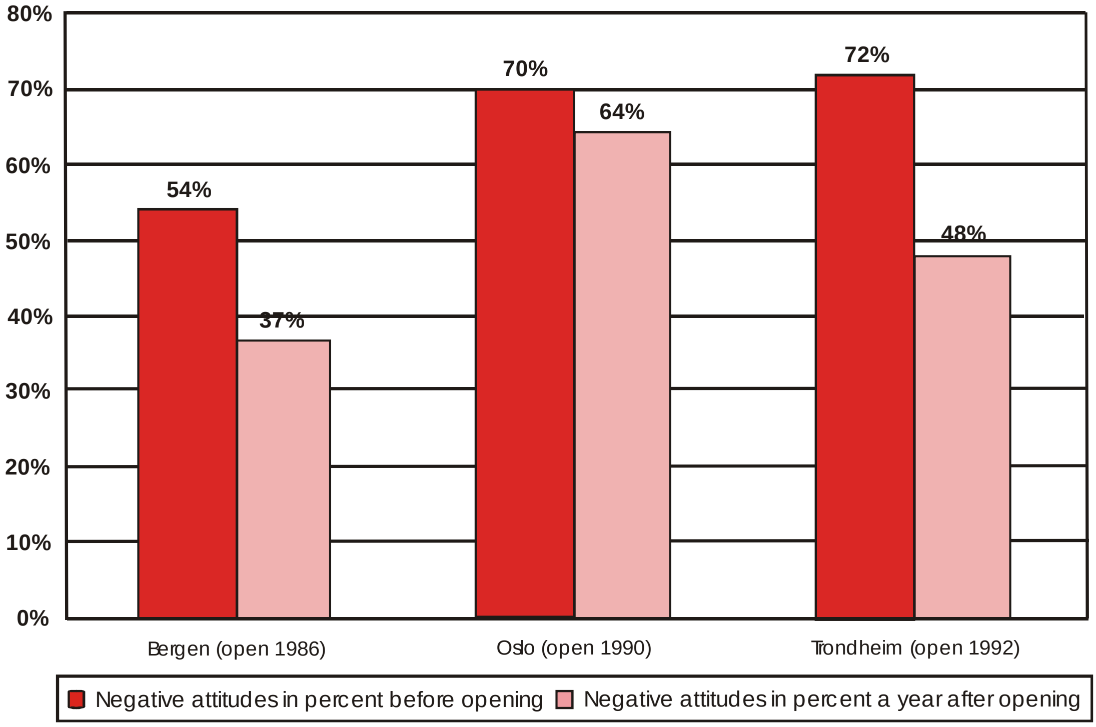

Figure 13: Users' attitudes before and after the introduction of urban tolls in Norway (Odeck and Brathen, 2002)

6.3 Acceptability and impacts of road pricing

The importance of the impacts of road pricing vis-à-vis the acceptability of the pricing systems increases with the clarity of the perceivable impacts. For this reason, the direct impacts on road users (such as the cost of travel and freight) are more important with respect to public acceptability than indirect impacts (such as regional development).

Factors that reduce the acceptability of road pricing are direct impacts on the costs of passenger travel and freight traffic. Road use charges are always evident in the increase in out-of-pocket costs of all road users, and road users who are already heavily taxed often experience the charges as a new burden. Road users do not appreciate the benefit brought about by improved traffic flow as a result of the charges in the same way.

The impacts that are important for public acceptability are the positive effect of road pricing on the natural environment and the comfort of the living environment in residential areas. On the other hand, it is difficult for citizens to see indirectly perceivable impacts on regional development that are only evident in the long term as benefits of congestion charging.

Companies often believe that road pricing is harmful to the development of the community structure and the regional economy because the charges treat actors within the toll area differently to those outside it. The assessments of politicians usually reflect the opinions of citizens and business.

The use of the funds collected can be perceived to be something that clearly improves acceptability or reduces it. If the funds are used in a way that benefits road traffic or the rest of the area's transport system, the use of the funds boosts acceptability among citizens and businesses. Conversely, the channelling of funds into the general state budget reduces the acceptability of road pricing. From the point of view of political decision-makers, additional funding is generally a positive matter regardless of the purpose for which the funds are used, as finding new sources of state/municipal financing is also in the interests of politicians.

Table 5: Road pricing acceptability-impact matrix

	Cost of travel and freight	Functionality of road links	Traffic Safety	Environ-ment	Community structure	Quality of the living environment	Regional develop-ment	Funding
Public acceptability	- - -	+		++	+	+	-	+++/- - -
Business acceptability	- -	+			- -		- - -	++/- - -
Political acceptability	- -	+		+	+	+	- -	++

+++ very important positive factor, ++ important positive factor, + small positive factor, - - - very important negative factor, - - important negative factor, - small negative factor, blank = very little or meaningless factor

In conclusion, the acceptance of RP requires demanding technical and economic preparation, as well as a social one involving public consultation, and, where possible, dialogue. The characteristics, rhythm, and intensity of this dialogue will vary according to the country where it takes place. In Norway, for each site, historical tradition and information campaigns muster initial acceptance by a large proportion of users, which subsequently becomes the conviction of the majority. In Stockholm, urban road pricing was really implemented as an experimental measure for a defined period in order to identify the impacts and poll the opinions of the locals. However, the majority of these experiments reveal a widening of the original issue as set up by the contract manager, which allows for a progressive integration of RP into transportation policies. Nevertheless, an assessment that would broaden its scope to study the practice of collaboration in the transportation sector in many European countries (public debates on infrastructure projects, local or national referenda on travel policies, opinion polls, etc.) could contribute to a better understanding of the socio-economic stakes of RP.

7 Conclusions

It is important to understand the impacts of road pricing when designing the pricing system and making decisions about its implementation. When designing the pricing system, there must be an understanding of the impacts of pricing, how pricing is targeted, and what impacts are important for the acceptability of the system. The objectives of the pricing system are set on the basis of this understanding. The system that achieves the objectives most efficiently and that can gain political acceptance is then chosen. The objectives are the intended impacts.

Generally speaking, the objective of road pricing is to obtain funding and/or to bring about an intended regulatory impact. When there is a shortage of funding for road management (especially investment), the main objective of road user charges is to obtain additional funding. Numerous European toll roads and the cordon tolls around Norwegian cities are examples of this. In this case, the intention is to set the fees at a level that ensures the desired income; the intention is not to achieve the above-mentioned regulatory impacts. The collection costs of the fees should also be low.

An efficient regulatory impact is achieved when road users pay for all of the costs they create. Under marginal cost pricing, road users must pay other road users and the rest of society for all the short-term additional costs they create through traffic congestion, emissions, and accidents. The realisation of the 'polluter pays principle' is usually the primary objective of road pricing, especially in congested areas. The objective has been implemented in practice in the new 'Eurovignette Directive', which enables the external costs incurred to be used as the basis for determining heavy goods vehicle (HGV) fees.

It is important to note, however, that trying to regulate demand and obtain funding do not exclude each other because marginal cost pricing also produces a surplus, and fees set with the intention of obtaining funding also have an impact on demand.

The socio-economic impacts of road pricing are diverse and far-reaching. The magnitude of the impacts depends on the scope and targetability of the pricing system and the level of the fees. Estimating the magnitude of direct impacts on road users and the rest of society (e.g. time savings, emissions, accidents etc.) is possible, but estimating the broader impacts on the community structure, companies, the regional economy, and the national economy is challenging and is often only indicative.

The impacts of road pricing can be described in simplified form using a causal impact mechanisms approach. Many of the impacts originate in the higher price of the trip caused by the fees and its direct impact on the demand for traffic. This results in direct impacts on transportation by motor vehicle and transportation costs. These impacts have knock-on impacts on the economy through changes in consumption, prices, production volume, and employment, and are ultimately visible as changes in gross domestic product. Road pricing also has an impact on the state's fiscal needs and therefore on the level of taxation.

In congested areas, the main impact of road pricing is a reduction in traffic volume. The causal chain originates from the fact that road users, as a result of the fees, change the time, route, or mode of transport of the trip or boost the efficiency of deliveries through more efficient utilisation of transportation capacity. The changes are visible in shorter travel times, a reduced fluctuation in travel times, and the improved convenience of travel experienced by road users. Practical examples (the London and Stockholm cordon tolls and the Swiss kilometre fee for HGVs) have demonstrated the effectiveness of road pricing in regulating demand.

Road pricing can either decrease or increase traffic accidents. The number of accidents will fall as the risk of an accident is reduced due to the decrease in traffic, the shift to safer routes, or to a safer time. However, road pricing can have the opposite effect if traffic shifts from a modern toll road to a less safe road, for example, or if vehicles move faster as congestion is reduced and the consequences of accidents become worse.

Environmental reasons are often used to justify road user charges. Although the price elasticity of demand for traffic is low, new fees increase travel costs and thereby reduce demand for transportation. From an environmental perspective, the greatest benefits of road pricing arise from pricing during congested conditions because as the flow of traffic improves, fuel consumption and emissions are reduced. Vehicle taxes can also encourage consumers to choose more environmentally friendly cars.

In the long term, road pricing also has an impact on the structure of the community and regional development. Together with effective community planning, road pricing can prevent urban sprawl because pricing has an impact on the location of people and companies, particularly in the case of cordon tolls in cities.

The introduction of road user charges always means an increase in consumers' out-of-pocket costs if the new fees are not compensated for in some way, e.g. by reducing prevailing taxes on road traffic. Different studies of both potential and real equity impacts show that road pricing can have both regressive and progressive impacts and that it does not necessarily have a negative impact on the poor and on mobility, which would lead to social exclusion. Given the huge differences in the findings and recommendations of different authors, equity impacts can probably be said to be area specific. Real impacts will depend on where people live, where they work, the modal share, and income distribution in society. It is, therefore, vital in this context that planners and policy makers pay specific attention to the various characteristics of the area under consideration for road pricing and that necessary measures are introduced to mitigate the potentially adverse equity impacts of the scheme being proposed.

The acceptability of road pricing is closely related to its impacts: acceptability increases when the actual impacts are similar to what was predicted. Experience has also shown that the acceptability of road pricing usually increases after the introduction of pricing as people start to experience positive impacts. How the income is used also has a clear impact on the acceptability of road pricing. Acceptability increases if the income is invested in roads or used to improve the rest of the region’s transport system.

Acceptability can be divided into public acceptability, business acceptability, and political acceptability. With the exception of financing, the views of the public and politicians are usually similar. Politicians usually see additional funding as a positive matter, while the increase in road use costs resulting from road use fees is of greatest concern to the public and the connection to funding is not perceived. Companies often oppose road pricing because they perceive it only as an additional expense and fear that cordon tolls around cities will reduce the number of customers visiting businesses in the city centre.

Although road management in Europe is usually funded from the general state budget, road user charges are becoming increasingly important in the regulation of traffic and the funding of road management. The most effective pricing instruments for achieving the intended impacts have proven to be cordon tolls around cities and distance-based network charges. Both have a clear impact on accessibility, traffic safety, the environment, the community structure, the quality of the living environment, and regional development and also create additional funding for road management. The magnitude of the impacts depends on the level of fees that are set. On the other hand, vehicle taxes and fuel taxes are only effective in obtaining funding; they are very ineffective in generating other impacts.

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Annex 1

The DG TREN Handbook on the external costs of transport

Following the mandate set by the 2006/38/EC Directive, the Commission developed the so-called IMPACT Study, which included an analysis of the costs of road infrastructures and taxes, as well as a *Handbook for the calculation of the external costs of Transport*[8].

The handbook[9] includes an analysis and a summary of available scientific literature on the external costs of transport (congestion, accidents, noise, air pollution, climate change, and other external costs). For each cost category, the handbook proposes a recommended methodology for the calculation of the output values, aimed at setting the optimum prices for the use of the infrastructure. Although the handbook covers all modes of transport, particular emphasis is placed on road transport and, to a lesser extent, on rail transport. Based on the proposed methodologies, the handbook shows the ranges of output values for the different external costs of road transport (cars and heavy goods vehicles), whose values are depicted in the figures below.

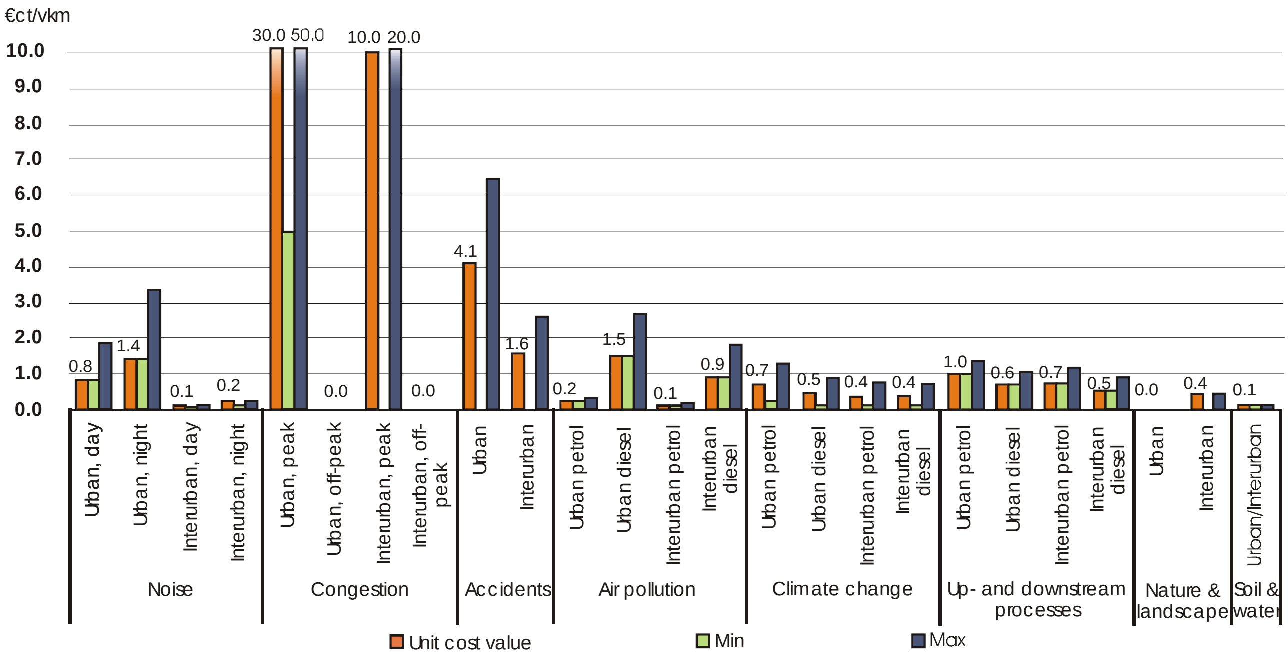

Figure 14: Passenger cars: unit values per cost category in €ct/vkm (in €2000)

[8] Handbook on estimation of external cost in the transport sector. Produced as part of the *Internalization Measures and Policies for all external Cost of Transport* (IMPACT) study. Commissioned by: European Commission DG TREN.

[9] The full document can be downloaded at: http://ec.europa.eu/transport/costs/handbook/index_en.htm.

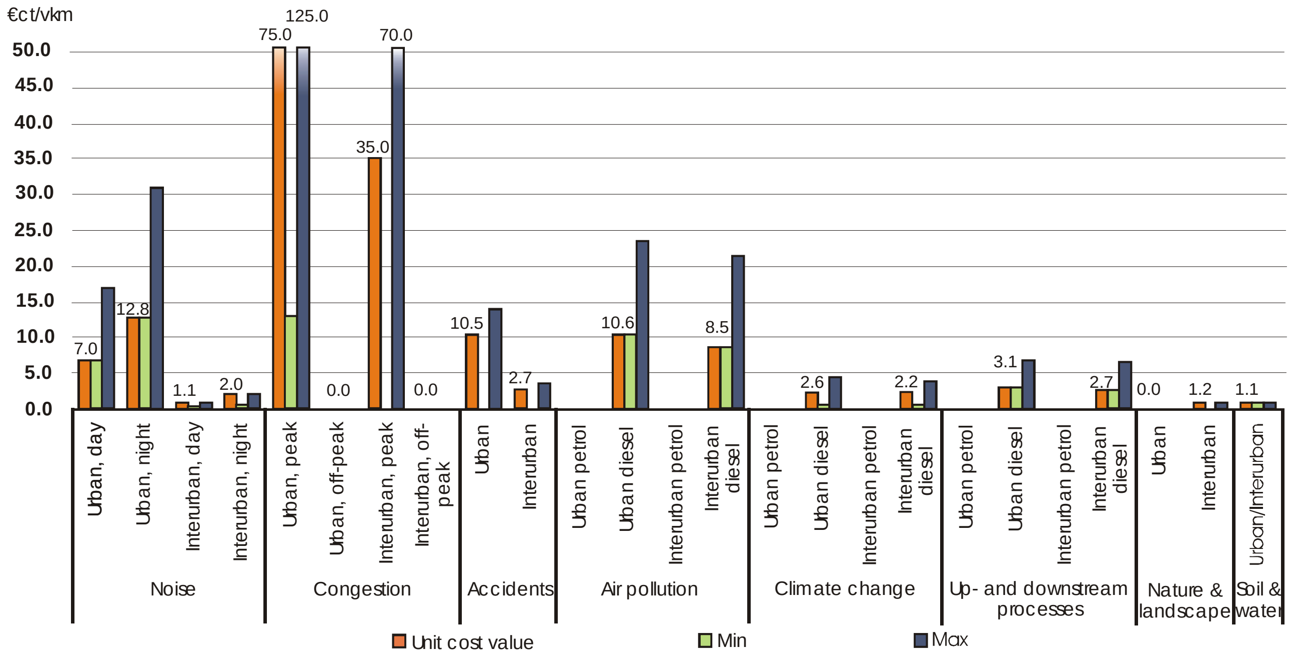

Figure 15: Heavy goods vehicles: unit values per cost category in €ct/vkm (in €2000)

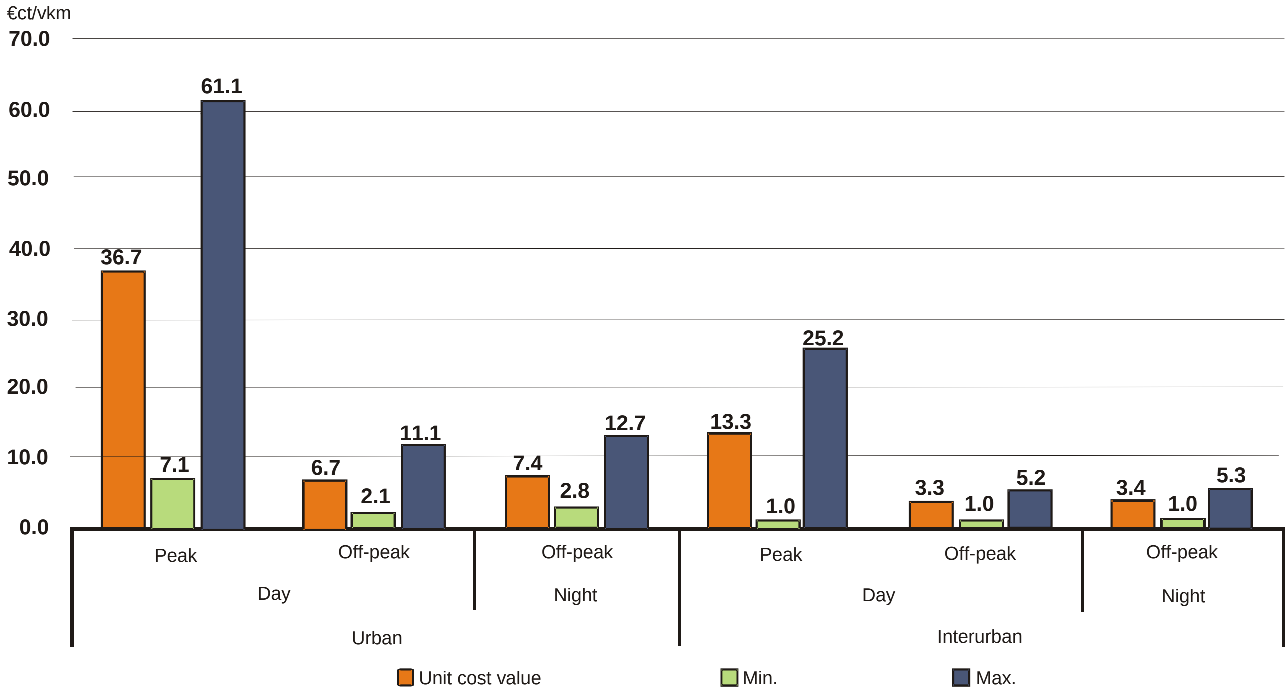

Figure 16: Passenger cars: unit values per traffic situation in €ct/vkm (in €2000)

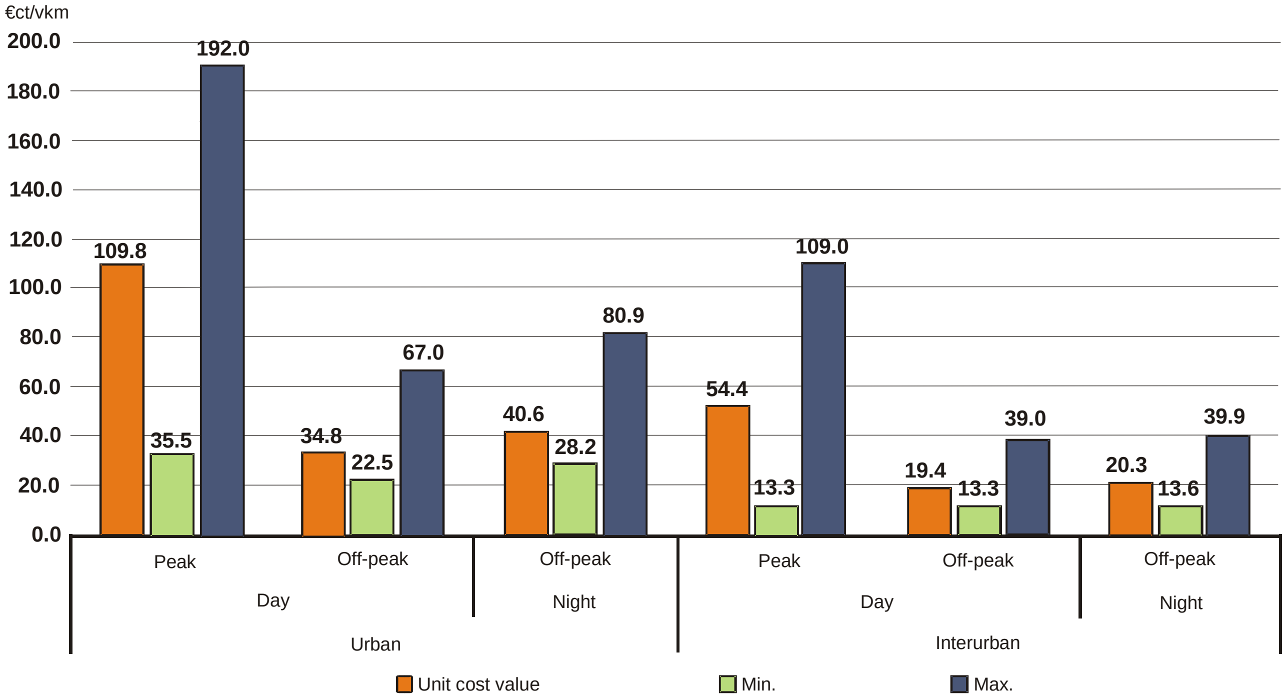

Figure 17: Heavy goods vehicles: unit values per traffic situation in €ct/vkm (in €2000)

Ref: CEDR report 2009/03 TDManagement2009 / RoadPricing

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