ECONOMIC RESEARCH CENTRE

TOLLS ON INTERURBAN ROAD INFRASTRUCTURE

AN ECONOMIC EVALUATION

ROUND TABLE

118

EUROPEAN CONFERENCE OF MINISTERS OF TRANSPORT

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ECONOMIC RESEARCH CENTRE

REPORT OF THE
HUNDRED AND EIGHTEENTH ROUND TABLE
ON TRANSPORT ECONOMICS

held in Paris on 30th November-1st December 2000
on the following topic:

TOLLS ON INTERURBAN ROAD INFRASTRUCTURE: AN ECONOMIC EVALUATION

EUROPEAN CONFERENCE OF MINISTERS OF TRANSPORT

EUROPEAN CONFERENCE OF MINISTERS OF TRANSPORT (ECMT)

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- helping to create an integrated transport system throughout the enlarged Europe that is economically and technically efficient, meets the highest possible safety and environmental standards and takes full account of the social dimension;
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Publié en français sous le titre :

Les péages sur les infrastructures routières interurbaines : Une évaluation économique

Further information about the ECMT is available on Internet at the following address:

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RETRANSFERENCE AND CONFLICT POTENTIAL BY INTRODUCING TOLLS ON INTERCITY ROAD INFRASTRUCTURE

SUMMARY

Vienna, October 2000

1. INTRODUCTION

A main and often underestimated problem when introducing tolls on intercity road infrastructure is the acceptance of the toll, the retransference and the conflict potential, to which this paper is mainly dedicated.

Generally, the degree of acceptance of tolls in case studies is determined by short-term surveys, during which people are asked:

- firstly, if they would accept a toll on defined roads or sections; and
- secondly, if they would not accept the toll, how they would react.

For those who would refuse the toll principle, the following alternatives are given:

- choice of another road – route change;
- change of transport mode;
- reduction in travel frequency;
- change of occupancy; and
- change of destination.

However, the people questioned under these conditions are in a prisoner's dilemma, i.e. they do not know how others would react. Their answers show how they would behave in the current situation if the framework conditions, such as traffic flows, etc., remained unchanged. If each user could know the reactions of the other users he would certainly react in a different way.

The first result of this process is the **initial acceptance**, which means acceptance without knowing the reactions of other users. This is shown in Figure 1.

Therefore, in the first stage of the survey, nobody knows how the others will react. But if others' reactions were known, the replies would not be the same because the conditions of choice and alternatives would be modified.

For instance, if the toll on a section is very high and the initial acceptance in general is very low, many users will first choose an alternative, parallel, untolled route. As conditions on this alternative route worsen, some of these "first refusers" will switch back to the tolled road.

This latter process is called "retransference" and can be investigated in long-term surveys and models. This process is demonstrated in Figure 2.

Figure 1. **Acceptance scheme at short-term view**

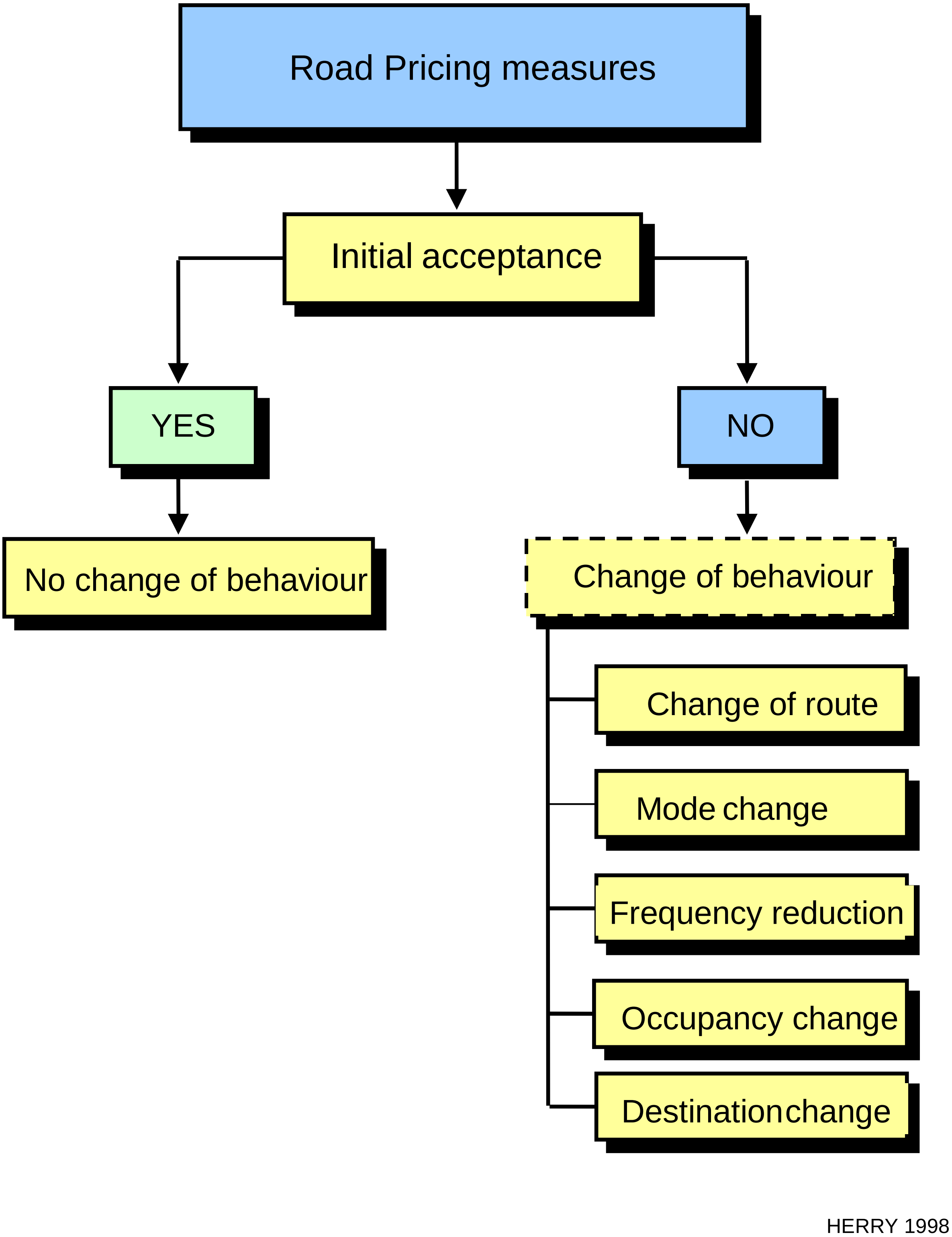
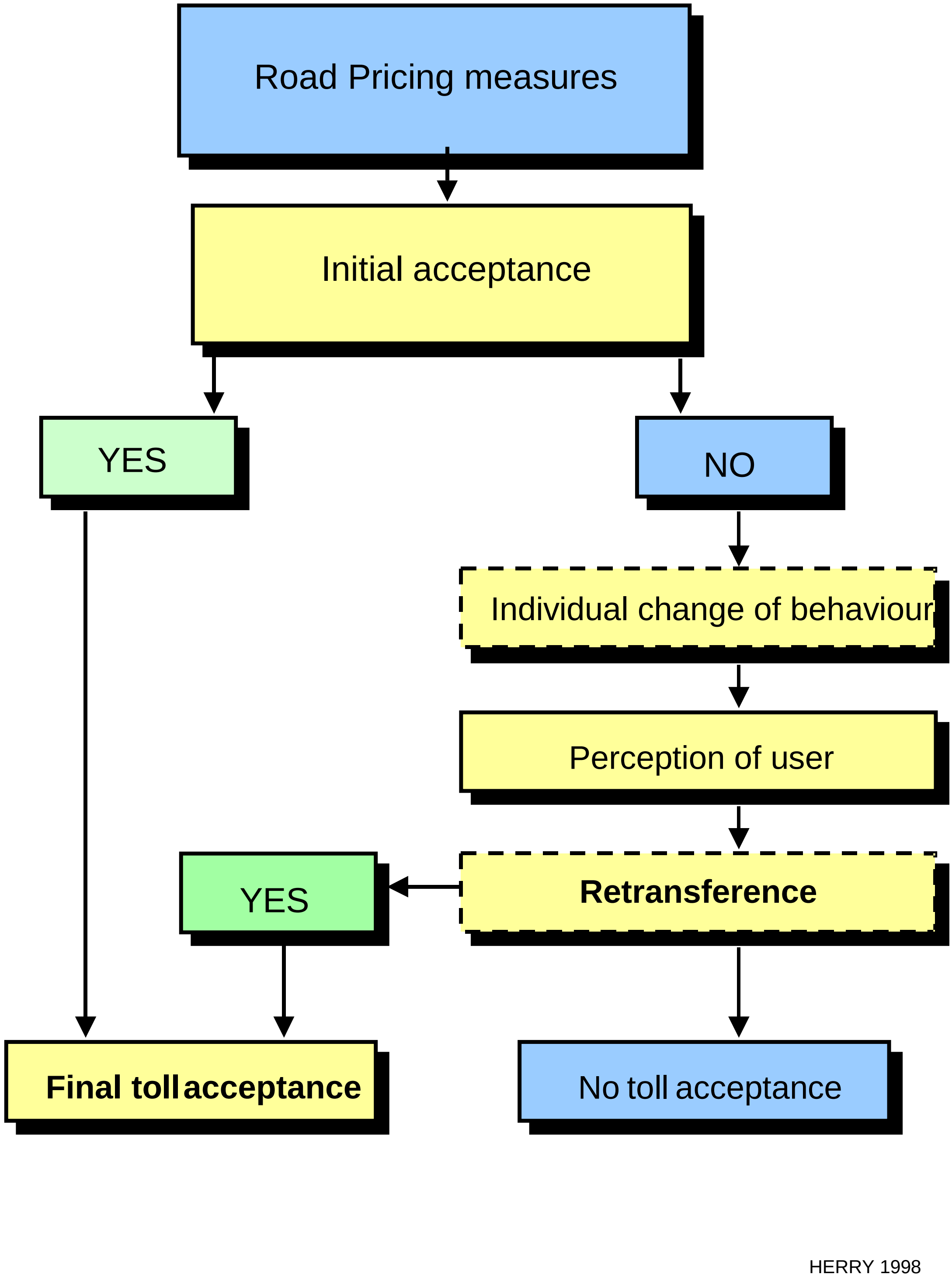


Figure 2. **Acceptance scheme at long-term view**



In Austria in recent years, several studies have been carried out, attempting to demonstrate the process of retransference[1 2]. All these studies used the stated preference method. In the Austrian case study survey of the Brenner Corridor, the fixing of target groups was essential, as the type of target group has a great influence on the definition of the hypothesis. The target groups have been defined according to traffic criteria (for example, frequency of vehicle use), situational criteria (purpose of travelling, type of vehicle, time of travelling) and geographical criteria (origin, destination of trip, used route).

The following chapter will describe this procedure in detail, based on studies carried out in Austria.

2. INITIAL ACCEPTANCE

Recently, two major road pricing surveys have been carried out[3 4], commissioned by the Austrian Ministry of Economic Affairs, which have contributed to the gathering of information on:

- (general) toll acceptance in Austria; and
- behaviour of drivers, who would not accept the toll.

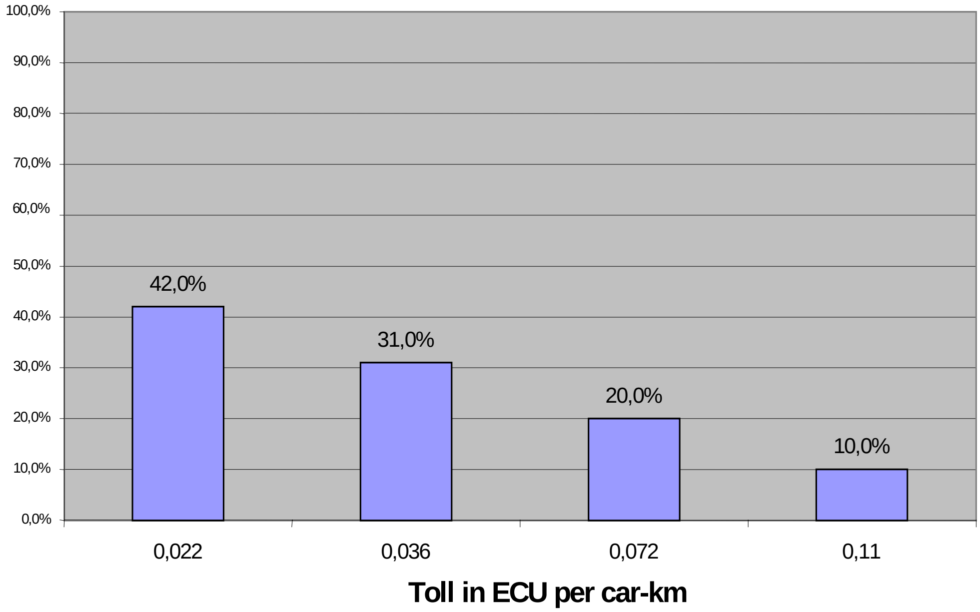
The results of these two Austrian road pricing studies will be followed in this paper, to demonstrate users' reactions.

To obtain a good overview of the degree of acceptance and behaviour, the following four scenarios of different toll levels on Austrian motorways and expressways have been investigated:

- toll amount of 0.30 ATS (0.022 ECU5) per car-km
- toll amount of 0.50 ATS (0.036 ECU) per car-km
- toll amount of 1.00 ATS (0.072 ECU) per car-km
- toll amount of 1.50 ATS (0.11 ECU) per car-km

Figure 3 shows the degree of initial acceptance obtained in each case.

Figure 3. **Initial acceptance of different toll levels per car-km on motor- and expressways in Austria (%)**



As can be seen in this figure, the initial acceptance varies greatly, depending on the level of toll and is, generally speaking, very low (for instance, only 10% for the highest toll investigated).

3. TRANSPORT DEMAND REACTIONS

If users do not accept the toll (see previous chapter), they have to react and change their behaviour. The way in which they would behave according to the different levels of toll is shown in the next four figures.

Figure 4. **Initial acceptance and resulting behaviour of a toll of 0.022 ECU per car-km on Austrian motor- and expressways**

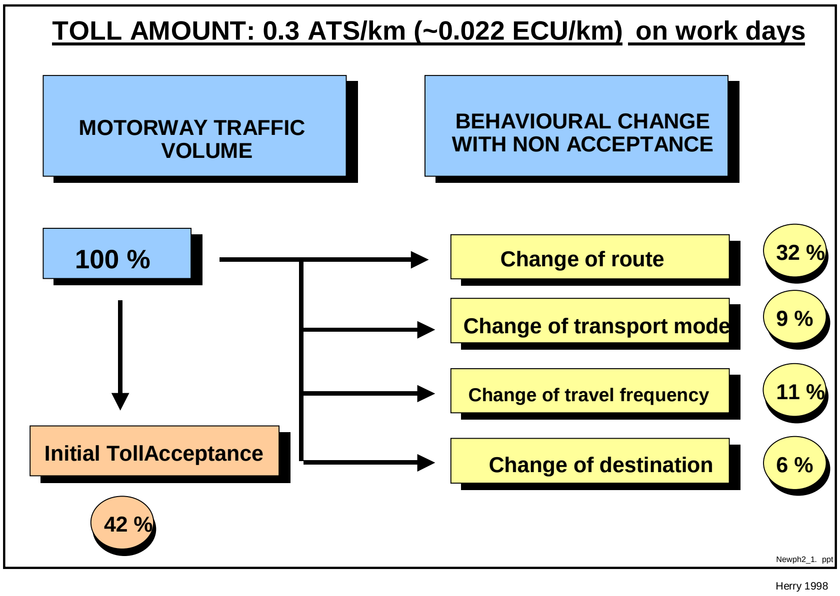


Figure 5. **Initial acceptance and resulting behaviour of a toll of 0.036 ECU per car-km on Austrian motor- and expressways**

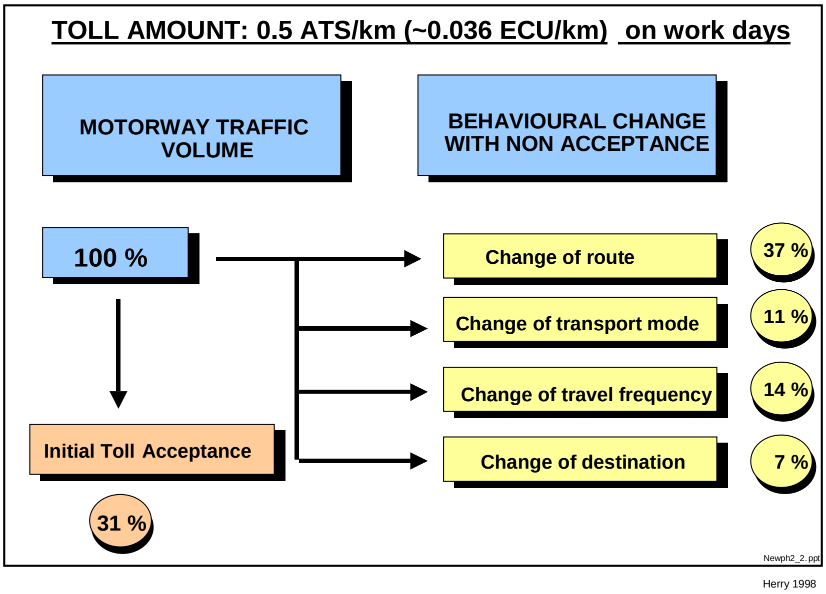
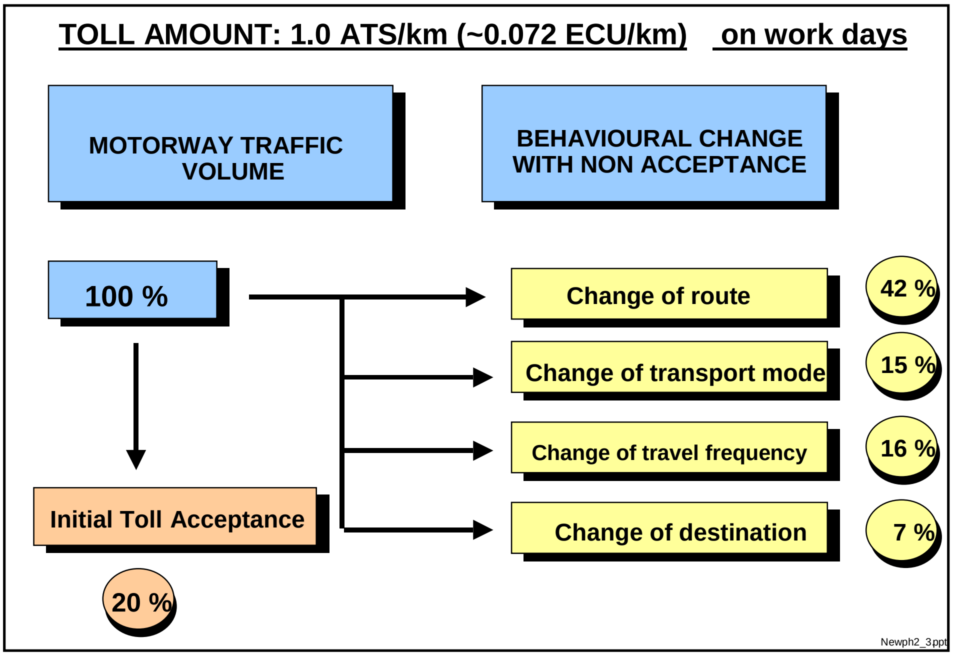
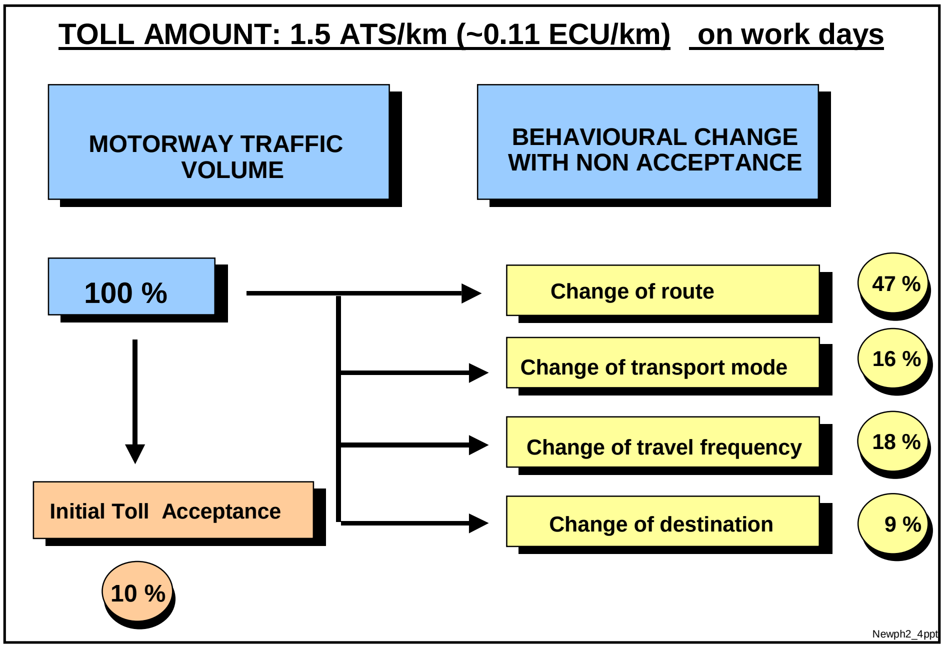


Figure 6. **Initial acceptance and resulting behaviour of a toll of 0.072 ECU per car-km on Austrian motor- and expressways**



Herry 1998

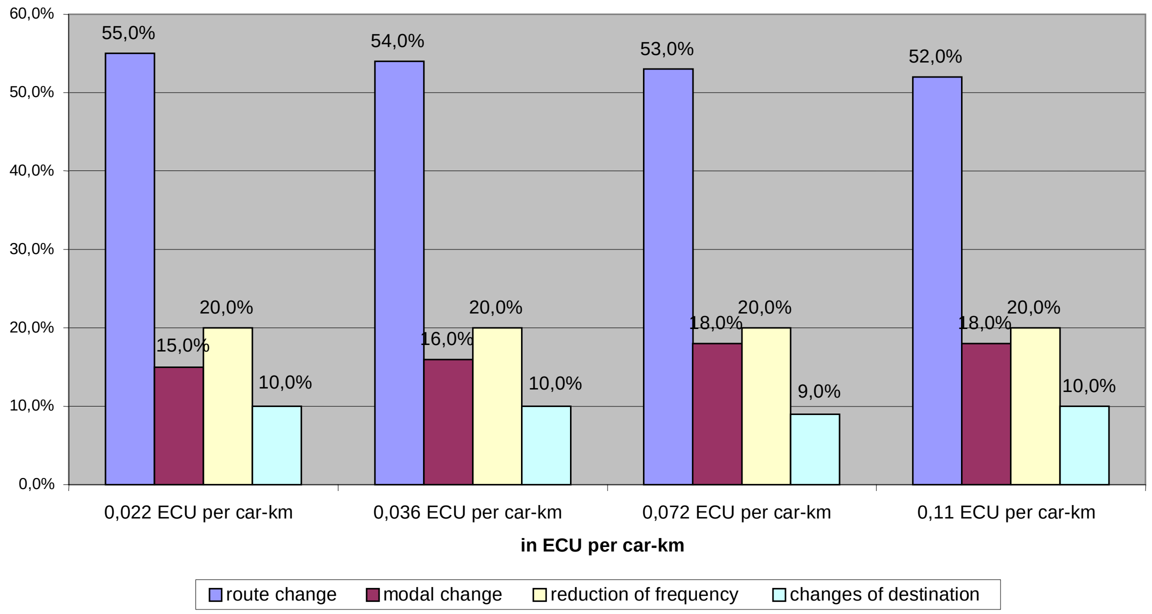
Figure 7. **Initial acceptance and resulting behaviour of a toll of 0.11 ECU per car-km on Austrian motor- and expressways**



Herry 1998

The alternatives adopted by users who do not initially accept the toll vary according to the level of toll in the following proportions:

Figure 8. **User behaviour of initial toll refusers at different levels of toll on Austrian motor- and expressways**



From these results the following remarks can be made:

- The higher the level of toll, the lower the initial acceptance: it varies from 42% initial acceptance at a toll of 0.022 ECU, to only 10% at a toll of 0.11 ECU per car-km!;
- The reactions of "refusers" remain quite constant, except for a slight shift from "route change" and "frequency reduction" to "modal change". In other words, if the toll increases, relatively more people would use another mode, especially the train, instead of changing to alternative routes (mode change rise from 15 to 18 per cent).

As already mentioned in the first chapter, this initial acceptance cannot be directly adopted in long-term studies and practice, because if all drivers simultaneously react as they wish, the conditions will change and some alternatives will considerably worsen or even become impossible. Therefore it is important that the phenomenon of retransference be included in acceptance studies.

4. RETRANSFERENCE

Depending on the number of road users changing their behaviour, some of the switchers will – as expected – return to the tolled highway, because of the worsened conditions on the chosen alternative caused by those who have switched.

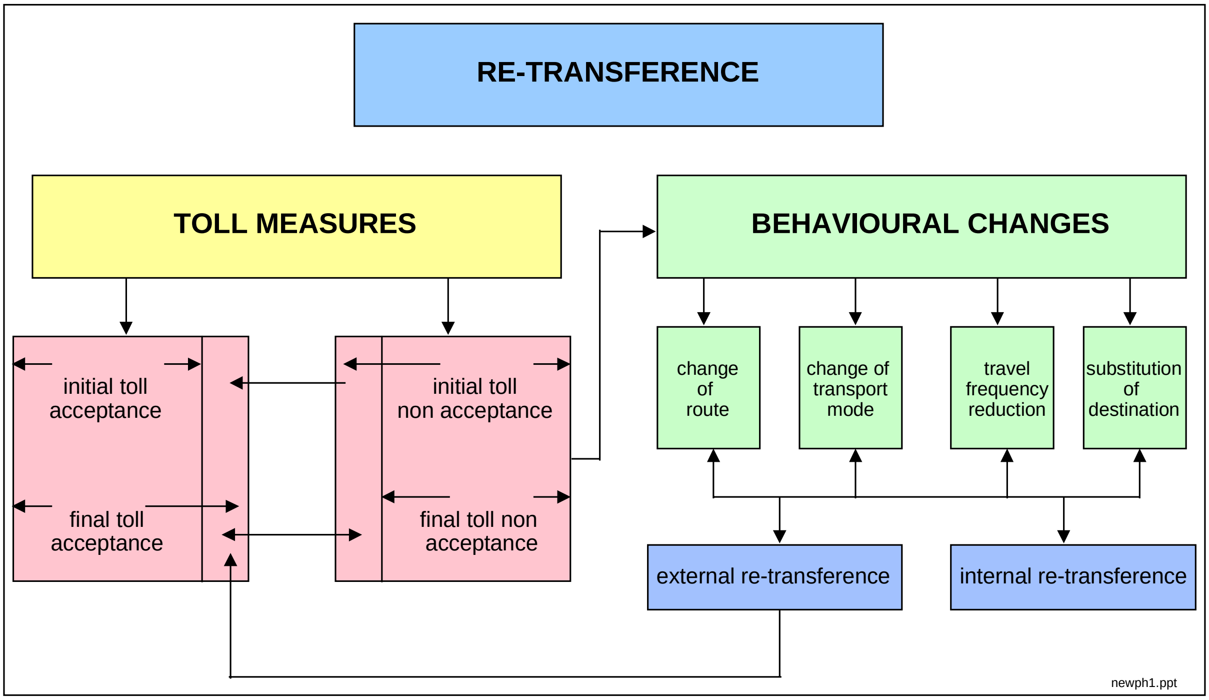
This process is called “retransference” and is very important for long-term studies and practice.

Concerning retransference caused by tolls, this can be:

– **external** retransference or
– **internal** retransference.

The process is explained in the following figure:

Figure 9. **External and internal retransference**



Herry 1998

If the alternative turns out to be worse than the (initial) toll, the refuser can:

- switch back to the tolled route (= external retransference) and become a final toll accepter; or
- switch to an alternative as listed in the figure above (= internal retransference) and remain a toll refuser.

Figure 10 gives an overview of the total percentage of retransference and of retransference to the various alternatives; Figure 11 compares the total percentage of initial refusers with the level of retransference of the initial acceptance:

Figure 10. **Retransference of initial toll refuser at different levels of toll on Austrian motor- and expressways (in per cent)**

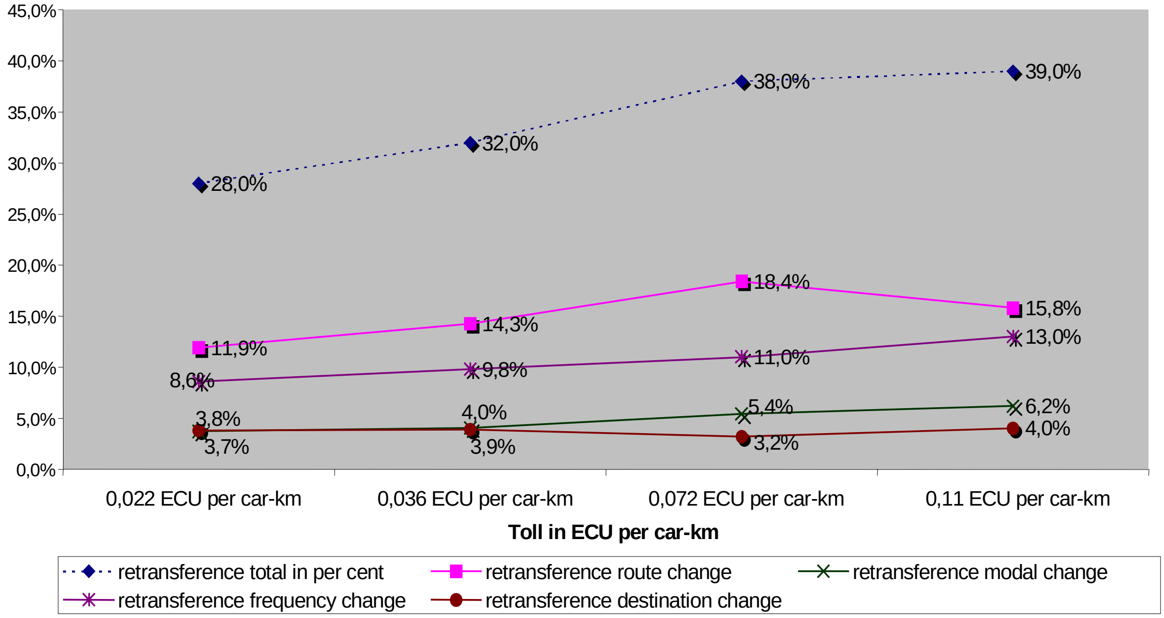
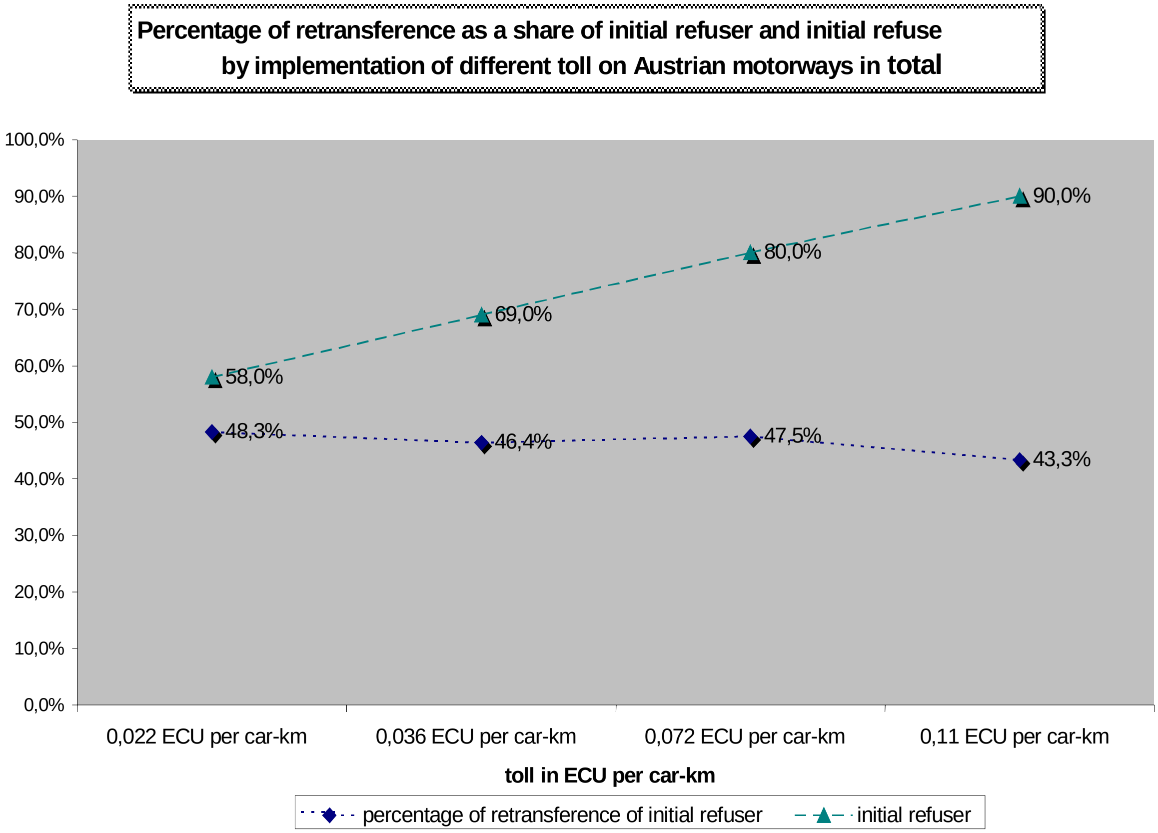


Figure 11. **Percentage of retransference as a share of initial refusers compared with the percentage of inital refusers**



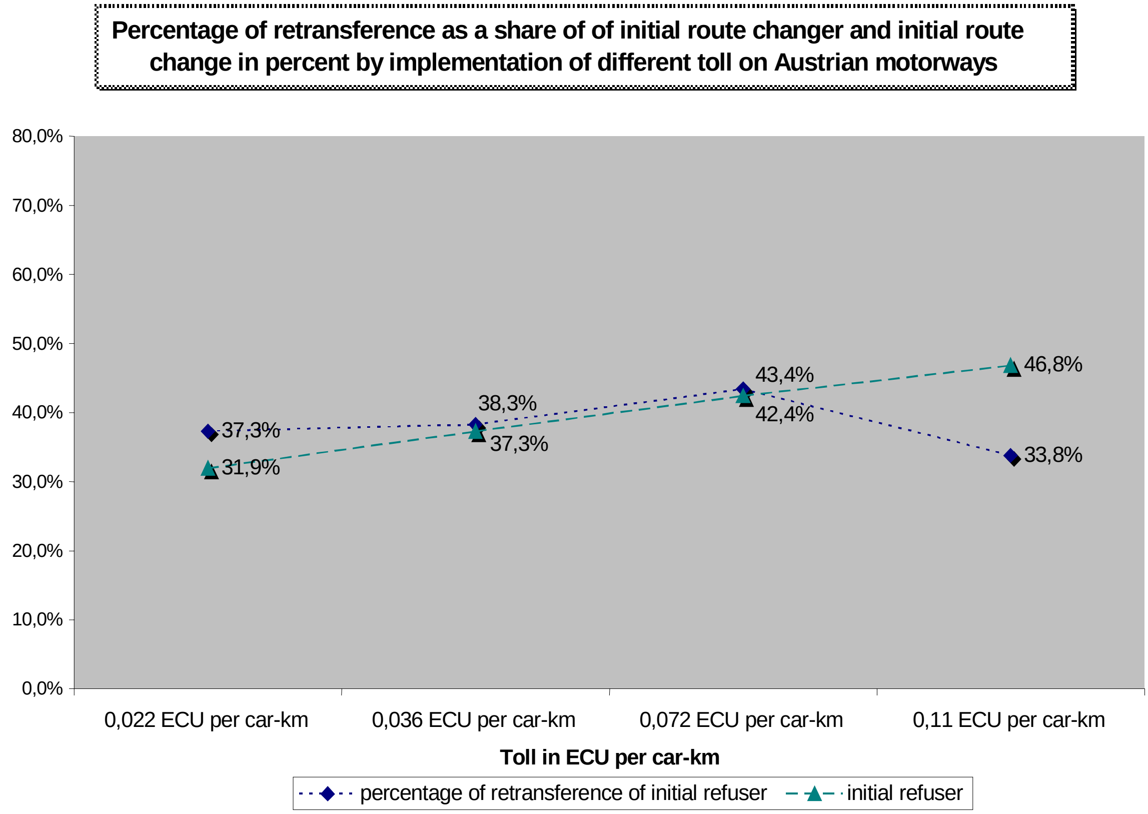
The main conclusions to be drawn from these figures are as follows:

- A retransference takes place essentially in the form of behaviour changes after road transference, modal change, reduction in travel frequency or destination change;
- The higher the toll the lower the percentage of retransference of the initial refuser. This means that in absolute terms, the number of those who switch back will rise, in relative terms it will decrease;
- There are two reasons for this: the "too" high toll on the one hand and the internal retransference on the other hand.
  Furthermore:
  - with a toll of 0.022 ECU per motorway car-km, nearly 30% (= 48.3% of initial refusers) will shift back to the toll roads;
  - with a toll of 0.036 ECU per motorway-km, 32% (= 46.4% of initial refusers) of the users will change back to the toll roads;
  - with a toll of 0.072 ECU per km of motorway, 38% (= 47.5% of initial refusers) will shift back; and, finally,
  - with a toll of 0.11 ECU per motorway-km, the transference will be about 39% (= 43.3% of initial refusers);

– The highest retransference takes place in the case of route change, i.e. after the initial most common change of behaviour;
– Retransference in the case of modal and destination changes remains, relatively speaking, very constant;
– The retransference at the highest level of toll for route change is remarkable, because the percentage of initial refusers will first increase from 11.9% (toll of 0.022 ECU per km) to 18.4% (toll of 0.072 ECU per km) and decrease to 15.8% at a toll of 0.11 ECU per km (see Figure 11). The reasons can be found, on the one hand, in the too high toll and, on the other hand, in the internal retransference, because many users, who become aware of the new conditions and never accept the high toll, switch, for instance, from the (initial) choice of changing mode to alternative routes.

The next figure, which shows the retransference after initial route change, again demonstrates the above-mentioned conclusion:

Figure 12. **Percentage of retransference as a share of initial route changers at different toll levels on Austrian motor- and expressways**



Finally, the retransference can be seen to be due to two opposing processes:

- on the one hand, the reluctance of the road users to accept a given amount of toll will make them “shift away” from the tolled road, for instance, to parallel toll free roads;
- on the other hand, the worsening traffic conditions due to the transference from tolled to toll-free roads will force the drivers to return to the motorways.

Therefore, one can say that the higher the toll:

- the more important is the toll refusal;
- and thus, the endeavours of users to return to motorways become greater, since the traffic conditions are worsening on parallel roads because of the transference.

5. FINAL ACCEPTANCE

After including the process of retransference, the results of the final toll acceptance can be shown in the following figures:

Figure 13. **Final acceptance of different toll levels per car-km on motor- and expressways in Austria (%)**

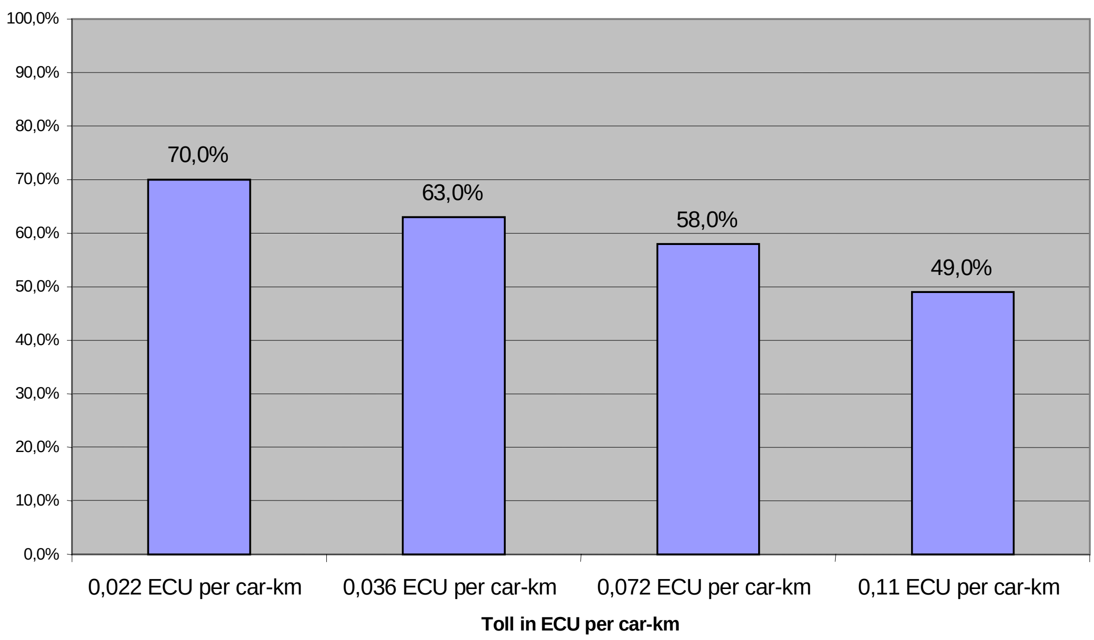
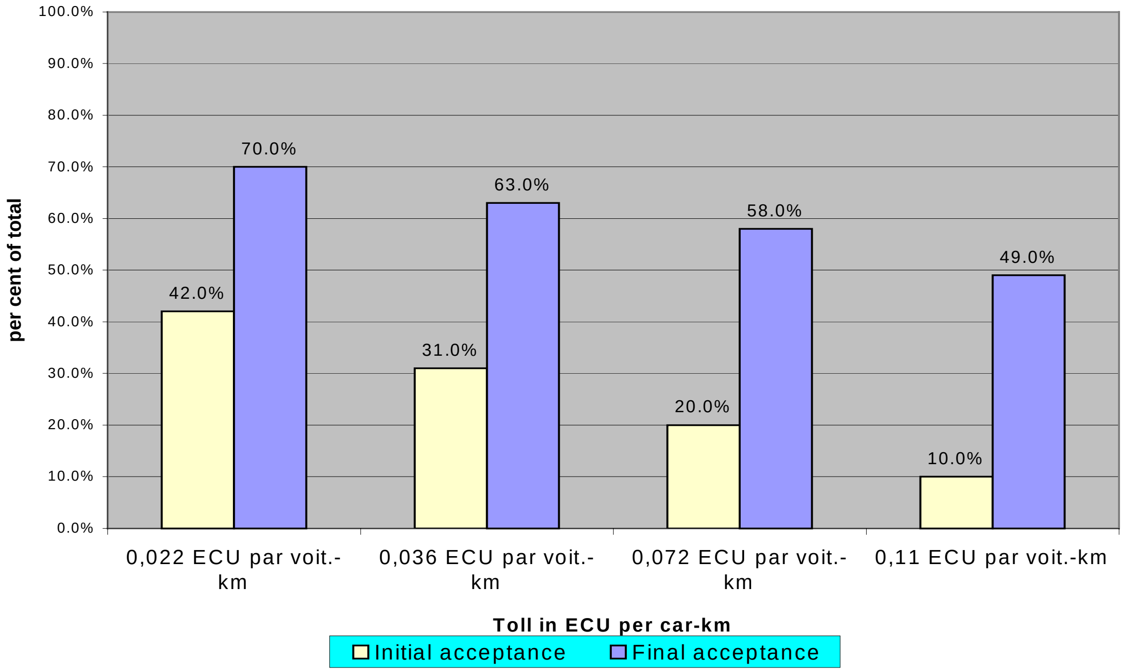


Figure 14. **Initial and final acceptance of different levels of toll per car-km on Austrian motor- and expressways (%)**



In comparison with the initial acceptance, the final acceptance increases greatly. This is due to the worsened conditions in the first alternatives chosen. For the highest toll investigated, acceptance rises from 10% to 49%!

The final detailed behaviour of users is summarised in the next four figures for each toll scenario:

Figure 15. **Final acceptance and resulting behaviour of a toll of 0.022 ECU per car-km on Austrian motor- and expressways**

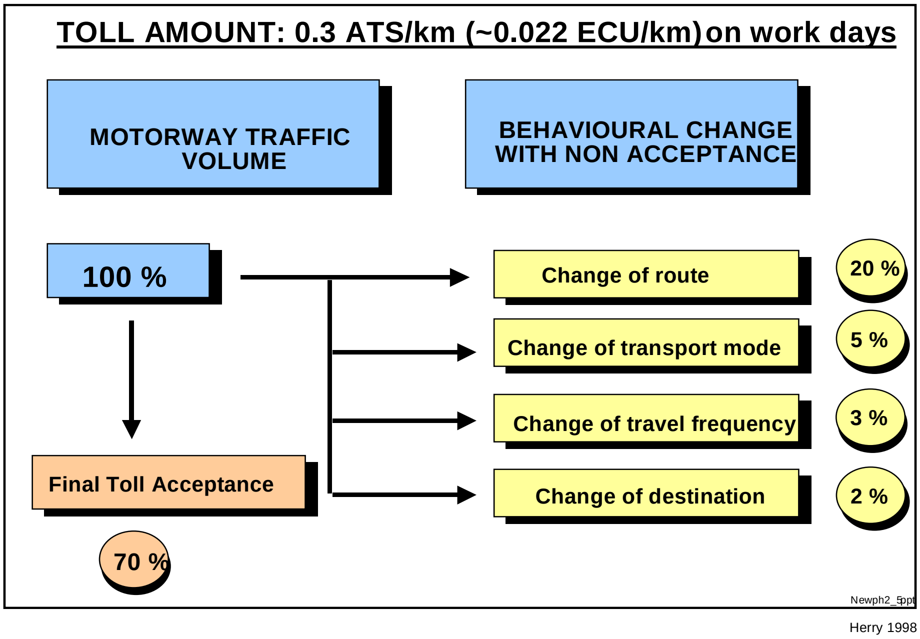


Figure 16. **Final acceptance and resulting behaviour of a toll of 0.036 ECU per car-km on Austrian motor- and expressways**

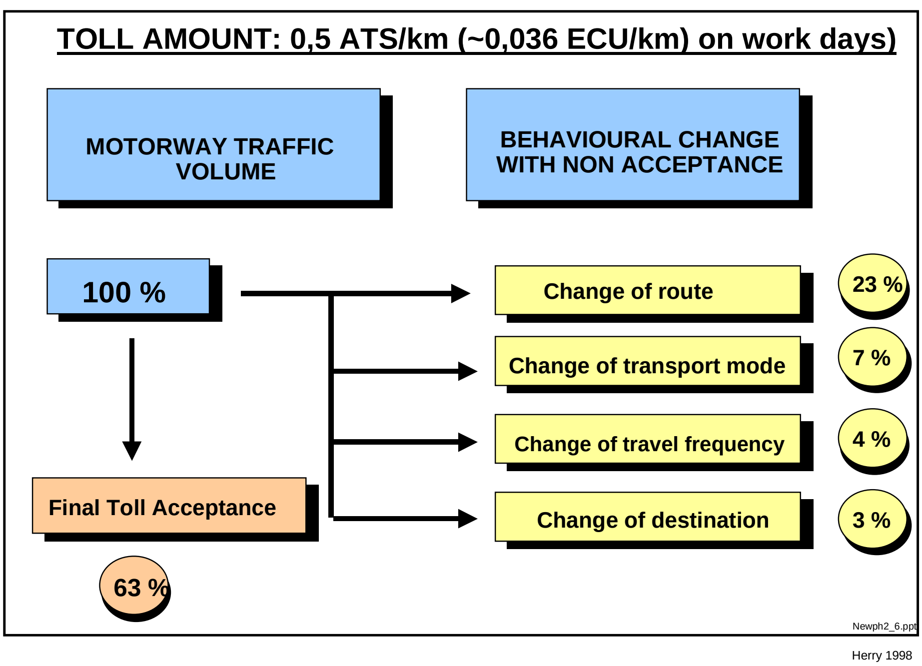


Figure 17. **Final acceptance and resulting behaviour of a toll of 0.072 ECU per car-km on Austrian motor- and expressways**

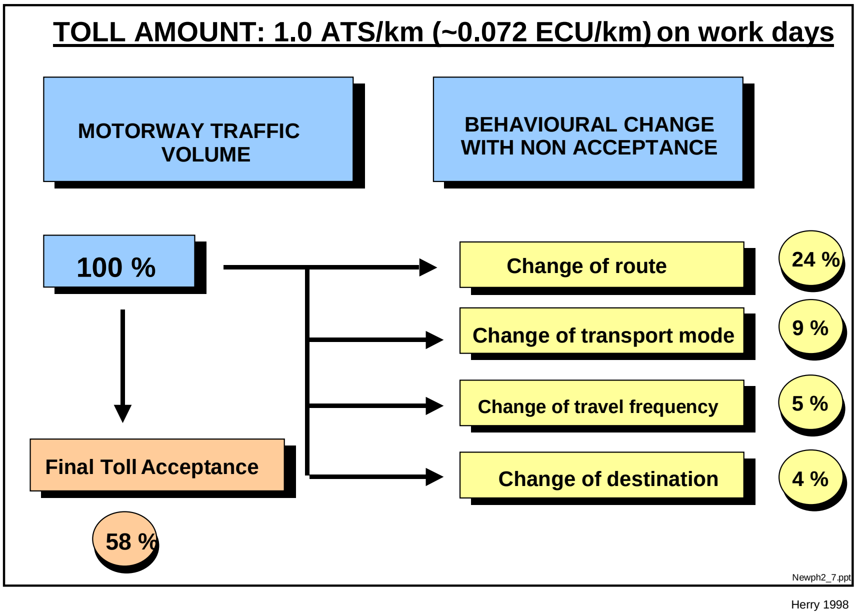
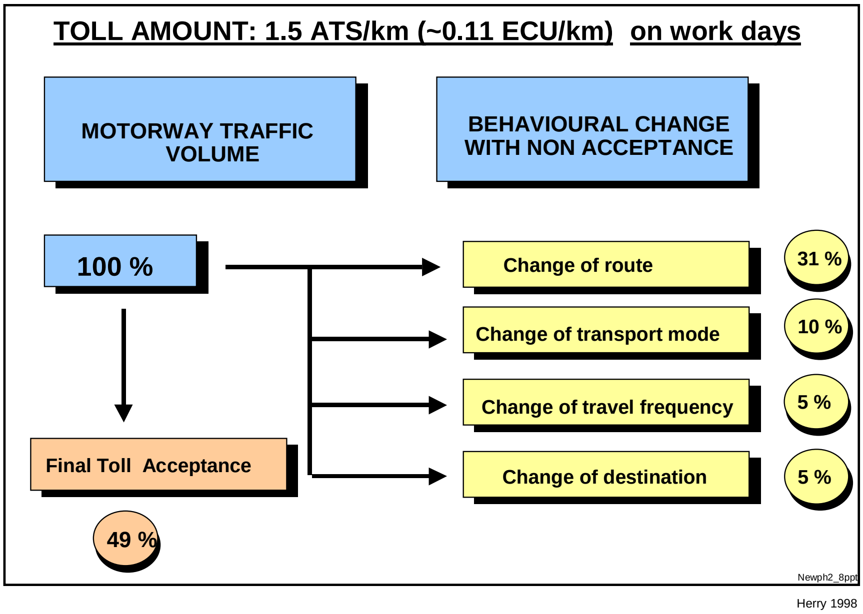


Figure 18. **Final acceptance and resulting behaviour of a toll of 0.11 ECU per car-km on Austrian motor- and expressways**

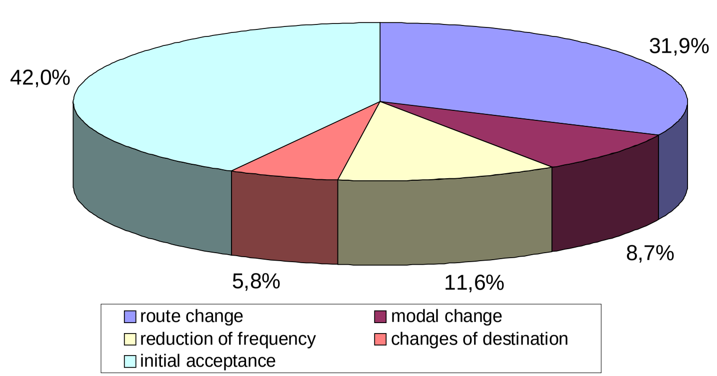


Figures 19 to 22 give a good overview of the differences:

- between the initial and final acceptance in general; and
- in user behaviour, if users do not accept the toll in both the above-mentioned cases.

Figure 19. **Comparison of the initial and final acceptance and resulting user behaviour of a toll of 0.022 ECU per car-km on Austrian motor- and expressways**

Initial acceptance and resulting transport demand reactions of users by implementation of a toll of 0,022 ECU per car-km on Austrian motor- and expressways



Final acceptance and resulting transport demand reactions of users by implementation of a toll of 0,022 ECU per car-km on Austrian motor- and expressways

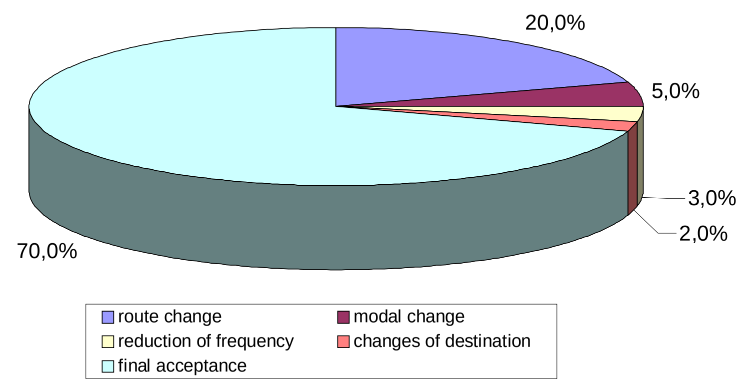
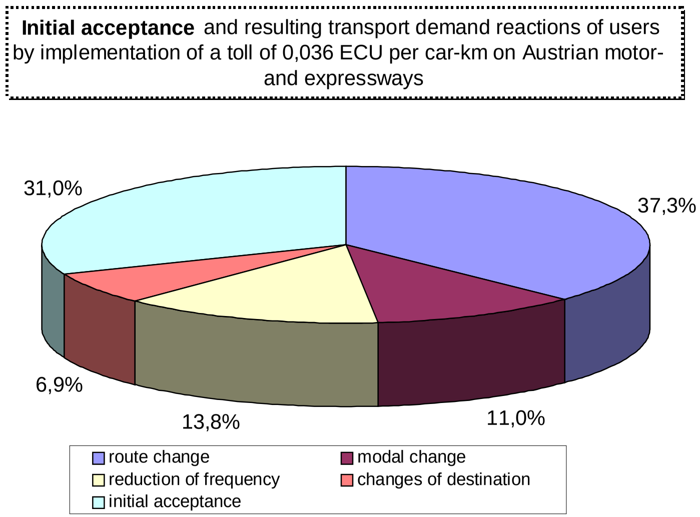


Figure 20. **Comparison of the initial and final acceptance and resulting user behaviour of a toll of 0.036 ECU per car-km on Austrian motor- and expressways**



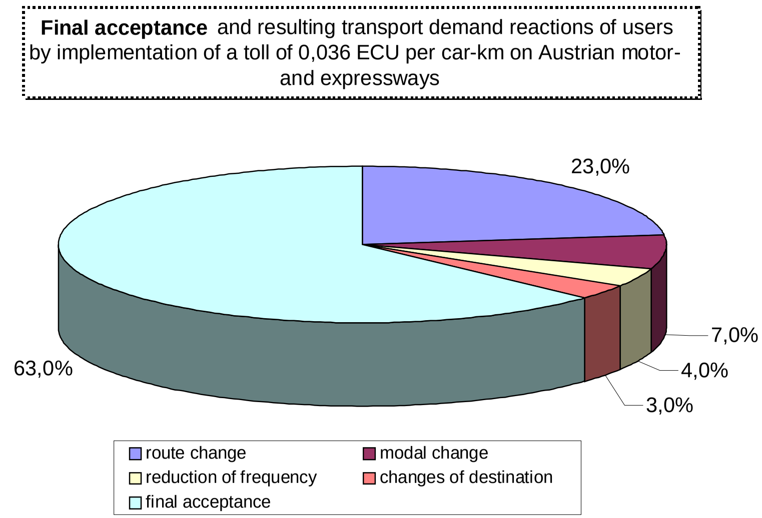
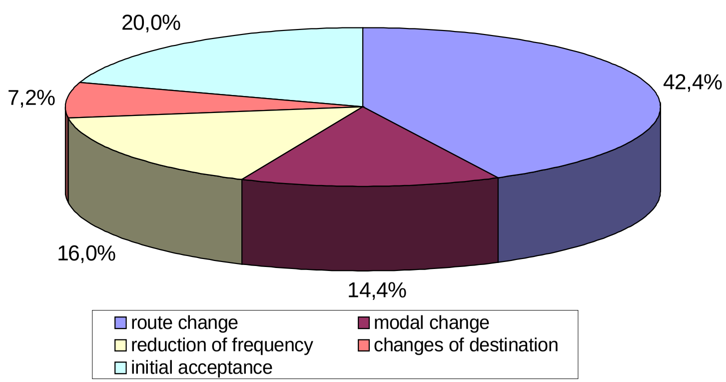


Figure 21. **Comparison of the initial and final acceptance and resulting user behaviour of a toll of 0.072 ECU per car-km on Austrian motor- and expressways**

Initial acceptance and resulting transport demand reactions of users by implementation of a toll of 0,072 ECU per car-km on Austrian motor- and expressways



Final acceptance and resulting transport demand reactions of users by implementation of a toll of 0,072 ECU per car-km on Austrian motor- and expressways

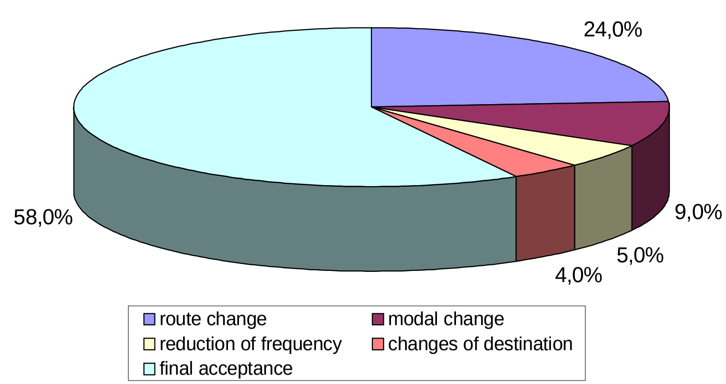
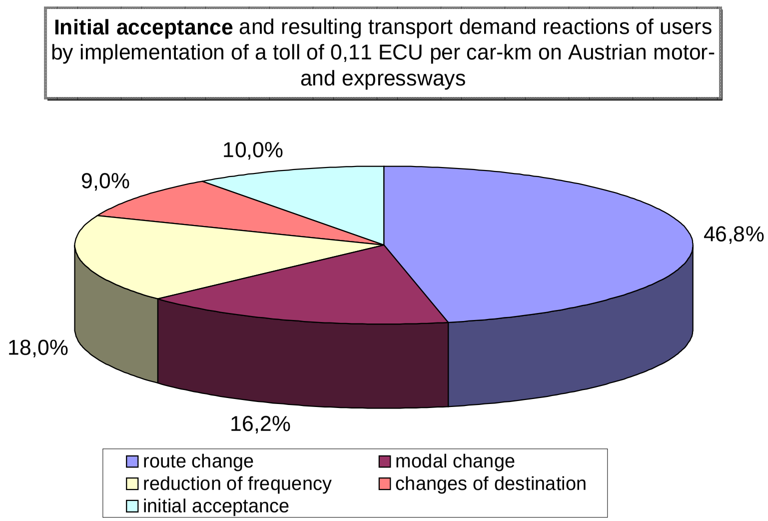
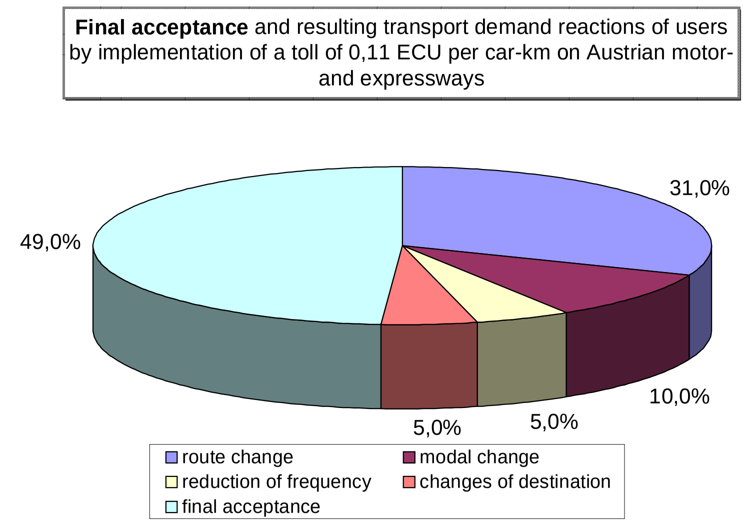


Figure 22. **Comparison of the initial and final acceptance and resulting user behaviour of a toll of 0.11 ECU per car-km on Austrian motor- and expressways**





6. RETRANSFERENCE: CONCLUSION

Estimating and measuring toll acceptance requires the inclusion of the retransference phenomenon because otherwise the results are quite invalid.

The differences between cases with and without retransference are very big. It can differ in the lowest case (toll of 0.022 ECU per car-km) from 42% initial acceptance to 70% final acceptance and in the highest case (toll of 0.11 ECU per car-km) from 10% initial acceptance (without retransference) to a final acceptance rate of nearly 50%. This shows, once more, the importance of paying attention to and including retransference.

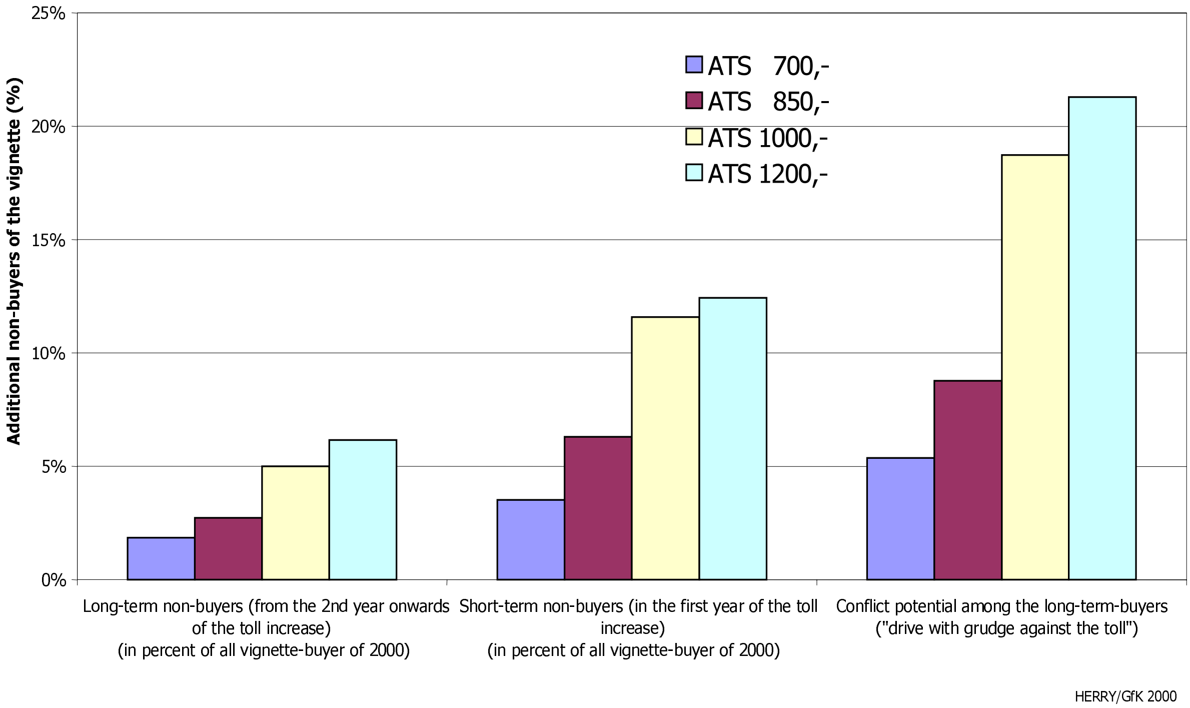
7. CONFLICT POTENTIAL

As can be easily seen, the retransference consideration is strongly connected with the conflict potential. This potential consists of those users who originally did not want to pay the toll, but finally pay because they cannot or do not want to refrain from using the toll road.

This conflict potential can be defined in different ways:

- as those people who are in the final acceptance group (see Chapter 4) but not in the initial acceptance group (see Chapter 1);
- as in the latest Vignette study in Austria[6], which deals with the estimation of acceptance of a more expensive vignette.
  For this reason, both basic and in-depth surveys were conducted. Via the question chain "not buy" – " nevertheless buy" – "not refrain from using the toll road" – "projection" and checking the last trip taken on the road before the toll increase, we found the conflict potential presented the following picture:

Figure 23. **Conflict potential estimated in latest Vignette study in Austria**[6]



8. CONCLUSIONS

The following conclusions can be drawn:

- The phenomenon of retransference is widely underestimated;
- Retransference is not so important concerning the financial results of the tolling but is, however, very important for political strategy;
- Retransference is more or less connected with conflict potential;
- The results of various case studies have shown that retransference and consequently conflict potential can reach impressive proportions: 50% or more of final users!
- When studying the impacts of (new) toll systems, the phenomena of retransference and conflict potential must be taken into account as standard practice;
- Studies of retransference and conflict potential require a well-developed survey tool.

NOTES

1. Herry, M. (1995), Road Pricing - Evaluation of acceptance including information feedback. In: *Proceedings of the 23rd PTRC European Transport Forum*, September.

2. Survey on the Brenner Corridor, as a case study in the EUROTOLL Project, commissioned by the European Communities Directorate-General for Transport DGVII-E, September 1997.

3. Herry, M., S. Snizek, Fessel+GfK (1992), Road Pricing in Austria (Road Pricing I), commissioned by the Ministry of Economic Affairs, Vienna.

4. Herry, M., S. Snizek (1993), Road Pricing in Austria, including information feedback (Road Pricing II), commissioned by the Ministry of Economic Affairs, Vienna.

5. Exchange rate: as at 07.08.1998, 1 ECU=13.8 ATS.

6. Herry/GfK (2000), Vignette Österreich – Prüfung der Elastizität, commissioned by the ÖSAG, Vienna.

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SUMMARY

Madrid, July 2000

1. INTRODUCTION

We need go no further back than ancient Rome to find the nearest precursors to tolls as we know them today. Initially, tolls were transit or passage duties and later operated as customs duties. They included gate tolls for entering cities and tolls for crossing bridges, mountain passes and rivers. Along with these other curious charges were also levied: the *pulveraticus*, a tax on the dust raised by carts and pack animals on roads; the *rotaticus* a tax levied on wheeled vehicles; and the *cespitaticus*, a tax on affected pastureland.

As previously mentioned, in the beginning, tolls were not intended to finance or contribute to the financing of roads, they operated more as a commercial tax applicable to goods transported throughout the territory. The construction and maintenance of public works was normally financed by the local residents and municipalities that benefited from them, or by the treasury, from the second half of the 18th century.

It was in exactly this period that, influenced by the liberal approach to economic theory propounded by Adam Smith, tolls began to take on a more economic dimension and to be used as an instrument for financing the maintenance of some public works. A brief look at Smith's work is instructive as it contains principles that could be regarded as the "foundations of toll theory".

In his work, *The Wealth of Nations*, Adam Smith assigned the responsibility for maintaining and financing roads and communications to the State. As roads are beneficial *"to the whole society… [they]… may, therefore, without any injustice be defrayed by the general contribution of the whole society. This expense, however, is most immediately and directly beneficial to those who travel or carry goods from one place to another and to those who consume such goods. The turnpike tolls in England and the duties called* peages *in other countries, lay it altogether upon those two different sets of people and thereby discharge the general revenue of the society from a very considerable burden."* This recognised, in a way, that roads have some of the characteristics of a divisible good and acknowledged the principle that the beneficiary -- in this case, the user -- is the one who should pay for the use of infrastructure.

In view of the substantial sums that construction and maintenance of roads required, Smith held that: *"The greater part of such public works may easily be managed as to afford a particular revenue sufficient for defraying their own expense, without bringing any burden upon the general revenue of the society"* and considered that: *"A highway, a bridge, a navigable canal … may in most cases be both made and maintained by a small toll upon the carriages which make use of them: a harbour by a moderate port-duty upon the tonnage of the shipping which load or unload in it."*

A few salient passages from Part III, "Of the Expense of Public Works and Public Institutions" of Book Five, *Of The Revenue Of The Sovereign Or Commonwealth*, which is of interest and continued relevance, are quoted below.

"When the carriages which pass over a highway or a bridge and the lighters which sail upon a navigable canal, pay toll in proportion to their weight or their tonnage, they pay for the maintenance of those public works exactly in proportion to the wear and tear which they occasion of them. It seems scarce possible to invent a more equitable way of maintaining such works. This tax or toll too, though it is advanced by the carrier, is finally paid by the consumer, to whom it must always be charged in the price of the goods."

"When the toll upon carriages of luxury upon coaches, post-chaises, etc., is made somewhat higher in proportion to their weight than upon carriages of necessary use, such as carts, wagons, etc., the indolence and vanity of the rich is made to contribute in a very easy manner to the relief of the poor, by rendering cheaper the transportation of heavy goods to all the different parts of the country."

"When high roads, bridges, canals, etc., are in this manner made and supported by the commerce which is carried on by means of them, they can be made only where that commerce requires them and consequently where it is proper to make them. Their expenses too, their grandeur and magnificence, must be suited to what that commerce can afford to pay. They must be made consequently as it is proper to make them. A magnificent high road cannot be made through a desert country where there is little or no commerce, or merely because it happens to lead to the country villa of the intendant of the province, or to that of some great lord to whom the intendant finds it convenient to make his court. A great bridge cannot be thrown over a river at a place where nobody passes, or merely to embellish the view from the windows of a neighbouring palace: things which sometimes happen in countries where works of this kind are carried on by any other revenue than that which they themselves are capable of affording."

It is interesting to note Smith's preoccupation with the widespread practice of diverting toll revenues for the private interests of the proprietors, rather than allocating them to the maintenance of public works. On this subject, he wrote, *"The tolls for the maintenance of a high road cannot with any safety be made the property of private persons… The proprietors of the tolls upon a high road…might neglect altogether the repair of the road and yet continue to levy very nearly the same tolls. It is proper, therefore, that the tolls for the maintenance of such a work should be put under the management of commissioners or trustees."*

Smith also recommended that local entities contribute to the financing of roads: *"Even those public works which are of such a nature that they cannot afford any revenue for maintaining themselves, but of which the conveniency is nearly confined to some particular place or district, are always better maintained by a local or provincial revenue, under the management of a local or provincial administration, than by the general revenue of the state, of which the executive power must always have the management."*

It is interesting to highlight some of the concrete points addressed by Adam Smith, which are still relevant today and which, as mentioned before, can be considered as the "foundations" of toll theory. These are:

- The character of a divisible good that he assigns to roads, which justifies the financing of that portion of costs considered as indivisible by a means other than fiscal (prices);
- The acceptance of the "user fees" principle, by virtue of which the most direct beneficiary, the user, should pay for infrastructure use;

- The principle that tolls should cover road construction and/or maintenance costs and be calculated in proportion to the wear and tear caused by each vehicle;
- The use of tolls as an instrument of social (redistribution of rents) and economic policy by allowing higher tolls on “luxury carriages” than on utilitarian vehicles (goods vehicles) because the latter underpin national trade;
- Financing by means of tolls ensures that new infrastructure built responds to the needs of demand, avoiding wasteful spending;
- The recommendation that local administrations contribute to the financing of roads.

2. HISTORICAL DEVELOPMENT AND FUNCTIONS OF TOLLS

Toll systems, in different forms, have operated in most countries throughout history, although it is true that their use has been shaped by the characteristics and regulations of each country and by the need to raise funds to finance the construction and maintenance of roads.

Regardless of the fact that the earliest tolls were simply transit duties, as previously mentioned, the objective of tolls, in theory at least, in later times and in practice in modern times, was to cover the costs of maintaining roads and public works, although in a few cases in the latter period -- in Spain for example -- they were used to finance construction.

The toll system, as propounded by Adam Smith, operated in virtually every country up until the second half of the 19^{th} century, which saw a change in the structure and operation of most public administrations with the adoption of national budgets and the principle of a single fund. However, this did not mean the total disappearance of the paradigm that had already led to a different concept: that of using tolls as a financial instrument – in much the same way as prices – with which to partially or totally meet the costs of building, maintaining and operating public works whose high investment costs the public authorities were unable to finance directly in their totality. It was the development of indirect management systems - specifically concession systems - for building transport infrastructure which again brought to the fore the advantages of this new concept of tolls for the execution of large-scale projects which otherwise might well never have seen completion.

This was the case with the road system in Spain, where the concession system expanded widely over the last 30 years and where tolls were used for the specific purpose of recouping the investment and maintenance costs incurred by concessionaires, in much the same way as a pricing mechanism. However, with steadily increasing maintenance budgets and the other financial problems now facing public administrations, thought is once again being given to tolls as they were first conceived of, i.e. as instruments for financing road maintenance.

Lastly, in this discussion of the development of tolls, traffic congestion problems in major cities and their environs have led road authorities to assign a new function to tolls: that of a demand management instrument and deterrent for the regulation and control of traffic. Advances in technology in the field of electronic tolls, which identify vehicles and enable direct charging of users without stopping at tolls, will facilitate the installation of such systems on conventional roads and for urban transport.

To summarise these historical developments which show the different concepts of tolls and the different functions they have served, most of which are still valid today, we can say that, initially tolls were transit duties levied on goods and passenger traffic in the same way as taxes. Later, they were used as taxes for the purposes of financing maintenance expenditure on roads and could be regarded as the predecessors of today's "soft tolls". With the development of concession techniques, their new function -- much as a price or charge for infrastructure use -- was the total or partial financing of construction, operating and maintenance costs. Lastly and most recently, with advances in technology they are now beginning to be used more as a new deterrent tax to be imposed in congested areas for the purposes of managing congestion and distributing traffic more rationally or as an instrument for internalising the negative external effects of transport.

3. ECONOMIC OBJECTIVES OF TOLLS

Looking at the historical development of tolls, we have seen that now that the traditional budget model is in crisis and that good infrastructure is needed more than ever before -- particularly in Europe, for the successful operation of the Internal Market and improved competitiveness -- many countries that have been reluctant to accept the concession system are turning to forms of private finance, most of which are based on the toll system. Statistics published annually in *Public Works Financing* show the strong increase worldwide in private sector financing of public investment.

Governments justify this in a variety of ways, but there are two real considerations behind road pricing: inadequate budget allocations for public investment and the pursuit of efficiency and market criteria in the operation and maintenance of infrastructure.

However, the explanations that the public authorities try to give their electorate and which they frequently have to defend to the public - whose opposition to the introduction of tolls is clear - are based on a series of economic objectives that can be achieved by introducing tolls, among which the principal are:

- to achieve the economic optimum;
- to finance infrastructure independently of the public budget;
- to contribute to intergenerational and interregional equity;
- to improve infrastructure management systems by introducing effectiveness and efficiency criteria.

3.1. Tolls as transit duties

From the above analysis it can be seen that the first objective of the toll system to consider derives from the possibility of using tolls as transit duties, just as they were originally conceived. Although this is not a major objective, it warrants some comment, given that there are cases in which tolls are levied for this purpose.

From this standpoint, a toll is considered simply as a charge for access to a network, not to raise resources for financing infrastructure or to charge an efficient market price. The main aim behind a transit duty is either that a country wants to guard against the undesirable effects generated by vehicular traffic from other countries or to establish another mechanism for collecting revenues for the public treasury, although these are not allocated directly to infrastructure finance.

The first of these considerations is evident in countries such as Switzerland and Austria which, years ago, introduced a *vignette* or transit duty on their motorways. The main aim was to avoid heavy vehicle traffic from other countries, which was destroying their networks and inflicting serious damage on the environment. In this way they sought to divert heavy goods traffic to other less environmentally harmful modes of transport, such as rail. It will be noted that this measure is highly protectionist in intent, since it aims to protect national roads from the damage produced by the transit of foreign vehicles.

The second aim – the need to increase the Treasury's revenues – is becoming less common, however, since generally it is much easier for public administrations to collect revenues by increasing the rate of specific taxes on fuels. This said, until recently it was not infrequent and, in some parts of the world, particularly in Latin America, there are still tolls directly managed by the State, for the main purpose of collecting revenue for the treasury rather than for allocating revenues to road maintenance, as initially intended.

Finally, it should be said that tolls are not widely used solely as transit duties these days. On the one hand, the integration process in which many groups of countries are involved (EU, Mercosur, etc.) is leading to the disappearance of protectionist ideas and, on the other, it does not make much sense to use transit duties as taxes when it is cheaper and easier to raise revenues by increasing taxes on fuels.

3.2. Tolls as an instrument of economic efficiency or as a financing instrument

Having analysed the use of tolls as transit duties, we will now turn to the two objectives which, perhaps, have played a more significant role in justifying infrastructure usage charges: tolls as an instrument of economic efficiency and tolls as an instrument of budgetary independence for the State. These two objectives will be addressed jointly as they are closely related. In fact, many studies in the field of transport economics have analysed ways of reconciling the two.

Within this framework, the theoretical basis for infrastructure usage charges is outlined. The importance of tolls as a means of securing finance for infrastructure from sources other than the public budget is analysed and, lastly, reference is made to some studies that highlight the interrelationships between both objectives.

3.2.1. Tolls as an instrument of economic efficiency

Some authors are opposed to road tolls or, what amounts to the same thing, infrastructure usage charges, because they hold that they are not an instrument of economic efficiency and therefore do not contribute to the optimum allocation of resources, in Paretan terms. Although in one way they may be partly right, no assessment of the situation can be quite so categorical.

Certainly, under conditions of perfect competition, optimum production of a good or service is attained when the price charged is equal to the marginal price and, even when the required conditions do not obtain, optimum allocation of resources – in accordance with Pareto's welfare theory – is likewise achieved when the price charged is equal to the marginal cost. Consequently, equilibrium is reached when the infrastructure user (demand) is willing to pay a usage price that is equal to the marginal cost (supply) of one additional vehicle using the infrastructure.

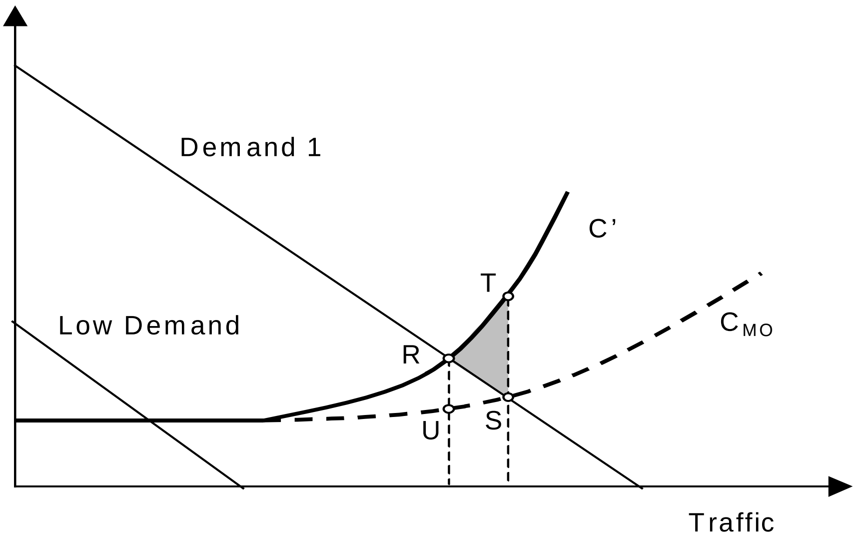
Now, it should be pointed out that the specific characteristics of transport infrastructure and in this instance roads, make it difficult to apply the rules outlined above. Firstly, they operate in the area of increasing returns in which marginal costs are lower than average costs. Secondly, they cannot be considered as pure public goods since they do not meet the assumptions of non-rivalrous consumption and non-excludability that are characteristics of public goods. Likewise, because of their characteristics, market rules do not apply, because roads generate externalities that entail high social costs.

As all these market failures are characteristic of most public infrastructure, it is not possible for the market to be self-regulating and "naturally" establish a price for provision and use that is equal to the marginal cost, thus achieving the economic optimum. For this reason many authors have proposed that the State, or state regulatory agency should be responsible for setting a price for infrastructure such that users perceive the marginal costs they generate.

The graph in Figure 1 illustrates the method for determining the price to charge the user. S, the point at which the demand curve intersects the average operating cost curve, is the point of equilibrium if no price is charged. However, as the marginal cost curve (C') lies above the average operating cost curve, the point of equilibrium that gives the maximum total surplus is at R, therefore if no price is set for infrastructure use the social loss will be equal to the area RTS. In order to avoid this loss, the solution is to set a price RU, such that the user-perceived cost will be equal to the marginal cost. Given that infrastructure generates externalities, the marginal cost in question should also include the costs generated for external agents, as explained in greater detail below.

Marginal-cost pricing has become a topical issue since the publication in 1998 of the European Union's White Paper, *Fair payment for infrastructure use: a phased approach to a common transport infrastructure charging framework in the European Union*. The White Paper proposes the phased introduction of charges based on marginal costs for all modes of transport so as to ensure the most rational allocation possible between modes, thus improving competitiveness and economic efficiency.

Figure 1. **Economically efficient pricing of infrastructure use**



Key (Figures 1-4):

Low Demand:	Demand curve without congestion problems
Demand 1:	Demand curve with congestion problems
Demand 2:	Demand curve
C_{MO}:	Average cost assumed by the users without including tools (time, fuel, etc.)
C_M:	Average total cost (cost assumed by the users (C_{MO}) + infrastructure construction costs + infrastructure maintenance costs + infrastructure operation costs)
C':	Marginal cost including congestion costs (without including social costs)
C's:	Social marginal cost (including social and congestion cost)

While there is no disputing the theory of marginal-cost pricing, in practice it poses serious problems. In this regard, the criticisms put forward by Prud'homme (1999) warrant mention and can be summed up as follows:

- For marginal-cost pricing of a system to be optimal, all systems connecting with it must also be subject to marginal-cost pricing;
- The variability of marginal costs and difficulties in accurately determining and calculating them, make it extremely difficult to put theory into practice;
- Marginal-cost pricing, in most cases, does not guarantee that sufficient resources will be generated to finance infrastructure.

3.2.2. Tolls as a financing instrument

In the previous section, we mentioned one of the most important objectives that infrastructure charges are intended to achieve, i.e. to pass on to users a price that covers the difference between perceived cost and marginal cost, in order to maximise overall social welfare.

However, road pricing can – and in practice does – serve another purpose, which is one of the major justifications for the decision to charge tolls on a particular infrastructure. This purpose is to avoid having to abandon all operations that would be of socioeconomic benefit simply because the public administrations do not have adequate resources.

One of the functions of the State is the provision of services which either cannot be provided efficiently by the public sector or which, although they may be efficiently managed by the latter, result in inequities between the citizens of a country. This said, limitations on the budgetary resources of public administrations and increases in budget areas considered as priorities by governments - health, education, pensions, social charges, etc. - have unfortunately meant that funding for infrastructure maintenance and construction has been subject to major budget cuts in many countries and public funds have not been sufficient to meet real needs.

However, as well as the high socioeconomic return on infrastructure construction and maintenance, many studies have highlighted their positive effects as part of a countercyclical policy aimed at mitigating the effects of economic slowdowns during recessions. In this light, it would be absurd to stop new transport infrastructure or transport infrastructure improvements going ahead because public administrations lack sufficient funds.

The opportunity costs of the unavailability of public funds are the economic social costs that are incurred by society when insufficient budget resources are available to undertake operations that are demonstrably efficient. Consequently, the Administration should assess the resources available, the opportunity cost of the lack of public funds and possible measures to avoid such costs.

In order to avoid this adverse effect – which has, of course, been particularly marked in developing countries – some international bodies have recommended the reintroduction of what are known as “road funds” in order to ensure that some of the public revenues from the transport sector - specific taxes on fuel, driving fines, etc. – are used to fund roads without the need for budget discussions. However, despite their apparent simplicity, such funds have given rise to a range of problems. Firstly, the states concerned have been reluctant to forgo a major portion of public revenue that they were previously free to use as they saw fit. Secondly, the legally established fund revenues do not guarantee that the size of the fund will be the most adequate in efficiency terms.

This being the case, road tolls are considered as a highly suitable mechanism for effecting infrastructure construction and maintenance when public administrations have insufficient funds available and the work is essential to avoid stifling the healthy development of the country. Tolls offer a means of collecting payment for infrastructure use and of ensuring that construction and maintenance can be carried out by a private firm which is guaranteed the revenue from users for the duration of the concession.

Road tolls are therefore a means of avoiding the opportunity costs generated by a shortage of public funds, since the tolls that will be paid by future users enable the construction of infrastructure that could not have been built by budget financing alone. Society thus benefits from early provision of the infrastructure, which will bring major advantages for the community.

One result of being able to construct or maintain a given infrastructure by means of user tolls is that the tax revenues of the State will increase as economic activity increases due to a reduction in transport costs and greater competitiveness, a rise in demand prompted by shorter journey times, greater mobility and the substantial increase in fuel consumption that this implies, etc. Other increases in its revenues to be factored in are value-added tax on tolls, which are considered as services and therefore subject to VAT, in the same way as any other service and taxes paid on profits by franchise-holders.

In this connection, with regard to the budget contributions by the public administration necessary to ensure that a non-profitable project becomes sufficiently profitable to attract funding from the private sector, Izquierdo (1997) defined the concept of financial return for the State. This concept assesses state contributions to project finance, not just as a charge that the State has to meet in order to ensure that the project will be profitable but rather as an investment which will generate resources for the State through the difference in tax revenues collected if the infrastructure is built, as compared to the "do nothing" scenario.

It is important to bear in mind that the reduction in social opportunity costs achieved through road tolls benefits not only motorway users and society as a whole, but the public administration as well, since the taxes collected will boost its budget revenues.

In this connection, the findings of the studies carried out by the Transport Department of the ETSI de Caminos, Canales y Puertos de la Universidad Politécnica de Madrid, are interesting. They provided the basis for an economic-financial model for road projects operated as concessions, which determines on a case-by-case basis the contribution that the public sector would have to provide for non-profitable projects to be sufficiently profitable for private enterprise and financial institutions to participate in funding the project. The model can also establish directly the financial return on the resources provided by the State. State contributions of the order of 30 per cent of the total investment can bring in revenues of 50 per cent and sometimes more, of the total contributions.

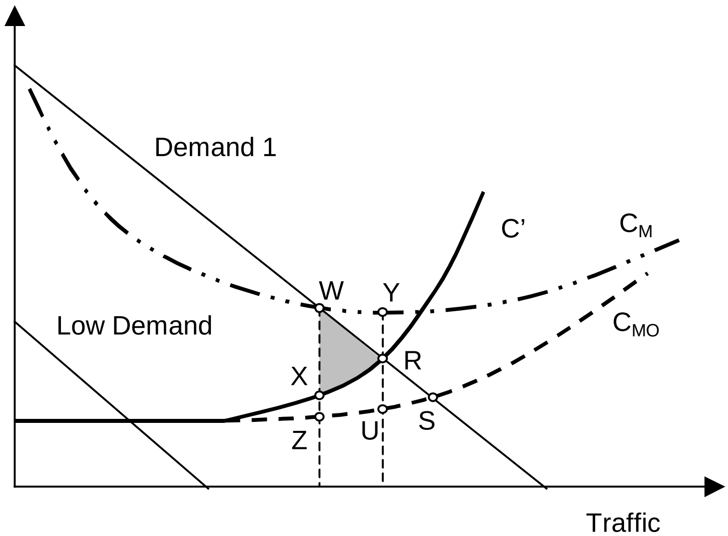
3.2.3. Infrastructure finance and economic efficiency

Having first described the two basic objectives that road pricing is intended to achieve: to establish a price that will achieve the economic optimum and, insofar as possible, to avoid the opportunity costs incurred through the lack of public funds, it remains for us to analyse whether the two objectives are compatible.

Figure 2 compares the two situations for cases in which equilibrium is reached at a point where average costs are higher than marginal costs, as is common for infrastructure which, as we have said, falls into the domain of increasing returns. The demand curve considered shows the relationship between traffic on a given road and the total cost – time, fuel, tolls, etc. – incurred by the user travelling on it.

If the objective is to finance infrastructure, the price of tolls should cover the total cost of construction and maintenance, in which case the equilibrium point will be at the point where the average cost curve (construction, maintenance and operation) intersects the demand curve, point W. At this point, the user should pay a toll equal to WZ, which will cover the average cost of construction and maintenance.

Figure 2. **Comparison of road tolls as a means of achieving economic optimum and as a means of financing infrastructure**



However, as the average cost at point W is higher than the marginal social cost (C'), the equilibrium point of tolls charged for the purposes of infrastructure financing does not give the economic optimum result and generates a social loss equal to the area WXR.

Conversely, where the economic optimum is the objective sought, the charged toll will have to be equal to the marginal cost, RV, such that the equilibrium point is at R, where the demand curve intersects the marginal social cost curve. While this would maximise the sum of consumer and producer surpluses (economic optimum), the disadvantage is that at RV, the toll would not be sufficient cover to ensure the average cost of infrastructure, YV and thus to finance infrastructure.

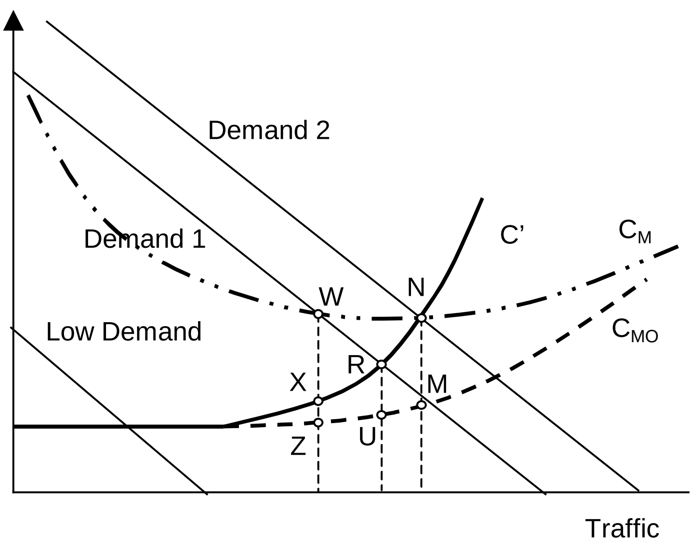
The situation illustrated above is commonly the case for roads that are not very heavily trafficked and, on which congestion problems and externalities are therefore not significant, as the average cost is higher than the marginal social cost at the point of equilibrium. Consequently, it seems quite reasonable to conclude that a large proportion of intercity roads exhibit characteristics similar to those shown in Figure 2.

Faced with this dilemma, many authors have attempted to reconcile the two cases above and have arrived at compromise solutions insofar as these are possible. The now classic contributions of Hotelling (1938) and Allais (1947) warrant mention here. While the former suggested that the financial shortfall resulting from this effect should be financed directly by the public administration and, consequently, by tax payers, the latter proposed that prices be set in direct proportion to marginal cost, which has frequently been the pricing strategy implemented by electricity companies.

In fact, both of these solutions diverge from the economic optimum established by marginal cost theory, for which reason Ramsey (1927) and Boiteux (1956), developed a new theory based on the assumption that when different goods having different demand elasticities are produced, the difference between the price that will secure infrastructure finance and the marginal cost is proportional to inverse demand elasticity. Thus the price that will maximise welfare can be calculated, provided that the firm is capable of self-financing. However, this solution, known as the *second best* theory, can lead to situations that run counter to the general principles of equity. On this issue Vassallo (1999) pointed out that implementing Ramsey-Boiteux pricing to finance the maintenance of an interurban road not subject to congestion and consequently with marginal costs much lower than average costs, can result in heavy goods vehicles, with highly elastic demand, paying more than light vehicles with much more inelastic demand, which clearly runs counter to overall equity.

In order to attain both of the above-mentioned objectives, the demand curve, average cost curve and marginal social cost curve would all have to intersect at the same point. This condition is met in Figure 3, which is exactly the same as Figure 2 except that demand is higher and better matched to infrastructure capacity. In this example, it can be seen that price NM, which guarantees maximum social welfare also finances construction and maintenance with no difficulty, thus achieving both of the objectives mentioned.

Figure 3. **Comparison of road tolls as a means of achieving the economic optimum and as a means of financing infrastructure**



In this latter case, the infrastructure is perfectly designed for the demand it caters for, while in the first example – in line with economic theory – infrastructure capacity is slightly over-sized for the demand it carries.

Just as in the two previous cases, the point of equilibrium may also be at a point where the average cost is lower than the marginal social cost. In this case, the optimum charge from the economic standpoint will be higher than that needed to secure adequate infrastructure finance. This situation clearly shows that from an economic standpoint the road is carrying more traffic than it rationally should, with the result that marginal costs are extremely high. It follows that infrastructure capacity has remained low and must therefore be expanded.

In summary, it should be mentioned that ensuring that the two objectives of tolls are accomplished simultaneously is quite complex, since this means that the average cost payable by the user – operating costs plus tolls – must be equal to the marginal cost and must also cover construction and maintenance costs. For this to be possible, the road has to be perfectly designed for the demand it carries, which is impossible in practice, since highway capacity expansions are discrete.

Consequently, highways located in peripheral regions, with very little traffic and minor negative externalities are much like pure public goods with marginal costs close to zero and – from the pricing theory standpoint – setting a toll to secure economic efficiency would therefore not be justified. Hence, assuming the unlimited availability of unlimited public funds, the best solution would be to finance the highway through budget appropriations.

As, in reality, it is not feasible to assume the unlimited availability of public funds, the price set must minimise the inefficiencies deriving from the opportunity costs of the unavailability of public funds and those deriving from setting a price that is distortionary in relation to the marginal cost.

For highways located in more developed regions, with major congestion problems and externalities, marginal costs are high. Setting charges such that the user perceives the marginal cost may well result in a price that can fully finance the infrastructure. In this case, the levying of tolls is totally justified from the standpoint of economic theory, although it is by no means certain that marginal cost pricing alone will suffice to finance infrastructure construction and maintenance.

3.3. Tolls as a means of internalising external effects

It is a fact that transport infrastructure generates major externalities resulting in a loss of economic efficiency, since road users or users of other modes who generate external effects do not have to compensate other users for the disbenefits they cause, nor indeed are they compensated for any benefits they may generate. This fact justifies state intervention with a view to correcting those effects and achieving greater overall efficiency.

Generally, an efficient production level does not require the total elimination of external effects, simply their reduction to efficient levels. In order to correct or internalise an externality, the price must reflect all the marginal costs and benefits of an activity if the activity generating the externalities is to operate at an efficient level.

With this in view, tolls can be used as a mechanism that helps to achieve – via differential charging – a price that leads to optimal output.

Figure 4. **Tolls as a means of achieving an economic optimum in the presence of externalities**

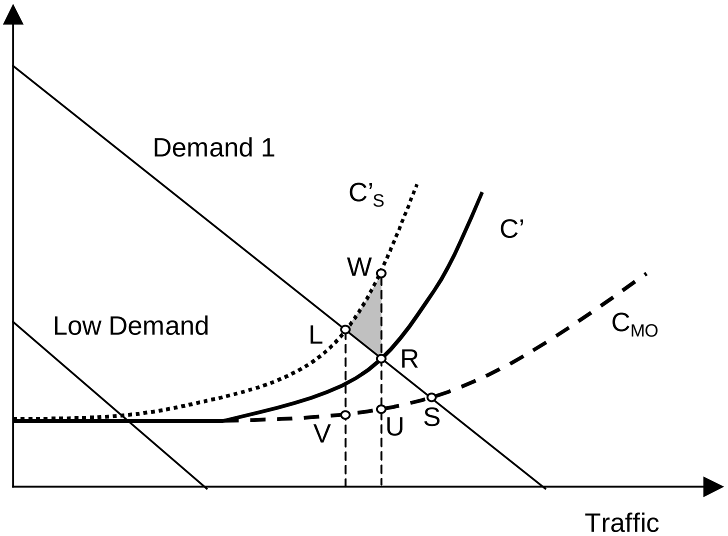


Figure 4 shows the equilibrium point for a highway that generates externalities. As in the previous figures, the average operating cost curve – time, fuel, lubricants, etc. – for users as a function of traffic flow on the highway is shown next to the demand curve, along with the marginal cost curve (C'), exclusive of external effects. The marginal social cost curve – which in addition to other marginal costs includes the marginal costs engendered by external effects – is shown separately.

If no tolls are set, the equilibrium point would be at S, where the demand curve meets the average operating cost curve, which results in an economic loss – loss of consumer and producer surpluses – as previously outlined. On the other hand, where there are external effects, if the price set is equal to the difference between marginal cost (not including externalities) and the average cost of operation, i.e. as RU, there would also be an economic loss – due to the external effects – equivalent to the area LWR.

The economic optimum that would maximise economic efficiency where there are external effects is at point L, i.e. the charge should be set as the difference between marginal social costs and the average cost of operation, segment LV. This passes part of the costs of external effects on to the user, ensuring maximum overall efficiency.

Throughout this paper, pricing mechanisms have been considered as means of preventing the external effects generated by a road exceeding those generated at the point of equilibrium which maximises consumer and producer surpluses. However, this approach, at least as a first approximation, does not tell us whether it is possible to allocate the amount levied to corrective measures designed to avoid external effects. This would reduce the marginal social cost curve and, consequently, the charge levied. This approach would lead to a second optimisation process that could maximise social welfare provided that part of the charge was reserved for financing preventive and corrective measures to reduce external effects.

3.4. Tolls as a demand management instrument

The use of tolls as a demand management instrument is simply a practical application of the approach outlined in the preceding section, since congestion is just another externality in that users joining a congested road give rise to a series of effects on other users and do not perceive the marginal cost that they are generating by so doing. To correct this externality, the charge set must be equal to the difference between the marginal social costs and perceived operating costs, as previously outlined.

Despite the in-depth theoretical analyses that have been conducted on this subject, tolls – or congestion pricing systems – have rarely been used on intercity roads. There are two main reasons for this: firstly, unlike urban roads that have major congestion problems, intercity roads are usually not subject to heavy congestion except on approaches to major cities; secondly, the demand curve on intercity roads shows large seasonal variations, due to distinct preferences to travel at specific times of the year or times of day, which makes it necessary to establish a variable price, although this is difficult with the collection technologies currently available. The widespread installation of electronic tolls could be very useful in the practical application of congestion pricing.

Furthermore, as previously mentioned, tolls have been used as a means of managing demand mainly on urban road infrastructure (*road pricing systems*) in order to avoid major congestion problems in cities and reduce car access to business centres as far as possible. Free *expressways,* on which only vehicles carrying two or more occupants may travel, have been introduced alongside toll roads. Trial schemes charging variable tolls throughout the day – at peak and off-peak times, during the week, at weekends, etc. - have also been implemented in an attempt to internalise the price of congestion as rationally as possible.

As is clear, through the introduction of tolls demand management measures are designed, firstly, to reduce congestion problems and, secondly, to promote vehicle sharing and the use of public transport. They have therefore been confined, for the moment, to urban roads. However, with the strong growth in congestion on some interurban links of the network and the development of electronic toll collection systems, we can reasonably expect to see these technologies in wider use on some corridors in the future.

3.5. Tolls as a driver for the development of a highway management industry

In the previous sections we outlined some of the objectives of tolls (transit duties, setting a market price, provision of finance, internalisation of external effects and demand management). All of these objectives are directly related to the economic advantages to be gained from the introduction of tolls.

However, another no less important objective of tolls has emerged over the last few years with the wider use of concession systems. The concession system involves the creation of a market for infrastructure construction, maintenance and operation in which competition between private firms is encouraged, thus promoting improvements in management efficiency. Although tolls are clearly not essential for the creation of this market, they have just as clearly been of great help in developing it.

This is due, partly, to the fact that problems caused by the lack of flexibility and incentives inherent in all administrative activities have led some public administrations, until now responsible for highways, to hand over the tasks of construction, maintenance and financing gradually to private firms while retaining responsibility for planning and supervision. As a result, private firms which compete with each other via the tendering process now generally perform highway construction. Similarly, over the last few years it has become commonplace for the State to contract out road maintenance and operation to private firms and to tend to rely on private financing to supplement its budget resources.

Tolls play a very important part in this process. Firstly, they are the basis of the concession system in which a private consortium, generally composed of construction firms and financial bodies, undertakes at its own risk and for a defined period of time, to build, maintain and finance a road or motorway, in return for which it receives the toll paid by road users as its principal source of income. Secondly, tolls ensure that the concessionaire's income is independent of the public budget and in direct proportion to the service it provides on the motorway, which offers an incentive for the latter to make every effort to attract users.

Consequently, tolls encourage the creation of a market for infrastructure management, fostering healthy competition between private firms. Obviously, this competition encourages the firms and consortia concerned to find ways of using to best advantage the means at their disposal to build and maintain the road or motorway at least cost, subject to the requirements specified by the Administration. This creates competition in the tendering process, since firms are required to take into account not only construction costs but also maintenance and service provision costs and have to optimise the overall package.

In addition, the possibility of charging tolls allows private enterprise to propose projects – not planned by the public sector – that are attractive for the proposer and of social benefit for the public administration. Many countries have now legislated to allow this, including the United Kingdom, Chile and others. It is worth noting that Chile's Public Works Concession Act stipulates that any private individual or corporate body can apply to the Ministry to construct public works under the concession system and is eligible for a premium at the bid appraisal stage if a call for tenders is issued, the amount of which is to be specified in the bidding conditions. In Spain, a Bill on Infrastructure Construction, Management and Finance, which is currently being debated, will also incorporate this proposal.

4. PROBLEMS WITH TOLLS

Having defined the objectives for introducing tolls, it is interesting to analyse the most pertinent effects - both positive and negative - that they can have. It is those effects which will determine how viable they are as a means of financing transport infrastructure today. Among these are the strong public opposition to tolls, issues of equity and inequity arising from their application, the whole debate on whether tolls should be considered as charges or as taxes, plus a series of other technical and economic impacts.

4.1. Public opposition

One of the main reasons that the public opposes the introduction of tolls is that society has always regarded roads as public property for public use. As they are viewed as essential for ensuring mobility in a given geographical area and are under public sector ownership, they should be financed through taxes and be free to the public. Current road legislation in Spain expresses the same concept.

This concept explains why, in many countries, the construction of a toll road is only considered where an alternative non-tolled route already exists. Clearly, this results in poor distribution of traffic, as the cost paid by the user, both on motorways and highways, is very distorted in relation to marginal social costs, since the average cost of construction and maintenance is recovered (through levying tolls) in the first case but not in the second. Consequently, it is quite common to find heavily congested non-tolled roads and totally underused high-quality tolled motorways in the same corridor, which is hardly rational from the standpoint of socioeconomic return.

To come back to the initial problem, many of the approaches that favour totally free access to roads lack rigour and are markedly populist in character. The main argument, based on the premise that tolls restrict free movement – which is considered a fundamental right – ignores the fact that when users undertake a journey either by private car or public transport they are already assuming a cost: the cost of fuel, repairs, etc., in the former case and the cost of the fare in the latter. Likewise, the argument that charging tolls benefits the wealthiest to the detriment of the poor does not accord with the facts, as we will explain in the next section.

Aside from this, some of the criticisms levelled at tolls are based on the fact that specific taxes are already levied on the roads sector - mainly fuel taxes, which are very high - and that the user therefore, in a way, is already paying for infrastructure use. For the proponents of this argument, imposing an additional charge through tolls for infrastructure use amounts to double taxation.

This latter argument is sounder than the preceding ones but, even so, would need to be further analysed from the standpoint of public finance theory in order to determine to what extent specific taxes are equitable and should be included in public budget revenues. Only when this question is answered and if the principle of earmarking taxes is accepted, up to a point, can we conclude that allocating taxes for infrastructure financing is right or wrong.

4.2. Equity aspects

While it is true, as previously outlined, that the optimum allocation of resources and infrastructure financing may be among the objectives of toll systems, it is equally true that other problems of intergenerational, interregional and social inequity, etc. can arise. As a result, state measures should not be governed solely by the Paretan principle of economic efficiency. Achieving equity should also be a priority consideration. Achieving short-term economic efficiency at the price of increasing the imbalances between different regions would not make much sense.

4.2.1. Intergenerational equity

One of the impacts of tolls, which can also be considered as one of their objectives, is to achieve intergenerational equity. Transport infrastructure requires very substantial investment that is subject to substantial risk during the construction period, but once work is completed annual expenditure on maintenance and operation does not require such large sums. Hence, it would not be fair to recover high construction costs from taxpayers in the year of construction, since they should not be required to pay for a future benefit which they are not sure they will have the use of. The best solution from the standpoint of intergenerational equity would be to recover infrastructure – construction and maintenance – costs from the potential beneficiaries, including future users and the members of a future society who will benefit from the economic advantages that flow from the opening of the new road.

As everyone is aware, public budgets use the current year's revenues to balance that year's expenditure and investment and do not allow for allocating substantial initial construction costs to future users. Although there have been some recent initiatives – such as shadow tolls – in which the Government assumes the total cost, enabling expenditure to be spread over the total life of the infrastructure – traditional tolls still remain the best mechanism for spreading the financial burden of construction over future years. Tolls are regarded as a very satisfactory means of achieving the economic objective of intergenerational efficiency, because the generations that will benefit from the infrastructure contribute to its financing in a rational manner.

4.2.2. Interregional equity

One problem that tolls pose - and that has been the subject of increasingly bitter controversy and criticism from many social actors as regionalism has gathered strength - is that in many cases they do not contribute to interregional equity, i.e. to the balanced and sustainable development of regions within a given territory.

This lack of interregional equity is a result of the fact that tolls -- which are in practice used as a financing mechanism -- only promote the construction of infrastructure in the most developed regions, where potentially high traffic flows will bring the required financial return and not in other, less developed regions with low potential traffic flows.

Several counter-arguments can be advanced. In the first place, the participation of private enterprise and the use of tolls in the most developed regions can free public resources that governments can then use to construct infrastructure in less developed regions. Secondly, tolls mean that infrastructure can be built earlier than would normally have been possible, thus providing early benefits, which can then be channelled, directly or indirectly to those regions. Lastly, once the State is willing – through subsidies, guarantees, etc. – to ensure that roads with sufficient traffic will be a financially viable proposition for purely private finance, tolls will no longer disrupt interregional equity.

Spain is a good example of the lively debate currently going on on this issue. The country has over 2 100 km of tolled motorways currently in operation, owned by both State and regions. Most of these were built in the late 1960s and first half of the 1970s. Spain also has 6 000 km of dual carriageways (many of them now almost to motorway standard) which were financed by the public administrations and are therefore toll-free, built mainly in the ten-year period from 1985 to 1995. As logic dictated, the tolled motorways were built in corridors with high potential traffic flows in the more developed regions, while dual carriageway construction centred mainly on radial roads and on other links with smaller traffic flows.

This situation recently gave rise to a series of discussions between the regions in which those with a denser network of tolled motorways complained that, unlike other regions, they had to pay for infrastructure use. Regions in which dual carriageways are under construction – whose per capita income is generally below the national average – claimed that, unlike regions that have tolled motorways, they will have to wait many long years to have roads that are up to standard. The Spanish debate gives an idea of the complex interregional equity problems to which tolls can give rise.

In conclusion – although Spain is not exactly a model example – it should be pointed out that there is no reason why tolls as such should cause distortions between regions now or in the future, provided that uniform guidelines are adopted throughout the country. A point to bear in mind is that it is hardly sensible to stop building roads in some regions just because they are not financially viable for the private sector and that using joint public-private financing mechanisms, such as PPPs, can solve many of the problems raised.

4.2.3. Equity between social strata

Another issue raised is that the introduction of tolls creates inequities between different income groups. According to this school of thought, transport is an essential good and as such its income elasticity is low, with the result that those on low income spend a much higher proportion of their disposable income on transport than higher earners. Its advocates maintain that expenditure on tolls does not help reduce disparities in wealth between the different classes of society.

The argument outlined above seems to make some sense, but is not without some populist overtones. In fact, goods that are considered as necessities and that take a very high percentage of the incomes of the least well-off families, are normally paid for and there is never any suggestion that they be provided free of charge by the State. The counter-argument advanced by some of the proponents of toll-free infrastructure is that roads are a unique case because they are natural monopolies, supplying services with some common characteristics for all social classes and that it does not seem fair that families with less resources should have to pay the same as those with higher incomes.

Another point that should be taken into account is that, in many cases, charging tolls will relieve congestion on roads and, therefore, public transport – used by those with fewer resources – will run better. The less well off will therefore benefit from improved public transport as a result of the introduction of tolls that, in the main, will be paid by the better off. This effect will be particularly pronounced on urban roads with major congestion problems.

In view of the foregoing, it is worth pointing out that mechanisms such as establishing criteria for progressive direct taxes, granting subsidies and aid for large or low-income families for the use of a given public service, etc., are more appropriate methods of ensuring social equity than not setting a charge for infrastructure use.

As in the previous case, we can assert that, by and large, there are no grounds for claiming that tolls conflict with the principles of social equity, provided always that adequate mechanisms are put in place to ensure the fair distribution of resources between the most and least well off.

4.3. Should tolls be viewed as a charge or a tax?

Another aspect of the toll problem is whether tolls should be legally defined as a charge - regulated by commercial law – or as a tax. The difficulty in classifying tolls as one or the other lies in the inherent complexity of the legal framework for road concessions. The stance adopted by many countries – at least those influenced by Roman law – is that from the legal standpoint roads are a public good and consequently are the property of the State, although this is no obstacle to transferring the management of construction, maintenance and operation to the private sector under the control and supervision of the Administration.

Taxes are defined as a compulsory contribution to the State for the use of public property, public services or for the exercise by the Administration of an activity relating to, affecting or benefiting the taxpayer. Although a component of tax is in payment for services rendered, the amount levied does not necessarily have to reflect the average costs of the service concerned. Thus, the collection of taxes is not specifically designed to finance the service provided; taxes are allocated to the general budget revenue for distribution, as agreed in the relevant budget debate.

A charge, on the other hand, is defined as a price paid for a service, whether public or private, for the primary purpose of ensuring financial equilibrium, apart from any subsidies or aid that the State may provide for various reasons. It should be quite clear, however, that a charge can be regulated by the State in order to keep it within prescribed limits, etc.

The criterion that most countries in Europe have adopted has been to view tolls as a charge, since in treating road concessions as commercial activities – leaving aside the fact that the good itself is owned by the State – the revenues obtained are intended to ensure the financial equilibrium of the company. In contrast, other countries, such as France, have chosen to view tolls as a public tax, on the grounds that they are mainly paid in return for a good or service.

As can be seen, there is as yet no unanimity on whether tolls should be legally classed as charges or public taxes. The main implication of opting for one or other framework is that value-added tax is not charged on taxes, but is charged on tolls, with the result that the latter are perceived by users as costing more than taxes.

Faced with this dilemma, the European Union has backed the stance taken by the majority of countries, i.e. it regards tolls as a charge subject to commercial pricing regulations and therefore subject to value-added tax (VAT). It therefore seems essential to reach agreement as soon as possible, since the diverging interpretations of tolls as taxes or as charges can give rise to discrimination, as some countries are passing on higher prices to users than others.

4.4. Other technical and economic impacts

An analysis of the costs generated by an intercity road generally includes vehicle running costs, construction costs and maintenance costs – which can be passed on to the user through tolls – and external costs. However, other costs that should be taken into account are the costs of collecting tolls – conventional tolls – which are very high. In Spain, they account for between 10 and 15 per cent of the motorway toll paid by users. These costs include the amortization of toll facilities, their maintenance and operation – including energy costs – and as a basic item, the wages of toll collectors.

From this standpoint, leaving aside the opportunity costs of the unavailability of public funding - analysed in greater depth elsewhere in this paper – a tolled road or motorway costs the public more than an identical motorway financed through the public budget.

The problem is that because of the high derived costs of toll facilities – for conventional collection systems – the number of access points to the motorway is necessarily limited and there are consequently very few connections to the existing road network. This often makes getting on to the motorway complicated and it is not uncommon to see some traffic (especially short-distance traffic) opting for alternative routes, exacerbating congestion problems on them.

As a result of these problems, the substantial progress made recently with electronic collection systems has gone a long way to resolving the difficulties we have outlined. Firstly, these new systems will eliminate wage costs, reducing costs substantially. Secondly, the resulting reduction in costs will mean more motorway connections to the conventional road network, attracting more traffic to motorways. Lastly, the advantage of these systems is that they facilitate variable charging in line with certain parameters, such as congestion, enabling higher charges at peak times and lower charges at off-peak times.

Another technical economic problem that should be taken into account is finance costs for toll road concessions arising from borrowing in the early years of operation, when high costs have to be borne in order to finance infrastructure construction. As a result, leaving aside the opportunity costs of the unavailability of public funding or inadequate funding at any given time, a tolled motorway will have to be able to pay finance costs and will therefore inevitably be more costly than an identical motorway built using public funds. In this connection, the greater the risks perceived by the agents involved in financing the road or motorway concession, the higher the financial costs the company will have to pay.

This said, to avoid any misunderstanding, the above comments are based on the assumption of unlimited public funds whose ready availability has no effect on the country's macroeconomic policy. A proper analysis of whether roads should be financed by tolls or by public funding would have to factor-in the higher costs of installations and finance for the toll option, the opportunity costs of unavailability and the potential negative impact on the economy of a large public spending deficit, for the public funding option.

Furthermore, in Europe at least, the prevailing philosophy dictates that there should always be a toll-free alternative to toll roads or motorways, which gives rise to another problem. As well as the sub-optimal distribution of traffic previously mentioned, repair and maintenance costs will be higher, since from a social standpoint they will have to be paid for both the motorway and the pre-existing road. Consequently, in addition to tolled motorway concessions, public administrations are constantly required to finance the maintenance of parallel roads, with the result that these resources are not available for other public activities with a more social component.

5. CONCLUSIONS

Tolls have been charged for various purposes throughout history. Initially they were levied as a duty of passage or transit duty and eventually as customs duties. Later, with Adam Smith, tolls began to include a more economic component and became a means of financing the maintenance and construction of public works. Today, in addition to the objectives just mentioned, tolls serve as a means of internalising external effects and controlling demand in areas with major congestion problems.

As a means of establishing an efficient price for the use of infrastructure, tolls make users aware of the marginal social costs generated by one additional unit. However, the introduction of this type of toll encounters a number of problems, principally: difficulties in calculating the precise monetary valuation of marginal costs, especially externalities; the need to implement marginal cost prices on all connecting systems, too; and the question of whether marginal cost pricing will be sufficient to finance infrastructure costs in their entirety.

Tolls are a basic instrument for securing infrastructure financing, outside of the public budget. In this connection, a concession system financed independently of the budget is crucial where the aim is to use infrastructure construction as an instrument of countercyclical policy in periods of economic recession. Also, having infrastructure as and when it is needed enables society to avoid costs deriving from the unavailability of public funds to finance infrastructure.

Tolls are becoming steadily more important as a means of internalising the congestion and externalities generated by roads and of instituting rational demand management, particularly in large cities.

Tolls, especially in European countries, have met with strong opposition from the public. While some of the grounds for opposition – for example, claims that tolls restrict mobility – are decidedly populist, others, such as the fact that roads are already subject to high specific taxes, are more plausible.

Tolls are extremely important mechanisms for ensuring equity between the different generations, since they ensure that infrastructure will be paid for by the generations that will reap the benefits of the positive effects.

Tolls and whether or not they contribute to social and regional equity is a subject that has prompted a great deal of debate, especially in recent years. As no clear answer has yet emerged on this issue, a more detailed analysis of the impact of tolls on equity should be carried out in the future. As regards the legal framework for tolls, there is an ongoing debate on whether they should be considered as a tax on a public service or, conversely, as a regulated charge subject to private commercial legislation, which will therefore be subject to value-added tax (VAT).

Tolls are also encountering other technical economic problems such as: the high cost of toll collection facilities; the high cost of debt servicing for infrastructure finance and, lastly, the obligation in practice to maintain a toll-free alternative route.

ANNEX

OVERVIEW OF POLICY REGARDING TOLLED MOTORWAYS IN SPAIN

This annex addresses some aspects of Spain's policy towards tolled motorways, focussing on some of the issues that are currently at the centre of a political debate. In order to form a clearer picture of the issues involved, it seems necessary to look briefly at the evolution of the high-capacity road network in Spain and in particular at the tolled motorway network.

The 1960s marked the beginning of the process of transformation of our main road network, with the emergence of the first plans for motorways. Like its neighbours, Spain adopted the concession system financed by tolls because of the lack of finance. However, in contrast with those countries, in Spain the concession-holders were private companies which were progressively set up to build, finance and operate sections of motorways which would be managed independently and which would in no way compose or be operated as a network. By the end of the 1970s, there were about 2 000 kilometres of tolled motorways.

Following the oil and economic crises in the 1970s and during the first half of the 1980s, many companies were obliged to renegotiate their concessions with the State and three of them were taken over by the public sector, which set up a public enterprise (Empresa Nacional de Autopistas) to run them. The Government is now considering privatising this enterprise, given the current revival in its fortunes.

Nineteen eighty two marked a change in policy. Tolled motorways were replaced by expressways (highways with separated lanes) which, in fact, were dual carriageways built on existing conventional roads and which were subsequently upgraded to standards similar to those of the publicly-financed and operated toll-free motorways. Moreover, during this period, some autonomous communities (regions) - with legislative powers in regard to road infrastructure - granted regional concessions under the powers which had been devolved to them. In 1996, the new Government redefined transport infrastructure policy, reintroducing the concession system and concessions for the construction of about 410 kilometres were awarded during this period. A second phase of almost 770 kilometres is currently planned. This does not prevent the public sector from building new expressways, however.

Nevertheless, it should be pointed out that most of the new concessions that were recently awarded, or are soon to be awarded, are not financially viable. The Government has therefore started to adopt public/private financing arrangements, in which it participates by offering reimbursable advances, equity loans or subordinated debt, thereby enabling the project to be financially viable.

The current regulatory framework was laid down by the Tolled Motorways Act of 1972, which was partially amended at the end of 1996 and 1999 in the laws accompanying the state budget, in order to adapt it to the new circumstances.

The reintroduction of tolls from 1996 gave rise to a series of problems, the first of which was the heterogeneity of the high-capacity road network (about 9 000 km), with two models existing alongside one another - one consisting of 2 250 km of tolled motorways in operation (with an additional 270 km under construction and 800 km planned) and the other of nearly 7 000 km of toll-free expressways. This has triggered a major political debate on the comparative disadvantages of regions in which tolled motorways are concentrated and those which have only toll-free expressways. The unbalanced structure of the network - 75 per cent of expressways and only 25 per of tolled highways (in contrast with neighbouring countries) - shows a manifest lack of interregional equity, which is discussed in the main paper.

In Spain, tolls are viewed as a means of financing the construction, operation and maintenance of infrastructure, the level of toll being set according to the cost of construction, potential traffic and the duration of the concession. Given Spain's mountainous terrain, the density and distribution of the population and the levels of car ownership, it is not surprising that tolls, which are not subsidised by the State, vary so much from one section of the network to another, and are very high compared with those in other European countries.

The rejection of tolls, due mainly to the factors outlined above as well as the demise of the "toll culture" of the 1970s - resulting from the launch of the Expressway Plan around 1985 - obliged the Government to take steps to lower tariffs and to change the system of adjusting them. Although isolated measures were adopted to this end at the start of the 1990s, it was only from 1997, when the regulatory framework for motorways was modified, that a policy of reducing tolls was introduced, with a view to bringing them into line with those elsewhere in Europe; by way of compensation, the motorway companies were given the possibility of extending their licences and building adjacent new sections. Likewise, since the beginning of 2000, tolls have been overhauled and cut by 7 per cent and corresponding compensation provided by the Government to maintain the economic and financial equilibrium of the concession-holders, in those cases where it is necessary.

In 1997, the low VAT rate (7%) on tolls was also introduced, in line with the rate on road passenger transport in Spain. This measure too is a means of reducing the cost of the toll borne by the user.

To sum up, the main price measures applied to tolled motorways in recent years are the following:

- Large cuts in tariffs (of 30 to 40 per cent), negotiated with some concession-holders, accompanied by equivalent compensation for the resulting reduction in revenue;

- Revision and reduction of tariffs by 7 per cent and provision of corresponding compensation;

- VAT rate cut from 16 to 7 per cent;

- State aids (reimbursable advances, equity loans) written into the terms of the concessions, enabling the companies to maintain their economic and financial equilibrium while setting low tolls;

- Concessions increased to 75 years, enabling the concession-holders, in return for toll reductions, to build new sections of motorway or extend existing ones.

In fact, these measures reflect the fact that tolls have recently become a political battleground instead of being an instrument of economic decisionmaking. It is thus necessary to launch a general debate on the issue and to adopt a coherent, rational policy, with a view to achieving a comprehensive solution to the disparities and heterogeneity of the existing model.

In conclusion, some of the findings of a recent nationwide survey by the ASETA (Spanish Association of tolled motorway companies) are presented, the aim of which was to find out what the Spanish, and users in particular, thought about motorway tolls. The findings of some studies, on the elasticity of demand further to the aforementioned tariff reductions, are also given.

- 72 per cent of the respondents approved the toll reductions which were made further to the motorway companies being allowed to extend their concessions;

- 75 per cent considered that the debate on the abolition of tolls is a highly-charged political issue, from which electoral considerations are not absent;

- 75 per cent considered that there is a clear link between the construction of tolled motorways and the economic development of the areas in which they are situated;

- 64 per cent of users thought that tolls are the fairest way of financing high-capacity road infrastructure;

- Most of the people questioned preferred private financing of motorways and that tolls be charged, rather than postponing projects until the Government has the funds to build them.

As regards the elasticity of demand with respect to toll reductions, the latest studies made it possible to obtain values that can be compared with the elasticity of demand with respect to other variables. However, these values should be treated with caution, given that the motorway companies are entirely private. The data provided are usually limited and sometimes unreliable, given the use that is made of them and the fact that it is not in the interest of those companies to make them public.

A study carried out by the Ministry of Public Works and recently published in a Spanish journal (Matas y Raymond, 1999), made an exhaustive analysis of demand elasticities for tolled motorways in Spain. The elasticities were calculated using statistical and econometric methods, not only for prices but also for other variables such as GDP and the price of fuel. The study exploited the data available further to the toll reductions mentioned earlier.

It was found that traffic on tolled motorways in Spain is fairly sensitive to the variables studied (GDP, the price of fuel and tolls), confirming the general belief that the elasticity of motorway traffic with respect to the level of tolls is almost rigid. The values obtained are broadly similar to those obtained by studies in other countries, although the latter are slightly higher.

Bearing in mind the very large difference detected between the price elasticities for the sections of motorway analysed, the concessions were divided into four groups with similar characteristics, as shown in the table below. Both the short-term and long-term elasticities exhibit this difference.

Table 1. **Estimated short- and long-term elasticities**

Variable	**Short-term elasticity**	**Long-term elasticity**
Elasticity with respect to GDP	0.887	1.440
Elasticity with respect to fuel price	-0.332	-0.539
Elasticity with respect to toll (Group 1)	-0.210	-0.341
Elasticity with respect to toll (Group 2)	-0.372	-0.605
Elasticity with respect to toll (Group 3)	-0.467	-0.758
Elasticity with respect to toll (Group 4)	-0.783	-1.273

Source: Anna Matas et José Luis Raymond (1999).

Overall, the average short-term elasticity of demand with respect to the toll is around -0.3 and the long-term elasticity is around -0.45. The long-term elasticity is higher than the short-term one because it takes users some time to adapt their behaviour to the change in toll. This period of adaptation was estimated to be about two years.

The study also sought to identify the variables that give the best explanation for the difference in elasticities between motorways. Detailed statistical analysis showed that the variables with the most explanatory power were the volume of traffic and the quality of the alternative road, expressed in terms of speed and percentage of heavy goods vehicles in total traffic. It was found that demand is less sensitive to price on corridors with a low level of traffic. It was also verified that the more the alternative road is saturated - and thus the greater the advantages of using the tolled road - the more demand is inelastic.

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THE "MICROECONOMIC" IMPACT OF INTRODUCING TOLLS ON INTERCITY ROAD TRANSPORT INFRASTRUCTURE

SUMMARY

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INTRODUCTION

The findings presented in this paper are taken from research conducted for various European Union (EU) projects. They were in part collated by the author for the EU's Concerted Action on Transport Pricing Research Integration (CAPRI Project).

To assess the impact of road tolls we, in fact, study the "incentives" provided by varying toll charges. At present there is little information from which to extrapolate separate data for light and heavy goods vehicles; however, projects that will specifically study HGV traffic are currently starting up under the Fifth Framework RTD Programme.

We cannot analyse the "microeconomic" impact of road tolls without first explaining the conceptual framework (infrastructure and user charging) within which a particular charging option will operate, and how it is viewed by current European legislation and other important reports (Chapter 1).

We can then go on to address the impacts studied (Chapter 2). In this report "microeconomic" is used in the broadest sense of the term. It therefore includes the concepts of "economic welfare" (which is evaluated using mathematical tools from a microeconomic standpoint), demand theory (individuals as infrastructure users) and user acceptance (of the charging option in question). While aware that this is a "misuse" of the normal terminology, the impact of the choice made is nevertheless limited by the fact that there are indeed two fundamentals operating: the individual and welfare. The lessons learned from analysing the short-term impact of tolling schemes can then be used to modify the conceptual framework for infrastructure charging (Chapter 3).

1. TRANSPORT INFRASTRUCTURE CHARGING: THE CONCEPTUAL FRAMEWORK

This chapter describes and cross-tabulates infrastructure charging options with objectives, based on the approach developed by the *Laboratoire d'Economie des Transports* (LET) for the Eurotoll Project. It then analyses the concept of tolls.

1.1. Charging options and their geographical base

Several charging options are in use. These options may have a national or territorial base (i.e. they may apply countrywide or when in transit through a given geographical area) and may be further categorised as having a weak or strong national or territorial base.

1.1.1. *Vehicle taxes*

These are generally nationally based. However, they can also be territorial if a vehicle stays in a country for a long time: for example, if a heavy goods vehicle from the European Union or Switzerland spends more than 14 days in Germany (more than one day, if it comes from another country), then vehicle taxes have to be paid. This type of tax can take the form of a *vignette* (road tax disc), as in France, payable each year by owners of four-wheel vehicles, or may be levied as an axle tax, etc.

1.1.2. *Fuel taxes*

These are territorially based taxes, but weakly so, since anyone can purchase fuel in any country they travel through.

1.1.3. *Charges for infrastructure use*

These are charges paid by users for the use of the road. Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructure defines the charges to which this type of option applies:

- Tolls, defined as the payment of a specified amount for a vehicle travelling the distance between two points, based on the distance travelled and the type of vehicle;

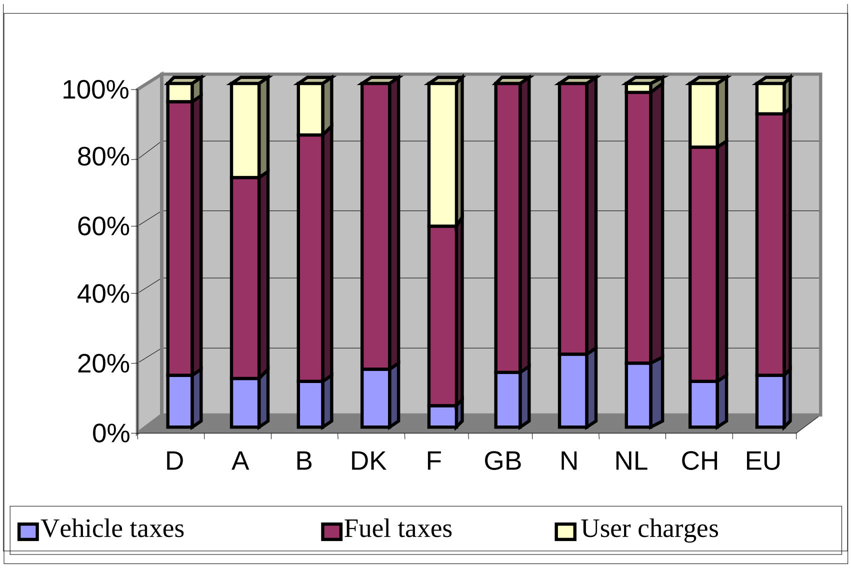
- User charge, defined as the payment of a specified amount, conferring the right for a vehicle to use a given infrastructure for a given period.

It is the first definition that this report is concerned with. "Tolls" may therefore be based on the distance travelled[1], either over the whole network [France, Spain, Italy, Austria in 2002 (Decree of June 1999), etc.] or part of it (Greece, Belgium, and the Netherlands). Tolls may also be based on both distance and weight (RPLP, Switzerland[2]). Other European countries (Belgium, the Netherlands, Denmark, Sweden, and Luxembourg) use the *Eurovignette* system, the second type of user charge.

1.1.4. *Respective share of charging options in total revenues in Europe*

The following figure shows the share of charging options in total revenues from heavy goods transport by road in nine European countries (including Switzerland). It shows that these shares vary from one country to another.

Figure 1. **Percentage share of charging options in total HGV revenues in nine European countries, including Switzerland**



Source: Based on DETEC, 1998.

Other taxes charged are income tax and value added tax (VAT), which is levied on fuels, vehicle sales and tolls. They are not strictly linked to charging mechanisms, but must be taken into account since they are a source of revenue for governments.

1.2. Charging objectives

The above options are used in order to achieve certain objectives. The first two objectives tend to be related (directly or indirectly) to finance.

1.2.1. Finance for new infrastructure

Finance for new infrastructure can be raised by a range of charging options, which vary greatly from one country to another. In several European countries (France, Spain, Italy, Portugal and Greece), tolls are widely used to finance motorways, often when they have been constructed by public/private partnerships, while in all European countries income tax, VAT, etc., are used to finance roads.

1.2.2. Network maintenance and operation

Network maintenance and operation are generally financed through general taxes (income tax, VAT, etc.) or special taxes (*vignette*, axle taxes).

1.2.3. Internalisation of external costs

The internalisation of external costs, which is one of the most discussed principles at the level of the European Commission[3], can be achieved through charging options. There are two approaches to the internalisation of costs: the "damage costs" approach (which taxes the generator of external costs *pro rata* to the damage caused) and the "prevention costs" approach (use of revenues from charges to reduce the extent of external effects).

Briefly, external costs can be divided into four categories:

- Damage to infrastructure;
- Accidents;
- Pollution (including noise, air and water pollution);
- Congestion (not all experts consider this an external effect).

1.3. Cross-tabulation of pricing options and objectives

The following table shows a simplified method of cross-tabulating charging options with objectives. It is for motorways and similar roads. This approach was described in detail by the Laboratoire d'Economie des Transports (LET) as part of the studies it conducted for the Eurotoll project, the results of which are presented at the end of this report.

Table 1. **Pricing options and objectives**

Options / **Objectives**	**General taxes**	**Vehicle taxes**	**Fuel taxes**	**User charges**
Infrastructure finance				
Network operation and maintenance				
Internalisation of external costs				

European countries use any of the various charging options above to finance their motorway and other similar networks, and the maintenance thereof. As we have seen, some countries raise finance through tolls, while others do so through general taxes and vehicle and fuel taxes by means of either a special fund [the Netherlands, Luxembourg and Belgium (Flanders)], state financing (Denmark, Sweden, Finland and Germany) or dedicated companies (the United Kingdom's Design Finance Build and Operate system).

An indirect objective of fuel taxes is to internalise external effects. This objective can also be met by charging tolls for infrastructure use (accident prevention, noise reduction, less congestion, etc.) through the very characteristics of the infrastructure that has been financed by these means (noise barriers, safety barriers, high capacity, etc.). This is a clearly stated objective of Switzerland's RPLP.

1.4. The stance taken by European Union institutions

1.4.1. The European Parliament and Council

In Article 7 of Directive 99/62/EC on the charging of heavy goods vehicles for the use of certain infrastructure, the European Union states "weighted average tolls shall be related to the costs of constructing, operating and developing the infrastructure network concerned" (i.e. motorways and roads with similar characteristics). The purpose of the Directive is to help to eliminate distortions in competition between heavy goods transport routes in Europe and to encourage the use of less polluting vehicles (the differentiation of taxes and user charges should not interfere with the functioning of the internal market). In addition, it stipulates that tolls and user charges may not both be imposed at the same time for the use of a single road section; however, Member States may impose tolls on networks where user charges are levied for the use of bridges, tunnels and mountain passes.

For the road networks concerned by the Directive, average infrastructure costs are generally higher than marginal costs (increasing average returns to scale and decreasing marginal returns). Infrastructure charging systems (i.e. tolls and other user charges) do not lend themselves to decentralised management and would give rise to an operating deficit if priced in accordance with optimal resource allocation theory (i.e. marginal cost).

1.4.2. European Commission discussions

The European Union is currently discussing ways of factoring variable external costs into charging policies. This is clearly stated in the White Paper and in the latest report by the High Level Group on Transport Infrastructure Charging (May 1999). The White Paper itself was based on a preliminary report by the High Level Group.

The White Paper stresses the diversity of approaches to infrastructure charging in the European Union and the need for gradual harmonization of these systems. In line with the report by the High Level Group, published two months before the White Paper, it proposes a charging system -- based on the "user pays" principle -- that takes into account the external costs of transport (i.e. marginal social cost[4]), but Member States would still be able to continue providing state aid for public transport services. The Commission does not impose a centralised Community charging scheme, it proposes a "step-by-step" approach to the implementation of these principles. For instance, in the road transport sector, it encourages Member States to develop distance-based road charging schemes to ensure good "interoperability" with HGV schemes (existing toll and *Eurovignette* systems) in the first phase (1998-2000)[5]. It also encourages Member States to develop urban "road pricing[6]" schemes to deal with the external costs of urban transport. In the second phase (2001-2004), distance-based charging systems should be extended to include external costs in addition to infrastructure costs. In the third phase (beyond 2004), charging schemes for HGVs and commercial passenger transport, based on marginal social cost charging principles, is due to be implemented Community-wide.

However, the White Paper is aimed solely at freight and commercial passenger transport (it does not cover private transport) and proposes no guidelines on infrastructure financing, although it does recommend the use of public/private partnerships for new infrastructure projects and states that new charging rules must not adversely affect current concession systems.

The Commission's draft White Paper was approved by the European Parliament in mid-March 1999. Parliament called on the Commission to include car traffic in the charging system (if it is not possible to do so on the basis of marginal social cost, the Commission is set to make new proposals on ways of including private car traffic) and pointed out that the revenues that charges were expected to generate must be reinvested in transport infrastructure. Two other points raised by Parliament related to a more precise definition of the charge calculation method (setting out in detail the cost elements included and to include capital costs among those elements) and the introduction of a charging system that would take into account the use of "environmentally-friendly" technology.

We should add that the Commission had launched several projects on the problem of accounting for external costs under the Fourth RTD Framework Programme. A good survey of existing research was published recently as part of the CAPRI Project (see Bibliography). Another reference document has been published by the ECMT (see Bibliography).

1.4.3. Synopsis

The following table cross-tabulates the types of cost and the economic agents concerned. The shaded boxes in the first row of the table (authorities/operator) show the types of costs covered by tolls. The shaded box (in column 3) shows the costs on which discussions at European level are now focusing in order to determine how they can be "internalised" through infrastructure usage charges.

The table shows that charging initiatives are inseparable from the categories of agent concerned. If variable external costs are to be charged, then road users and possibly other users will have to pay them either via their own fixed or variable costs (use of vehicle) or under the general tax system (income and other taxes).

Table 2. **Fixed and variable external costs**

Type of cost / **Agent**	**INTERNAL COSTS**[7]		**EXTERNAL COSTS**
	Fixed costs (1)	**Variable costs (2)**	**Variable costs (3)**[8]
Authorities and operators (infrastructure costs) (A)	Finance costs (80%[9]) and fixed operating costs (20%) • 70%	Variable operating costs • 30%	
Road users (and other users for external costs) (B)	Related to vehicle ownership	Use of vehicle (fuel) and infrastructure (user chargers)	**Congestion, accidents, noise, air pollution**
Society (C)			Climate change, water pollution

Fixed costs are the same whatever the distance travelled, while variable costs vary with distance. Fixed operating costs are generated by weather conditions and the time of year (lighting, traffic management, information, etc.). Variable operating costs are essentially the costs incurred to maintain the service provided by the infrastructure (road maintenance, replacement of crash barriers, sundry repairs, etc.).

Europe's current toll systems are simply a form of user charging, the main aim of which is, in the first instance, to repay annual instalments on loans taken out to build the road infrastructure in the first instance and to finance network operation and development. Tolls are an integral and inseparable part of the conceptual charging framework. As such, no discussion on the impact of tolls should mask the basic objectives assigned to this charging option, since tolls cannot be raised or lowered for either a limited or indefinite period without affecting the equilibrium of the finance system for the intercity road transport sector. This is true for all countries that use tolls.

Bearing the above comments in mind, we can now turn to the "microeconomic" impacts of tolls.

2. THE MICROECONOMIC IMPACT OF TOLLS

Tolls can have two kinds of microeconomic impact. The first is their impact on "socioeconomic welfare", which is represented by a composite function devised for the transport sector. The second is their impact on transport demand. In the first case, time is used as the baseline for setting certain objectives in the scenarios. In the second, the situations are short term or very short term.

2.1. Impact of tolls on socioeconomic welfare

As previous studies have found, EU Member States use differentiated charging options to achieve certain objectives. One of the questions that the European TRENEN Research Programme (see Bibliography) asked was: what is the best set of pricing options for maximising socioeconomic welfare? In other words: what are the pricing options that will best allow us to optimise social welfare all round?

In the TRENEN Project, scenarios were tested for two case studies, one in Belgium and the other in Ireland. The approach was based on modelling.

The main scenarios tested were:

– The reference scenario (RF): based on transport demand (traffic) forecasts for 2005, with policies on charging and infrastructure use unchanged.

- The optimal scenario (FO): based on a package of optimal policies and the assumption that the regulatory instruments are capable of maximising social welfare. This is a long-term scenario and is very difficult to implement. It should be regarded as a benchmark against which to compare other scenarios. If the RF scenario equals "0", the FO scenario equals "100", and the other scenarios will be somewhere between the two.

- A uniform pricing scenario (UPT): based on a minimum level of tax on fuels in conjunction with user charges for motorways (flat-rate user charges, i.e. vignette, or tolls). It includes a "clean technology" component for diesel vehicles. This scenario is easy to implement (no need for sophisticated equipment such as electronic charging systems);

- An infrastructure usage cost pricing scenario (CPT): in which tolls are set at optimal levels for peak and off-peak times on motorways and similar roads. A "clean technology" component is included for diesel vehicles. This scenario is not easy to implement (need to optimise toll levels, uses electronic charging systems).

In the case studies conducted, socioeconomic welfare was represented by a function derived from a combination of four components: pollution (for passengers and freight), accidents, depreciation of roads and congestion.

The case studies conducted using the UPT and CPT scenarios took into account two of the charging objectives previously mentioned (road network operation and the internalisation of the external costs) and introduced a new objective: demand management by differentiated toll levels. While they did not cover infrastructure funding, they also took two pricing options (fuel taxes and user charges) into account.

The results obtained were as follows:

Table 3. **General results of case studies**

	Welfare gain as a percentage for FO scenario	
	Belgium	**Ireland**
RF	0.00	0.00
UPT	8.93	0.43
CPT	83.93	60.68
FO	100.00	100.00

As can be seen, the most promising scenario is the CPT scenario, which can achieve 84 and 61 per cent, respectively, of the optimal social welfare level defined in the FO scenario.

In the Irish case study, the research team went one step further and analysed two other scenarios:

- A "fuel and vehicle tax scenario (FV)" that can be implemented without recourse to tolls (policy attempt to internalise costs of transport by increasing existing taxes only). This scenario does not require the introduction of any particular technology.

- A "public transport (PT) scenario" in which car use is reduced and there is a shift to public transport brought about by varying toll levels at different times of day and in which major subsidies are allocated to public transport. This scenario requires a great deal of technology.

The FV and PT scenarios cover two further pricing options: taxes on vehicles and general taxes. The results obtained show that the respective gains in terms of welfare are 21 and 27 per cent. As can be seen from the first of these two figures, the gain achieved by a rise in existing taxes is not very significant. The second shows that it is the "toll" component that offers the gain in utility, but that its efficiency is nonetheless limited by the level of public transport fares, which is maintained by the direct subsidies they receive.

The approach taken in this study was to include both congested and congestion-free areas. In fact, by definition it is not possible to compare networks that have virtually the same characteristics (number of lanes) but that link the near and far suburbs (gravity model). The conclusions were as follows:

In congested areas, the scenarios can be ranked as follows:

CPT > PT > FV > UPT

The most promising pricing options are time-differentiated user tolls, although there are certainly major implementation costs and difficulties.

In congestion-free areas:

FV > UPT

The most promising pricing option is a mixture of general taxes, vehicle taxes and fuel taxes.

The TRENEN case studies show that tolls (or rather tolls that vary with time of day) could have a positive impact on economic welfare and, at the same time although to a lesser extent, could bring about a modal shift to public transport at peak periods. These results apply to congested areas and, in terms of impact on transport demand, show how flexible this pricing option can be.

2.2. Impact of tolls on transport demand

2.2.1. Demand elasticity under tolls

The TRACE Project (see Bibliography), one of the reference projects under the Fourth RTD Framework Programme, dealt with estimating the direct impact of pricing options on demand. This study, unique in its kind, produced a series of findings. Unfortunately very few of them relate to tolls.

Nevertheless, it is possible to give some data for elasticities for "variable costs" [B(2) in Table 2] and tolls, although the project concentrated primarily on fuel price elasticities. The former relate demand (vehicles) to variable costs, the latter to tolls.

The elasticities for variable costs range from -0.99 to -0.43, for a value that had been estimated by the authors at -0.74. In other words, all things being equal, a 10 per cent change in variable costs would reduce traffic, expressed as the number of vehicles, by 7.4 per cent (in the short term).

The elasticities for tolls vary depending on the studies reviewed for the project, i.e. still short-term for 1994 for Germany (an INRETS calculation for France is also given, but this is long-term).

- Vehicle base: -0.38;
- Baseline number of trips per driver: -0.17;
- Baseline number of trips per passenger: -0.30.

Although elasticities should be treated with caution, the findings presented nevertheless show that the "toll" pricing option cannot be considered as having no impact on demand, all things being equal. We would just add that, in the short term, variable tolls generally have more of an impact than changes in fuel taxes, as is clearly demonstrated by the TRACE project. This can be put down to the learning curve for transport costs and marginal approaches to estimating these same costs.

2.2.2. Short-term impact on demand

The aim of the Eurotoll project, conducted under the Fourth Framework RTD Programme, was to undertake an in-depth investigation into the effects of toll-based demand management strategies on transport demand. The interurban case studies for the project were based on actual trials (France) and modelling (Austria and Germany).

2.2.2.1. General framework

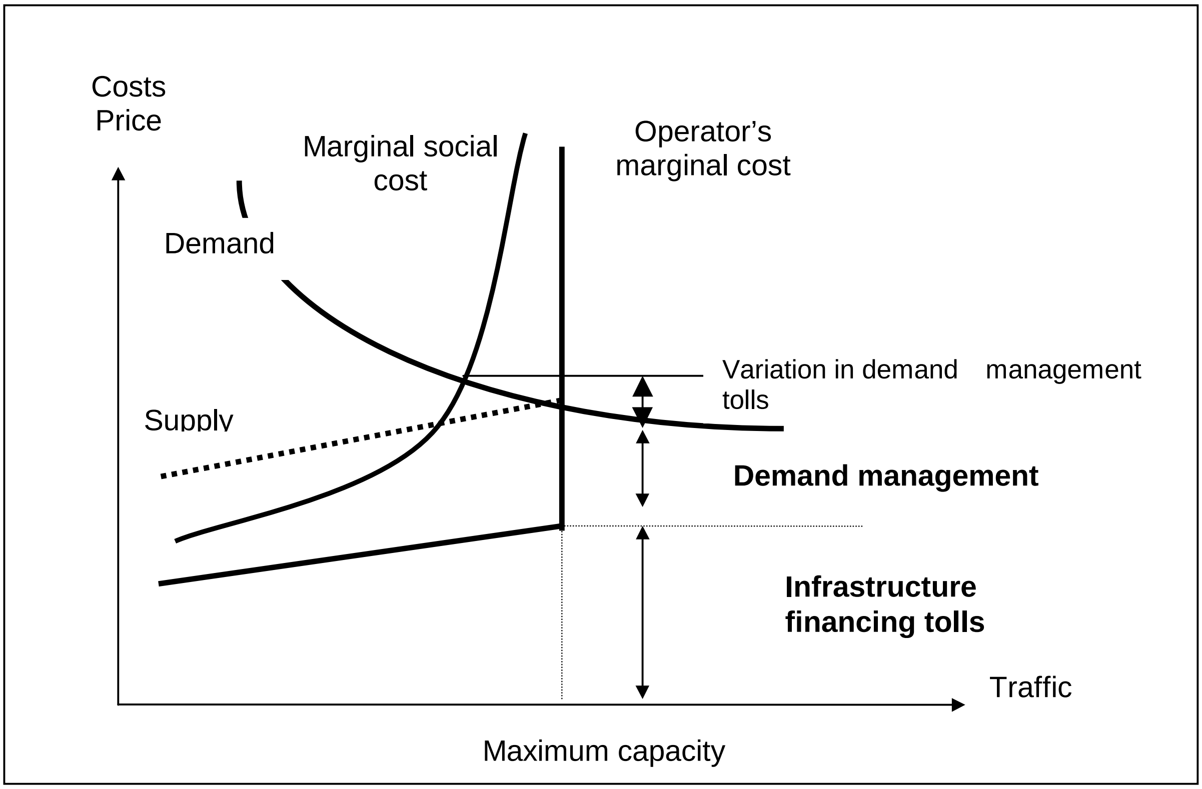
As we have stated, the main objective of tolls is the repayment of the annual instalments on loans taken out to build road infrastructure and to finance network operation and development. From an economic standpoint, tolls can be divided into two categories, with the first serving as the "base" for the second.

- "Infrastructure financing" tolls: i.e. tolls paid for use of the infrastructure, the receipts from which are used to finance certain fixed and variable infrastructure costs;

- "Demand management" tolls: i.e. tolls that are used to influence transport demand levels.

Both these types of toll and the way in which they operate can easily be simulated using the traditional models of economic theory. We should mention that in this case the scenario is the tolled intercity motorway where there is no alternative route available. Marginal cost pricing is applied for a peak period. This gives us two marginal cost curves illustrating the price that the user should pay in terms of the variation in traffic. The first curve represents the costs incurred by the operator for a one-unit change in traffic: these variable costs, shown in A(2) of Table 2, relate to supply. The second curve represents the social costs (congestion, accidents, noise, air pollution, etc.) of one additional unit of traffic. These are shown in B(3) of Table 2. As this is a very short-term scenario, the social costs are essentially congestion costs. The introduction of demand management charges would achieve equilibrium. Varying the demand management charge would internalise congestion-related costs accordingly.

Figure 2. **Types of tolls**



2.2.2.2. Results

Two sets of results were obtained, one for the impact on overall transport demand and another for impact on travel behaviour.

Impact on overall transport demand

The first important point to mention regarding the impact of toll variations on demand is that neither the modelling case studies (TRENEN) nor the empirical case studies (Eurotoll) showed any evidence of an impact on overall transport demand.

The TRENEN project, for example, demonstrated that the largest decrease in demand was produced by the "congestion pricing" scenario (CPT), with a reduction of 1.97 per cent in total forecast traffic compared with the reference scenario (RF). For the other scenarios, there was either no or very little decrease. None of the Eurotoll studies showed any change in overall demand.

This finding is important as it shows that changes in charges have no adverse affect on overall mobility, as a corollary of business and social activity, but that the impacts are of a more "behavioural" order.

Impact on travel behaviour

The results for the impact of toll variation on demand, which are presented below, relate only to French motorways, for the sake of uniformity (these are results for actual trials). The toll variation trials in every case were conducted at peak periods for the scenarios outlined above (i.e. congested roads). Specifically, they were for holiday departures or weekend and Sunday return trips, the only periods when French motorways are congested. The detailed results are given in the relevant Eurotoll reports (see Bibliography).

The toll variation trials were all undertaken for the purposes of demand management strategies. Table 4 gives brief details of the case studies (status, objectives set before changes in tolls were introduced, measures taken).

Table 4. **Selected Eurotoll case studies**

Case study	Status	Objectives set before changes in tolls introduced	Measures
A1	**In operation since 1992**	• Reduction of congestion on A1 motorway	• Differentiated toll charges at peak/off peak times for weekend returns to Paris • Information + PMV
A10/A11	**In operation since 1996**	• Reduction of congestion by "smoothing" peak times	• Differentiated toll charges at peak/off peak times for weekend returns to Paris • Information + PMV
A5/A6	**In operation from 1995 to 1997**	• Reduction of congestion on A6, transfer traffic from A6 to A5	• Different tolls depending on route (seasonal variation) • Information campaign on A7 (seasonal)
A7/A75	**In operation**	• To attract users to the A 75, a toll-free motorway, and thereby reduce congestion on A7.	• Different toll charges (permanent) • Information campaign on A7 (seasonal)

Table 5 shows the impact of varying toll charges on travel behaviour.

Table 5. **Summary of impacts identified by Eurotunnel case studies**

Case study	Expected impact	Confirmed?	Comments
A1	Change in departure time Change of route Journey not made	YES NO NO	Reduction in traffic at peak times: -4.4 per cent in the autumn
A10/A11	Change in departure time Change of route Journey not made	YES YES NO	Demand spread: -12 per cent compared with peak time Negligible: 0.5 per cent of traffic transferred to national road per weekend
A5/A6	Change in departure time Change of route Journey not made	YES YES NO	Decrease in number of peak periods 15-20 per cent of users who could transfer used the A6 (4-5 per cent with no demand management strategy)
A7/A75	Change of route Change in departure time	YES YES	Total who could change route: 25 per cent switched to A75 at peak times in summer. During week outside of summer period, total increased from 25 per cent (1993) to 37 per cent (1997) for light vehicles. Change in departure time: between 12.7 per cent and 20.8 per cent of users in 1998 (9 to 17 per cent in 1997)

The above findings show that, in the short term, tolls can in fact have a substantial impact on user behaviour, but in all of these cases variable tolling was accompanied by information campaigns. The strategies carried out mainly helped to reduce congestion, which had been the original goal. A reduction in levels of traffic of a few thousand vehicles at peak hours, which may seem minimal in percentage terms, can very significantly reduce congestion (marginal approach).

In addition, the main undesirable impact, which is the use of an alternative route, is minimal. In actual fact, studies conducted in Austria (A12/13) have shown that a "rebound" effect can operate: very short-term behaviour can change again in the short term. Users who leave the motorway because of tolls, come back quite quickly to it because congestion builds rapidly on the alternative route. Other adverse effects, which were highly exaggerated in the press (waiting at tolls to go through during the "green period", for example) were very short-lived and only ever a minor phenomenon.

The partners[10] in the Eurotoll Project endeavoured to summarise the conclusions of all thirteen case studies, and ranked the impact of tolls on user behaviour ordinally as follows.

- If the charging scheme so allows, the main responses are a change in departure time or a change of route (provided that there is no congestion on the alternative route. This is very much the case for urban areas).

- As regards changes in departure time, charging schemes with a time-related component (green periods/red periods) are successful in modifying behaviours (A1, A10/11). For example, in the case of the A1 motorway, an increase of over 13 per cent in traffic was observed when charges were lowered by 25 per cent in off-peak periods[11]. This resulted in better traffic conditions at peak times. How successful they are depends, of course, on whether change is feasible (length of peak periods).

- Although it is related to choice of route, the impact of demand management strategies on infrastructure usage capacity was also effective. For instance, in the case of the A5/A6 motorways, an increase of 13 per cent in toll charges on the "highly congested" A6, and a reduction of 53 per cent on the new A5 motorway resulted in 15 to 20 per cent of users who were able to choose another route switching to the A5. However, it should be kept in mind that where there are several itineraries of which one corresponds to a route of inferior quality, there may be switches to that route, but of short duration (cf. the case of the A12/A13 in Austria).

- As the main focus of the Eurotoll project was on the short term, the case studies did not find any evidence of a change in destination. Conclusions have been drawn for urban areas (the Stuttgart, Leicester and Florence case studies) but are not reported here.

- The significance of one behavioural "model" relative to other models can vary over time. In the middle to long term, user responses become more efficient, more significant than over a short period.

- With regard to modal choice problems, few changes in behaviour were observed. This was true for both intercity and urban case studies: the PETS project (the case study of the Nordic intercity triangle) and the TRANSPRICE (urban) project came to the same conclusions.

It is interesting to note that the general remarks above have been confirmed by studies conducted in the Netherlands on the implementation of electronic charging systems[12]. These showed that charges could reduce traffic at peak times by 10 to 15 per cent and that around two-thirds of road users would opt to change their departure times. They are also expected to reduce congestion by up to 40 per cent.

However, the Netherlands' studies point out that tolls alone will not solve the problem of congestion. It is not enough to introduce tolls or vary them to get road users to "play the game". Accompanying measures must also be implemented.

2.3. Acceptance of toll-based demand management strategies

There are numerous difficulties in implementing toll-based demand management strategies (the image of the operator, opposition, prohibitive set-up costs, practical problems of deciding on time bands, etc.) and numerous problems in gaining user acceptance of such measures. In fact, a change in behaviour will occur only if there is a reason and if change is feasible. Therefore, this report does not address the problem of public acceptance (public acceptance of such measures, mainly relevant for urban areas, is currently being studied in the PATS and PRIMA European research projects).

2.3.1. Basic implementation principles for ensuring success

Two important principles should be pointed out. These are the need for:

1. Thorough familiarity with: the levels and characteristics of demand (for different time bands, the type of information systems, in-car or other, to be developed); targeted road users, the appropriate marketing approach; the systems technologies to be used, etc.

2. The definition of "compensatory measures". If the aim is to provide for variable toll levels, so that road users respond, clearly operators' revenues are going to increase to the detriment of the remaining users. To avoid or alleviate the social loss, alternatives must be provided. These may be alternative routes (especially in urban areas) or alternative travel times (different prices for cheaper "green" periods and more expensive "red" periods). Whatever the case, individual travel should not and must not be curbed.

2.3.2. Acceptance factors

Without going into too much detail on this point, it should be said that acceptance depends on a number of factors. The intended *objectives* should be clearly stated and communicated to users (why is this type of operation being organised?), as should the *fairness* of measures (what compensatory measures are there?) and trip *characteristics* themselves should also be taken into consideration, as resistance can vary and it is important to identify the end "*payer*" (company, direct user, etc.).

Let us consider for a moment the problem of awareness: are the people who will be affected by the operation aware of what is going to happen? It is important to pave the way for the measures so that they will be understood and accepted. In the case of the strategies used on the A1 and A10-11, only 21 to 27 per cent of users did not know about the measures. It can be seen from this example that information plays a vital role in the acceptance of variable tolls. What can seem obvious when reading about information problems is not necessarily so in practice, as some recent cases in urban areas have demonstrated.

2.3.3. Marketing aspects

Marketing aspects are extremely important. Any impact that tolls are expected to have on demand will be effective only if there is a thorough understanding of the factors referred to above and the right marketing approach is taken. This approach must take account of the fact that:

- the charging scheme must be comprehensive;
- the charging scheme must be linked with the measures taken and must benefit the user;
- the effects in terms of trip time and ease of travel must be stressed as users are not always aware of them;
- light and heavy goods vehicles are two different marketing targets;
- only the "policy" objectives that will have an impact on users' understanding should be selected;
- external support (consumer associations, etc.) is crucial to the success of the operation.

3. VARIABLE TOLLS AND THE CONCEPTUAL CHARGING FRAMEWORK

The aim of this paper was to attempt to assess the short-term impacts of variable tolls. It took the theme of the Round Table, intercity tolls, as its basis. Other similar approaches have been implemented through public transport pricing in urban areas, while differential charging and the experience gained from it has been widely applied, particularly by our German and Swiss neighbours.

Tolls are one option for charging for the use of road infrastructure in the framework already outlined. The advantage is the "flexibility" that tolls offer.

While we know what impact variable tolls have in the short term, we know far less about their long-term impact.

For the short term, we can assess how users respond and can identify "trends" without being too far wrong. Changes in departure times and routes (according to the case studies) are the main reactions, without any decrease in overall mobility. There are no changes in mode of transport and destination (in the cases studied). The corollary of these impacts is a reduction in congestion.

In addition, the factors to be taken into account in setting up such operations are well known, as are the limitations to be taken into consideration. Indeed, as stated in the conclusions of one of the Eurotoll projects, "*It appears that at least three conditions govern the acceptability of a tolling scheme. These are: an improvement in travel conditions for those who use the tolled facility and pay; the availability of acceptable alternatives for those who shift (mode, time, route); supply of compensations for those who accept to postpone their travel.*"

On the input side, the demand elasticities of tolls have been calculated, but data are scarce and give only vague indications, which are valuable only in relative terms (they are higher than demand elasticities for variations in fuel taxes). Furthermore, toll-based strategies can be said to improve socioeconomic welfare much more substantially than implementing other available pricing options.

In conclusion, it is important to keep in mind that the strategies described in this paper are inseparable from the conceptual charging framework of which the tolling scheme is part; that framework has been improved by the addition of a new component that fills a gap that vignette-type user charging schemes cannot. In terms of charging policy, this means that marginal social costs and toll-based pricing strategies – time and space differentiated charges – have a common basis. This is also the conclusion reached by the Eurotoll study. The detailed implications of this conclusion are given in the summary report of that project.

Table 6. **Charging objectives and options**

Options / Objectives	General taxes	Vehicle taxes	Fuel taxes	User charges
Infrastructure finance				
Network operation and maintenance				
Internalisation of external costs				
Demand management				Variable tolls

NOTES

1. And to the characteristics of the vehicle (size, number of axles).

2. Switzerland is not an EU Member State and will implement a system of tolls under the EU-Swiss Agreement, which is to enter into force in 2001, if ratified by the national parliaments before mid-July 2000 and if passed by referendum. The *Redevance Poids Lourds Proportionnelle* (RPLP, a weight-proportionate charge for heavy goods vehicles, is the cornerstone of Swiss transport policy. It will raise the bulk (over half) of all funding for transport policy projects (including the Lötschberg and Saint Gotthard piggyback links) and will be introduced when Switzerland opens its borders to 34 tonne HGVs (in 2001). The weight-proportionate charge will be levied on all vehicles of over 3.5 tonnes on all Swiss routes. It will raise SF 1.5 billion per year (i.e. SF 30 billion, in all, over 20 years, of which two-thirds is to go to the *canton*s and the remainder to the Federal Government. Seventy-five per cent of the revenues raised by the RPLP will come from Swiss hauliers (domestic and export traffic) and 25 per cent from foreign hauliers (transit and import traffic). The cost of transiting through Switzerland will be roughly SF 325 (Basel-Chiasso). The RPLP will be payable at the maximum rate when the first tunnel opens, i.e. in 2007 (weighted average of 2.75 centimes per t-km). It will vary with maximum authorised weight and pollutant emissions: rate 0.6 to 3 centimes per t-km and one-third of these revenues will go to the *cantons* in order to internalise the external effects of transport.

3. This principle is not permitted in Directive 99/62. At the very most, Member States can vary the rates at which tolls are charged according to vehicle emission classes (Euro classes) or time of day [Article 7, paragraphs 10 (a) and 10 (b)].

4. The marginal social cost is the cost of the last unit "produced" (the costs of one additional vehicle, for example).

5. As in the new *Eurovignette* proposals, the EU is proposing an environmental classification for HGVs in order to better reflect the true costs of vehicle use.

6. The term "road pricing" covers all types of charges for the use of urban roads: cordon, corridor, congestion, distance-based and time-based pricing.

7. Internal to the transport sector.

8. Fixed external costs are not considered here (severance effects, deterioration of the countryside, visual intrusion) nor are the external benefits that might offset these costs (accessibility improvements, productivity gains, etc.). Little information is available on these issues.

9. Rough estimates based on French figures.

10. ISIS, ASFA, LET, SETRA, Cologne University, Patras University, ATAF, Autostrade, Buro Herry, HB, Autostrade, TRL, H. Humphreys.

11. These figures cannot be used to calculate elasticities, only marginal variation coefficients.

12. See http://www.minvenw.nl/rekeningrijden

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PRICING INTERCITY ROAD TRANSPORT: EXPERIENCES IN THE NETHERLANDS

SUMMARY

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ABSTRACT

Externalities of transport not only depend on the number of kilometres driven, but also on factors such as road type, time of day, car type and on driving behaviour such as speed and acceleration.

The present pricing system of car use and ownership in the Netherlands is such that the degree of differentiation is small, except for the car type aspect. Thus there is a clear mismatch between the differentiation in external costs and in pricing. A considerable share (55 per cent) of all car-related taxes in the Netherlands relates to car ownership. The rest (45 per cent) is paid for car use. The structure of the tax system is only vaguely related to the differentiation in the external effects. The tax system is not very helpful, especially for the most rapidly developing problem of congestion.

The marginal external costs of road use in the Netherlands are estimated to be relatively high in urban areas. In intercity transport they are somewhat lower, because noise nuisance and accidents are less of a problem in lower density areas. Congestion is certainly not negligible in intercity transport in the Netherlands: its polycentric structure, with many cities at relatively short distances, means that intercity traffic is often mixed with transport within metropolitan areas so that congestion is also important here.

Variabilisation has been a main objective during the past twenty years or so in the Netherlands. For intercity road transport, potential tools are fuel taxes, congestion pricing or a kilometre charge. The potential of the fuel tax is limited in this respect as long as neighbouring countries have lower fuel prices. Spatial differentiation of fuel taxes within the country to solve the border problem has large negative side effects. Congestion pricing has been on the political agenda for over 10 years, but it was not easy to mobilise social and political support up to now. A kilometre charge has been proposed recently as an alternative measure, but its merits depend strongly on the question of how differentiated it can be. A flat charge will probably be rather ineffective in alleviating the external effects of road transport.

The treatment of transport costs as a deductible in the income tax leads to major distortions: a low variable cost for commuting, a zero variable cost for the company car and a negative cost in the case of private car use for business purposes. The conclusion is that discussions on fair and efficient pricing should not only address the issues concerning the differentiation in the present taxes on car ownership and car use, but also the removal of distortions caused by the structure of the income tax.

Tolling has been a rather unimportant part of infrastructure pricing and financing policies in the Netherlands during the last fifty years. The number of tolled links was small and mainly of a rather local nature. More recently, the increasing congestion on the highways has stimulated the political debate so that in the present situation the interest in tolling is increasing.

Social acceptance of pricing measures is relatively low: a main reason being that the perceived effectiveness of pricing measures to reduce congestion is low compared with measures to increase the quality of other transport modes (see Table 11). This leads to overly optimistic views on the effectiveness of pull measures (better transport alternatives) and to negative views on the effectiveness of push measures (higher costs of car use).

Social acceptance of pricing measures strongly depends on the way the receipts are used. From surveys, it appears that where the receipts are used for road investment, the acceptance is much higher compared with uses such as a general reduction of taxes. This is also confirmed by the way the negotiation processes between national and local governments take place.

1. INTRODUCTION

Pricing mobility is a subject high on the political agenda of many countries (see, for example EU, 1998; CE, 1999). The issue bears upon such topics as the appropriate level of fuel prices, the imposition of tolls and congestion charges and the size of the subsidies to public transport. The strong involvement of governments in these pricing issues is caused by the need to correct for externalities of transport (such as pollution, noise, congestion, accidents) and by the role of governments as (co-)providers of infrastructure, which leads to the need for securing finance. An additional consideration of government concerns the social equity aspects of transport and infrastructure.

In the present paper we give a review of pricing issues in the Netherlands. After a general discussion we will focus on one particular aspect, i.e. the pricing of *interregional road transport*.

A short review of pricing principles is given in Chapter 2. In Chapter 3 we provide a brief account of recent developments in mobility in the Netherlands. This chapter also contains a comparison of current pricing procedures with the pricing principles in Chapter 2.

Chapter 4 contains recent estimates for the Netherlands of the marginal external costs of road transport and the costs related to infrastructure use. In Chapter 5 a review is given of the Dutch experience with the introduction of road pricing. Chapter 6 contains a discussion of recent proposals to introduce a kilometre charge in the Netherlands. Chapter 7 discusses fuel price policies as a baseline alternative. Pricing distortions related to the fiscal treatment of company cars and commuting are discussed in Chapter 8. The social acceptance of various pricing alternatives is treated in Chapter 9. Chapter 10 concludes.

2. PRINCIPLES FOR PRICING TRANSPORT

Several principles are used in the discussions on the pricing of transport:

- Efficiency;
- Equity 1: balance between what people get and what they pay;
- Equity 2: balance between what people need and what they can afford.

The *efficiency principle* states that the optimal level of transport is achieved when the marginal cost of an extra kilometre of transport is equal to the marginal benefit. Since the marginal benefits of transport tend to decrease with the distance travelled and marginal costs are constant or increasing, there will be a point where marginal costs and benefits converge. A reason for concern is that, due to the external costs mentioned above, travellers are not incurred with the appropriate level of costs: for example, they tend to ignore noise problems produced by the aircraft in which they travel. This situation leads to overconsumption; a charge for the externality to correct for this would increase the marginal costs as experienced by the traveller, implying a decrease in the distance travelled.

The *equity 1* principle stipulates that there should be a balance between what people pay and what they receive. This principle is often used for road transport. There is a general feeling in many countries that road users pay more than they get in terms of quality of infrastructure available to them, but for public transport services the reverse often holds: the existence of subsidies implies that public transport users get more than they pay.

The *equity 2* principle is used for specific groups, such as handicapped persons, elderly people and persons living in isolated areas (peripheral rural areas, islands, etc.). The discussion in this context is on the extent to which the public sector has a task to correct for the gap between transport needs and the costs of producing the services and, if such a task has indeed been identified, how to reduce this gap. The problem can be resolved by a lump-sum income transfer, a dedicated transfer of income (e.g. via vouchers used for transport), subsidies on transport activities conducted by the private sector or the organisation of transport by the public sector itself. The reasons for the large gap between what persons in these groups can afford to pay and what the transport services cost emerge from two entirely different sources. The first factor is that the income of the groups in question is usually low (most handicapped people depend on social welfare payments; isolated areas may well have low average income levels). The second factor pertains to the costs of providing the services: elderly and handicapped persons may need specially adapted carriages and services with high costs. People living in isolated areas encounter high costs because of the lack of opportunities to exploit economies of scale.

We will not enter into discussion of the third pricing principle here because it obviously refers to rather specific market segments. Insofar as the first two principles are concerned, it is important that the efficiency principle is strongly connected to the notion of *marginal costs*, whereas the equity 1 concept corresponds to *average costs*. Another difference between the two principles is that efficiency considers all costs, whereas equity 1 usually focuses on the position of the public sector in the distribution of monetary flows into and out of the public budget.

The importance of the notion of marginal costs of transport can be illustrated by comparing them with the well-known lists of the total costs of transport (see Quinet, 1994). For example, the total costs of transport can be estimated by including figures concerning accidents, various types of pollution, congestion, etc. In particular, the costs related to accidents may appear rather high in many cases; the problem with such figures is usually that they ignore the difference between average and marginal costs and that they are not explicit on the question of to what extent they are external. The first point (marginal versus average) is especially clear if we consider the costs of delays due to congestion. The very nature of congestion implies that the marginal costs may be much higher than the average costs (see also Small, 1992 and CE, 1999). Within the category of accidents there may also be a substantial gap between average and marginal costs. An extra car-km may lead to more congestion and hence to lower speeds, thus implying lower risks (cf. Blauwens *et al.*, 1995; Persson and Odegaard, 1995; Shefer and Rietveld, 1997). The second point is that the failure to distinguish between external and internal costs may lead to a distorted view. For example, it is estimated that most of the accident costs of transport in the Netherlands apply to costs of damage and costs of health care, which are already paid by the causal agent of the accidents (SER, 1999). These costs are, of course, still important as determinants of transport volumes but they do not deserve special attention in transport pricing policies.

3. ROAD TRANSPORT IN THE NETHERLANDS

3.1. General

Before discussing pricing issues in the Netherlands, we give a concise presentation of developments in road transport (see Table 1). During the period between 1986 and 1997, car transport increased by about 29 per cent. During the same period, the number of casualties and emissions of NO_x decreased, implying a case of both absolute and relative decoupling. The progress in NO_x emissions has been the result of the gradual introduction of catalytic converters. One observes an example of relative decoupling for CO_2 emissions where they grow slightly slower than transport volumes. This outcome is the result of two countervailing forces: a gradual improvement of energy efficiency of cars combined with a gradual increase of the average weight of cars, due to higher consumer demand for comfort and safety. A clear outlyer is the rapid development of travel time losses on expressways; an increase in total travel volumes of 29 per cent leads to an increase of travel time losses of no less than 73 per cent. This underscores the non-proportionality between travel volumes and travel time losses and implies that an increase of travel volumes of 1 per cent leads to an increase of travel time losses of about 2.2 per cent.

Given the rapid increase of travel time losses on expressways it is no surprise that policies to reduce congestion on these roads are high on the political agenda. The two basic solutions (more roads or less demand via congestion pricing) both lead to the issue of tolling traffic on expressways, either as a means to mobilise financial resources or as a means to curb demand.

Table 1. **Developments in road transport in the Netherlands (1986-97)**

	Index 1997 (1986=100)	Decoupling absolute	Decoupling relative
Travel time losses on expressways	173	no	no
CO_2	125	no	yes
NO_x	61	yes	yes
Casualties	76	yes	yes
Passenger car km	129		

Source: CBS, AVV.

Table 1 emphasizes that in particular cases (NO_x) technology can be quite instrumental in helping to solve transport related problems. However, in the case of CO_2 technology, effects have been offset by other developments for the problem of congestion. Technology can also offer some solutions in the form of various telematics applications in order to improve the level of information on present or expected congestion (cf. Emmerink, 1998). Technological progress will not occur automatically, however. Consistent price signals to the developers of vehicles and the consumers will accelerate the introduction and adoption of new technologies.

3.2. Tolls on intercity road transport infrastructure in the Netherlands

In the nineteenth century, tolls on roads were quite a common phenomenon in the Netherlands. The importance of these tolls was mainly only local, since long-distance transport was dominated by railroads. In the twentieth century, these local toll roads gradually disappeared. Tolls were not a major instrument to finance road construction projects. Finance took place via an ownership tax levied on car drivers irrespective of what roads they used. After World War II, some road projects were realised by means of tolls. The largest example was the so-called “Zeeland bridge”, a 15-km long bridge realised in the 1960s and linking parts of the province of Zeeland with the rest of the country. Toll collection stopped in the 1980s when enough money had been received to cover total costs of interest and instalments. There were two other examples of tolled water crossings.

The Prins Willem Alexander (PWA) bridge, crossing the Waal river near Tiel, had a toll for about twenty years. Tolling stopped in 1995. The toll was imposed to finance the bridge. The charge amounted to Euro 1.60. After the abolishment of the toll, bridge crossing car traffic increased by about 68 per cent, the main reason being a change in route choice (see MVW, 1996 and Van der Vlist *et al.*, 1998).

A tunnel near the city of Dordrecht, created in the 1960s, is still being tolled. Just like the PWA bridge mentioned above, it is a water crossing of rather local importance. The level of charges to be paid is similar to that of the PWA bridge. A main consequence of the toll is that car drivers are affected in their route choice. They make detours of about 5-10 km to avoid payment of the toll (see BGC, 1991 and Van der Vlist *et al.*, 1998).

More recent toll initiatives in the Netherlands have been made in two directions. The first concerns the imposition of a toll in the Wijkertunnel. This water crossing is an important expressway link, about 25 km west of Amsterdam, where congestion is problematic. The tunnel was built by the public sector with a private sector loan. The outcome of negotiations between the public and private sectors is that the banks involved will be paid by means of a “shadow toll”. This means that the Government will pay a certain amount of money per car using the tunnel. However, car drivers will not be charged, so that they will not notice the toll.

Another more recent toll initiative concerns the proposed introduction of a congestion charge on cordons around a number of large cities in the western part of the country. These proposals will be discussed in more detail in Chapter 5.

Our conclusion is that tolling has been a rather unimportant part of infrastructure pricing and financing policies in the Netherlands during the last fifty years. The number of tolled links was small and mainly of a rather local nature. More recently, the increasing congestion on the highways has stimulated the political debate so that in the present situation the interest in tolling is increasing.

3.3. Charging drivers in accordance with the external costs

In Table 2 we compare some external effects of transport with a number of features of drivers, vehicles and infrastructure. That the levels of the external effects usually depend on each of these factors is noteworthy.

For example, noise nuisance imposed on citizens in the area depends on the number of kilometres driven, road type (location of nearby dwellings), car type, time of day (during the night, nuisance may be higher) and driving habits, such as speed and acceleration behaviour. A similar result is found for most of the other external effects of transport. This table leads us to an obvious conclusion: it is not meaningful to speak of one uniform level of external costs of car transport, because the actual level may vary strongly according to a large number of situational circumstances.

Table 2. **Determinants of the external costs of transport**

	Number of kms driven	**Road type**	**Car type (technology)**	**Time of day**	**Driving habits**
Noise	x	x	x	x	x
Accidents	x	x	x	x	x
Pollution	x	x	x	x	x
Congestion	x	x		x	

It is interesting to compare this result with the actual pricing of mobility in the Netherlands. In Table 3 we compare the Netherlands with two other countries (Switzerland and Japan) and observe a substantial part of total tax payments allotted: they are paid once when a new car is purchased and regularly thereafter by the car owner, but these payments do not depend on actual vehicle use.

Table 3. **Taxation of car transport in various countries according to source (%), 1997**

	New vehicles	Vehicle ownership	Vehicle use (fuel)
The Netherlands	31	24	45
Switzerland	10	19	67
Japan	11	18	71

Source: NVWB.

When we draw a parallel between the Dutch situation of taxation and the various factors outlined in Table 2, we see that fewer than half of the total tax receipts correspond to the use of cars. A strong differentiation takes place with regard to the fuel inputs: taxes on diesel and LPG are relatively low per litre, while the taxes on owning cars that use these fuels are relatively high. Taxes also vary according to car type: owners of heavy cars pay higher taxes. No differentiation takes place according to type of road (as indicated in section 3.2., toll roads are almost non-existent in the Netherlands), time of day (no use of congestion pricing) or according to the driver's characteristics (there may be some differentiation in insurance premiums, but this is handled by the insurance companies, not the public sector).

We conclude that the present structure of Dutch car taxes is mainly aiming at influencing the choice of car technology and much less at the actual intensity of car use. The structure of the tax system in the Netherlands is only vaguely related to the differentiation in the external effects. For the most rapidly developing problem of congestion (see Table 1) in particular, the tax system is not very helpful. Part of the problem is that the fixed part in the total taxes is rather low. This has led to the issue of variabilisation of transport taxes, as discussed in the next section.

3.4. Variabilisation of transport charges

Variabilisation is a budgetary neutral shift of fixed to variable taxes. Budgetary neutrality means that the total tax receipts remain constant. In the case of inelastic demand for transport, this concept can be applied in a straightforward way, since when the volume of transport is given, one can easily compute the consequences of a reduction in the fixed costs for the increase in variable costs. However, when demand is elastic (and when elasticity for variable costs is higher than for fixed costs), such an increase in variable costs would lead to a decrease in transport volumes. Thus, in order to keep the total tax receipts constant, the increase in variable costs should be larger with elastic demand compared with the case of inelastic demand.

Budgetary neutral tax reforms are expected to be better received in the political arena compared with a simple increase in taxes. Budgetary neutrality is a simple example of a policy package approach with a mixture of attractive and unattractive elements. There is clear evidence that in the field of road transport drivers prefer schemes of variabilisation where the additional receipts flow back to the group paying the money, compared to schemes where the additional receipts are used for purposes where other people may also benefit. Examples of the latter are a general reduction of income tax or investment in public transport infrastructure (Verhoef *et al.*, 1997). The obvious result of variabilisation is that travellers who travel long distances per year are confronted with higher costs. Travellers with distances below the break-even point would benefit from budgetary neutral tax reforms.

A few obvious candidates for variabilisation that have received attention in the Netherlands are an increase in:

- Congestion pricing and tolls;
- Km charge;
- Fuel tax;
- Parking;
- Tradable permits;
- Trip charge.

In Chapters 5-8 these variabilisation alternatives will be discussed in greater detail. First, however, we will give some information on the marginal social costs of car use in the Netherlands.

4. THE MARGINAL COSTS OF ROAD USE IN THE NETHERLANDS

A recent study (CE, 1999) estimated the marginal external costs for several transport modes. The cost categories distinguished were safety, noise and emissions. In addition, the costs of congestion and infrastructure use were estimated. Here, a variable part is distinguished (operations and maintenance) plus a fixed part (the annual capital expenditure costs associated with infrastructure investment). It is not so easy to take into account the latter category of costs: in the short run, the marginal construction-related costs of infrastructure are zero. Therefore the latter part is treated as an average cost component by dividing the total cost of construction by the number of vehicle-kms. Some results on non-local road use are shown in Table 4 for various types of modes in the field of passenger cars, buses and trucks.

Table 4 gives an impression of the marginal costs and the charges for non-local road use for various transport modes. A first observation is that for public transport (buses) subsidies play an overwhelming role: they are many times larger than the other cost components mentioned in the table. Leaving aside public transport, we observe that the marginal costs per vehicle-km are higher than the corresponding marginal charge for private passenger transport and for freight transport. For petrol-driven cars, the gap between variable charges and variable taxes is rather small. For the other vehicle types the difference is much larger, however. For freight transport, in particular, the gap is considerable. Another observation is that the average charge (based on vehicle ownership) is relatively high in the Netherlands. This holds true in particular for passenger cars using diesel and petrol. Owners of these cars face very high fixed costs and relatively low variable costs per km. Note that these figures are consistent with the discussion in Chapter 3.

When we take into account both the marginal costs per vehicle-km and the average costs related to the fixed costs of infrastructure provision, we find that in most cases the vehicles are charged less than the costs involved. The exceptions are public transport and the petrol car. The latter exception is an important one, however, because the petrol car is the most frequently used car type (about 82 per cent of all cars and 67 per cent of all car-kms).

Table 4. **Marginal and average social costs/charges of non-local road transport in the Netherlands in Eurocents per vehicle-km**

Transport mode	(2) Marginal costs	(3) Marginal + average costs	(4) Marginal charge	(5) Marginal + average charge	(6) (2)-(4)	(7) (3)-(5)
Passenger cars:						
-petrol	4.7	6.5	4.2	10.2	0.5	-3.7
-diesel	4.9	6.8	1.7	6.8	3.2	0.0
-LPG	4.6	6.4	0.2	4.6	4.4	1.9
Public transport bus:						
-diesel	23.0	26.0	- 187.0	- 186.0	209.0	212.0
-LPG	17.0	21.0	- 194.0	- 194.0	211.0	215.0
Freight transport (diesel):						
-vans	6.1	7.9	2.9	6.0	3.2	1.9
-medium	10.0	14.0	3.9	4.9	6.6	9.2
-large	18.0	24.0	9.1	11.3	8.9	13.0

Notes:

- Does not include congestion costs and costs of travel time.
- Does not include private costs of car ownership (insurance, interest, instalment) and fuel costs (only fuel taxes are included).
- Average costs computed as annual capital costs of infrastructure construction divided by total volume of vehicle-kms.
- Car technology based on Euro-1 emission norms.

Source: CE (1999).

In Annex 1 we present the underlying figures of the marginal and average costs per transport mode. According to these figures, the noise-related costs of transport are relatively low. Marginal safety costs and emission costs are considerably higher. This annex also contains a table with the marginal costs of *local* transport. A general conclusion is that the marginal external costs of local transport are considerably higher than those of non-local transport. This would call for a differentiation in charges as outlined in Table 2.

The figures above do not yet reflect the marginal costs of congestion. Congestion takes place both within cities and between cities. In the Netherlands the major points of congestion can be found on expressways at a certain distance from large cities. Therefore congestion costs are certainly important for our study of pricing interurban roads. CE (1999) estimates that marginal congestion costs may fall in a range of 0.2 to 2.0 Euro per km for passenger cars. For buses and trucks they would be a multiple of these figures given the higher capacity claims of these vehicles. In a study for Belgium, Mayeres *et al.* (1996) and De Borger and Proost (1997) find marginal congestion costs that may be as high as 3.0 Euro per vehicle-km in the case of buses and 1.50 Euro in the case of cars (see Table 5).

Table 5. **Marginal external costs of congestion during peak period (Belgium, estimated for 2005 in Euro per km)**

Transport mode	Urban	Interregional
Passenger car	1.50	0.83
Public transport (bus)	2.95	-
Truck	-	1.66

Sources: Mayeres *et al.* (1996); De Borger and Proost (1997).

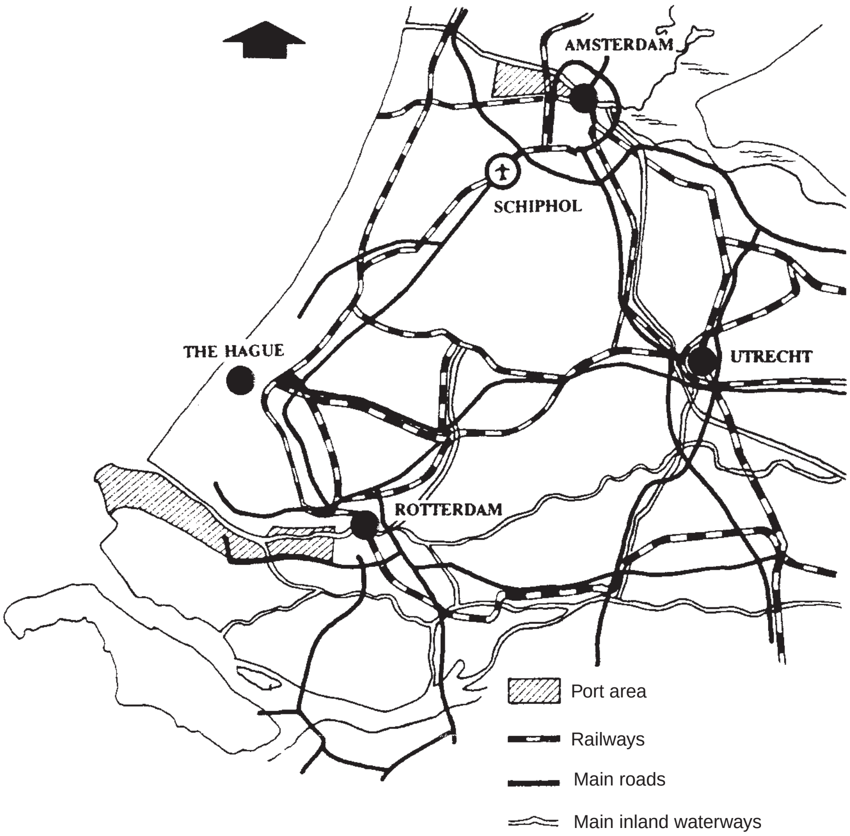
When we compare the order of magnitude of this table with those in the preceding tables, we note that the marginal congestion costs can be much higher than the other external costs distinguished above. We conclude that, in addition to the differentiation according to the location of transport (local versus non-local), the differentiation per time period would be an important dimension of road transport pricing.

5. CONGESTION PRICING ON EXPRESSWAYS

As already indicated in Chapter 3, congestion has increased rapidly during the past decades in the Netherlands. In this paper we will only address recurrent congestion. Non-recurrent congestion, caused by traffic accidents, maintenance and other non-structural factors, is estimated to account for about 30 per cent of total traffic time losses; it is of limited importance for the discussion on tolling road transport. Recurrent congestion is concentrated in the western part of the country, where the four major cities (Amsterdam, Rotterdam, The Hague, Utrecht) are located. These metropolitan areas have populations ranging between 500 000 and 1 000 000 persons. Among the twenty most severe congestion points in 1998, 90 per cent are within a distance of 25 kms of each of the city centres involved. A good number of congestion points coincide with bridges and tunnels where the expressways cross waterways. Other points of congestion are found at expressway junctions.

An important feature of the Dutch urban system is its polycentric nature. Within the western part of the country there are five other medium-sized cities of about 100 000 inhabitants in addition to the four large cities mentioned above. This leads to a complex pattern of transport flows with high mixtures of urban and interurban components (see Figure 1). Many of the points where congestion takes place do not only concern interurban flows but also have an impact on flows between the large cities and the European hinterland (especially the large cities in Belgium and Nordrhein-Westfalia).

Figure 1. **Map of the western part of the Netherlands**



The precision of the estimates of total travel time losses is surprisingly low. The best estimate available is that the total time loss in 1997 is about 4 per cent of the total travel time of car drivers in the Netherlands. Most car drivers are not confronted with congestion in their daily travel pattern. The share of commuters that have to pass the major congestion points is estimated to be only about 5 per cent. The rest succeed in avoiding these bottlenecks, because they live in other parts of the country, they take other transport modes, travel at other times of day, commute short distances, etc. The conclusion is that the nuisance of congestion is distributed in a rather uneven way: the large majority of the population is not affected by it, but a small part is relatively strongly affected[1]. Given the value of time involved, the costs of expressway congestion in the Netherlands are estimated to be about Euros 800 million per year.

Given the high costs involved, road pricing has been high on the political agenda in the Netherlands for the past 15 years. Government proposals have assumed various forms, ranging from low-tech implementations, such as traditional payments of tolls, to high-tech electronic toll collection. Policy initiatives have come mainly from the Central Government and, given the polynuclear structure of the Dutch city system, it is no surprise that the proposals involve implementation in more than one city.

The first proposal, launched at the end of the 1980s, involved a fee to be paid in an electronic way for passing two cordons around the above-mentioned cities during peak hours. This proposal led to extensive debates on the technical feasibility of the system, the problem of rat-running (traffic diverted to the underlying road network in order to avoid the payment of fees) and the problem of privacy. The proposal met with heavy criticism and was replaced by a much more modest proposal in the form of conventional tolls. Meanwhile, on certain expressways new road capacity was built to create dedicated lanes for freight traffic, since this sector was considered to be most affected by the congestion problems. For a further review of this phase of congestion pricing, see Pol (1994).

A flaw with conventional tolls was that they would require the construction of large toll plazas, which would not be easy to construct, given the high population density of the regions. Therefore, in a subsequent stage, the Government formulated the idea of introducing a seasonal licence to pass the cordons, thus removing the problem of finding land for the toll plazas. A problem with this proposal was that its effectiveness was likely to be small: the large majority of regular users would simply regard the seasonal licence as another tax on car ownership, therefore implying that there would be little effect on its use. Once the licence was bought, it would not impact on the use of the car during peak hours.

A new government returned to the high-tech proposal in 1995; they anticipated the introduction of electronic tolls around the four major Dutch cities in the year 2001. Again a cordon system was proposed (with one or two cordons). The system was only envisioned for the morning peak hours between 7.00 and 9.00 a.m., with a flat fee of about US$2.50 for those who pay electronically and US$3.50 for those who pay otherwise. The proposed system resembles the ERP (Electronic Road Pricing scheme), implemented in Singapore in 1998. In order to be able to pay the low tariff, the car driver needs a transponder in his car which can charge an equivalent of US$2.50 to a smart card when the car passes the cordon during the morning peak. Equipment along the road is required to check whether the car indeed has a well-functioning transponder and a smart card with a sufficient amount of money. If the result is negative, cameras photograph the number plate of the passing car and, via a computerized system, bills of US$ 3.50 per crossing are sent to the car owner’s address.

A constant feature of the various proposals has been that cordons are fairly distant from city centres. In most cases, the proposed distance is about 7.5 to 20 km away from the centre. Given the fairly small size of the Dutch cities under consideration, this means that the toll points would all be located outside the cities. This scenario implies a spatial setting which is different from that of Singapore or the Norwegian toll rings, where the cordon is closer to the centre.

When the Government launched its 1995 road pricing proposal, they announced that receipts would be channelled back to the groups that paid the bill, designating a clear example of variabilisation. When a new government was formed in 1997, road pricing was still part of the government programme, but this time the receipts were proposed to be returned to the entire population via a general reduction of the income tax as part of a larger tax reform. In 1999, heated opposition against the road pricing proposals took place, initiated among others by the association of car drivers and the association of larger firms. The major complaints against the road pricing proposals in this case were that they would not work (because of a lack of travel alternatives, drivers were expected to be insensitive to the fee) and that costs for implementation, including transponders and equipment along the road, would be too high. The opposition compelled the Minister of Transport to adjust the plan: instead of a full-scale implementation around the four cities, she proposed that a test be carried out around only one city. At the time of writing, negotiations are taking place between the Ministry of Transport and the four large cities. In order to make road pricing more attractive for the large cities, the Ministry is offering various "extras" to the cities in the form of more (or the earlier availability of) money for large urban infrastructure projects (road or rail). At the time of writing, it is not yet known which of the four cities will volunteer. But it is clear that the policy to use part of the money for the city's transport problem has helped to arrive at a more co-operative attitude by the cities.

As part of the debate, opponents against the road pricing proposals formulated alternatives such as "pay lanes". Instead of the situation where all cars entering the city would pay a toll, the pay lane alternative stipulated that a toll would only have to be paid for using particular lanes. The other lanes would remain free, thus leaving a choice to car drivers as to whether they want to pay. One inadequacy with the pay lane alternative is that, if it were to be introduced at given levels of capacity, it would aggravate the level of congestion on the lanes where no charge is paid, because a shift may be expected from the pay lanes to the free lanes. A situation such as pay lanes can only be expected to operate smoothly if those who use pay lanes have values of time which are much higher compared to those who do not use the pay lane. Also, the pay lane approach may lead to the rat-running problem, whereby car drivers who encounter expressway congestion begin to use local roads.

A special case of toll roads is the A4 link between Rotterdam and Delft. The construction of this 6 km expressway link stopped after a conflict between the Minister of Transport and the Parliament, which did not want to spend money on the project. A private consortium would be interested in financing and building the project. In order to finance the project a toll would have to be imposed. An interesting aspect of the project would be that it runs parallel to another expressway where a congestion pricing charge is foreseen. The opportunities for the successful commercial exploitation of the new link would, of course, be better if, on the parallel link also, congestion pricing was introduced, otherwise many car drivers would simply choose the free public expressway. It is also clear that the opportunities for a successful exploitation of the new link would be better if the toll varied in time (higher during the peak period, when demand tends to be less elastic).

In those areas where new road capacity is planned, it is obviously easier to introduce "pay lanes". A problem may be, however, that where new capacity is available (for example, a second tunnel under a major waterway), there is, in the short run, excess capacity and low congestion levels, consequently leading to small traffic volumes in the pay lanes. But in the long run, however, with an autonomous increase in traffic, this option may become attractive. A general finding with capacity improvements is that congestion problems shift from one place in the network (a bottleneck such as a bridge or tunnel) to another place (a junction at the end of the link where the bottleneck was removed), cf. Rietveld and Bruinsma (1998). In this case, it would be better to impose a toll near the new bottleneck instead of at the location where the previous bottleneck existed.

The conclusion is that the large-scale introduction of road pricing in the Netherlands is uncertain in the short term. A possible alternative scenario is the gradual introduction of road pricing schemes as observed in the USA (see, for example, Small and Gomez Ibanez, 1998; and Richardson and Bae, 1998). The role of pricing as an instrument for alleviating congestion problems has been limited thus far, but it is expected to increase.

6. KILOMETRE CHARGE

Road pricing specifically addresses the congestion problem. The kilometre charge potentially has a broader orientation. It can be used in a general way to charge drivers for the use of the infrastructure. When differentiations are added according to time, place, type of road, type of vehicle, etc., it can in principle be used to address several other transport externalities mentioned above. One might argue that such a differentiated kilometre charge can be interpreted as a generalisation of road pricing. It can also be seen as a generalised version of tolling. The kilometre charge would enable one to avoid the construction of toll booths. Compared with the fuel tax to be discussed in Chapter 7, an attractive feature of the kilometre charge is that it is less sensitive to the border problem than a fuel tax would be.

The basic idea now under investigation in the Netherlands is that every car be supplied with an electronic device that counts the number of kilometres travelled. Car drivers regularly pay a tax, which is computed as the product of the number of kilometres travelled and the charge per kilometre.

In this simple form, the system can indeed help to reduce the fixed share in the total car tax so that it provides an example of variabilisation. However, its degree of differentiation will be minimal. It would not, for example, differentiate between cars according to their degree of fuel efficiency. If it were to be used simultaneously to replace fixed taxes, which do have a clear differentiation according to fuel efficiency (heavy cars pay higher taxes than light cars), it might have an adverse effect on the choice of car type. Therefore it is recommended to introduce a system where the charge per km is differentiated according to the type of car. To add still other differentiations to the kilometre charge would require more advanced technology. For example, if one considers all the dimensions mentioned in Table 2, a much more refined system needs to be introduced, implying the possibility of communication between the device in the car and devices outside it (for example, via a global positioning system). The latter devices would inform the in-car device of the level of charge to be applied, differentiated according to time of day, noise sensitivity in the road's vicinity, level of congestion, etc. Road pricing in this variant (see Chapter 5) would simply be one of the many aspects considered.

What are the expected consequences of the introduction of a kilometre charge? MuConsult has carried out an analysis of several alternatives (see Table 6). The last column of this table indicates the initial increase in the transport expenditure of an average household.

Table 6. **Policy alternatives for a km charge; initial effects on transport expenditures**

Policy alternative	**Content**	**Initial effect on total variable costs of an average household (Dfl per month)**
A	Moderate km charge, uniform (7 cents per km)	100*
B	High km charge, uniform (14 cents per km)	200
C	High km charge differentiated:	
	- 8 c/km for small cars	175*
	- 14 c/km for medium cars	205
	- 20 c/km for large cars	260
D	Large increase of fuel price	100

* The difference between Dfl 100 and Dfl 175 for an almost equal price level is caused by the fact that the effects have been measured at household level. Some households will have more cars with varying sizes implying that in the C alternative a household may also be confronted with price increases of various levels.

Source: MuConsult (1998).

In the analysis of the effects of the kilometre charge, it is assumed that car users receive a reduction of the fixed monthly car ownership tax that is equal to the amounts mentioned in Table 6. Thus, households get an incentive to reduce the total number of kms driven per period. The effects on car ownership cannot be predicted *a priori* since the decision to own one or more cars depends on both fixed and variable costs. A rearrangement of the price structure may lead to both a decrease and an increase in the number of cars owned. The analysis of MuConsult leads to the conclusion that the variabilisation tends to lead to a *decrease* in total car ownership[2]. The expected effects on kilometres driven are presented in Table 7.

Table 7. **Relative changes in number of km driven per car, as a consequence of a km charge (A-D represent the alternative charging mechanisms of Table 6)**

Travel motive	**A**	**B**	**C**	**D**
Commuting	- 4.9	- 18.6	- 16.7	- 4.3
Business	- 0.9	- 7.2	- 6.1	- 0.4
Social-recreational	- 7.9	- 23.1	- 19.9	- 8.0
Total	- 6.1	- 19.6	- 17.1	- 5.9

Source: MuConsult (1998).

The table shows that a non-linear effect is expected of price changes on travel behaviour. Doubling of the charge leads to a more than double effect on kms driven (B versus A). Among the three travel motives, business traffic is least sensitive to the km charge, whereas the social/recreational trips are most affected. Commuting takes an intermediate position. It is clear that the km charge as analysed here has substantial effects on the total number of kms driven. The effects of alternatives B and C are much higher than those of a large fuel price increase. One of the reasons for this high sensitivity is that, in the case of a fuel increase, an obvious response in the long run is that more fuel-efficient cars would be bought. This would obviously dampen the fuel price effect. A similar mechanism explains why alternative C has less consequences than alternative B: in the case of alternative C, households may buy a smaller car to avoid the high variable costs related to the use of large cars. Note that the degree of differentiation in alternative C is limited. It only concerns the weight of the car. Given the dimensions mentioned in Table 2, several other types of variation could have been considered.

What are the foreseen bottlenecks with a kilometre charge? A first point of attention has to do with the use of technology. The probability for a failure in the system should be very small and it should also be fraud-proof. Another sticking point is the border effects that arise in the event that other countries also adopt a km charge. About 10 per cent of the mileage of Dutch cars takes place in foreign countries and is driven during holiday trips. There is no immediate reason for the devices to be deactivated while the cars are abroad. But one has to consider the case of foreign cars used in the Netherlands and in particular, the possibility that people introduce cars with foreign number plates in the Netherlands (about 1 per cent of all cars in the Netherlands have a foreign number plate). There is little reason to bother about incidental foreigners visiting the Netherlands. The case of Dutch residents using foreign number plates is a more serious threat to the system, but that is not very different from the present situation. Another theoretical possibility is that Dutch residents would move to one of the neighbouring countries. Due to the differences in income tax, in the past, some Dutch citizens have moved to places just across the border in Belgium. But it is rather improbable that the economic importance of mobility taxes would be great enough to justify such a move.

An important question concerns the payment of the tax in terms of the frequency and payment method. The present car-ownership tax - being a constant figure - is paid once every three months. The easiest way to deal with this situation seems to be from the perspective of the standard policy of suppliers of a public utility such as electricity companies and to charge a fixed monthly amount based on past consumption with a final bill at the end of the year based on the actual number of kilometres driven during the past period. A possible disadvantage of this approach is that its effect on behaviour is small because it is only once a year that the consumer is confronted with the real bill. The alternative of more frequent measurement of the actual kilometrage is probably rather costly, however. One means of improving the behavioural effect would be to supplement the in-car device with a meter informing drivers about the accumulated tax amount. In the event that a second-hand car is sold, part of the process must include the settlement of the remaining tax. Another payment approach would be that the driver has to put a loaded smart-card into the in-vehicle device and that, in a way comparable to telephone cards, the value on the smart-card is reduced according to the number of kilometres travelled. This would call for measures to prevent drivers from using the car with empty smart-cards.

7. FUEL TAX

The fuel tax in the Netherlands has been used several times in the context of variabilisation. The most recent case was in 1996, when the petrol tax was increased by about 8 Eurocents, (suggesting a 7 per cent increase in the total petrol price). The basic problem with the use of fuel tax in the Netherlands is that neighbouring countries have lower petrol taxes (the difference with Germany is about 15 Eurocents). This leads to substantial flows of Dutch residents fuelling in neighbouring countries. Because fuelling is often combined with shopping, there is a negative effect on total tax receipts and on the economy in the border regions.

This is an interesting case of fiscal competition (Kanbur and Keen, 1993). It is not difficult to see that small countries can benefit from fiscal competition by fixing low tax levels on products such as petrol. The reduction in total tax receipts from domestic consumers is more than compensated for by the receipts from foreign consumers. This strategy is followed, for example, by Luxembourg, which indeed results in a substantial increase in total tax receipts for that country (cf. Rietveld *et al.*, 2000). the Netherlands, although a rather small country, followed exactly the opposite strategy and raised their fuel tax to about Euro 0.70 per litre.

One possible way to overcome the tax competition model is for the high tax country to introduce a spatially-graduated scheme -with fuel tax levels at the border being equal to the level in the neighbouring country- and with gradually increasing levels as one moves away from the border. As shown in Rietveld *et al.* (2000), however, this strategy is not problem-free. A point to be taken into account is that the slope of the graduation profile should not be too steep, because otherwise Dutch car drivers would be motivated to make domestic fuel fetching trips. In addition, even if the graduation profile were rather modest so that fuel fetching is not profitable, difficulties may emerge since some drivers are simply unaware of the full costs of fuel fetching trips. Another difficulty is that even in the complete absence of fuel fetching trips, drivers will adjust their fuelling behaviour if they are confronted with graduation of fuel taxes. One might expect a shift away from fuelling near the place of residence to fuelling in the places one already had visited regularly and that now happen to have low fuel taxes. This would result in rather drastic reductions in the total returns of some fuel sellers, which therefore makes spatial graduation a difficult policy to implement.

The conclusion is clear: a small country such as the Netherlands, with densely populated border areas, cannot afford to have fuel prices substantially above those of neighbouring countries. Spatial graduation of fuel taxes does not solve the issue. Perhaps a better solution would be to give smart-cards to car users in border regions, thus enabling them to buy fuel at prices similar to those in the cheap neighbouring country, but this would nevertheless imply additional implementation costs and possibly create fraud problems.

8. DISTORTIONS DUE TO THE FISCAL SYSTEM

The aforementioned comparison of the pricing structure of transport with the structure of its costs leads us to the conclusion that there is a clear lack of correspondence between the two. We discuss a related theme below, i.e. distortions that are the consequence of the income tax and its deductibles. We pay special attention to the treatment of the company car and to commuting costs.

8.1. Company cars

In the Netherlands, company cars have a high share (43 per cent) in total annual sales of new cars. This is not far from the European average (see Table 8 for an international comparison). The number of company cars in the total stock is lower, however, since company cars are usually sold to other users after a few years. Assuming that company cars are used for three years before they are sold to other users and that the average life of cars is approximately 12 years (ignoring differences in expected lifetime of cars that begin as a company car or as another car), we find that the share of company cars in the total stock is about 10 per cent. The importance of company cars for the composition of the total national fleet is higher, of course, because in a steady state, 43 per cent of all cars started as company cars. The choice of particular features of company car, such as engine power, acceleration capacity, fuel efficiency and safety performance, retains an impact on aggregate figures during the entire lifetime of the car.

It should be noted that the percentage in total mileage of company cars is higher than the figure of 10 per cent mentioned above, because company cars are known to have above-average annual mileage (about 25 000 km per year compared with 16 000 km per year for the average car in the Netherlands (see Pepping *et al.,* 1997). The well-known fact that the mileage of new cars is higher than that of older cars can thus be partly explained by the fact that many new cars are company cars.

Table 8. **European company car fleet market, new cars sold in 1995**

Country	Total business purchases ('000)	Total market share (%)
Belgium	126	32
France	950	46
Germany	1 520	46
Italy	506	30
The Netherlands	193	43
United Kingdom	1 030	53
Western Europe	5 069	42

Source: The Economist Intelligence Unit.

Fiscal arrangements for the company car in the Netherlands are such that a certain amount of money is added to the taxable income of the user. This amount is proportional to the price of the car. Most companies do not charge the users for the use of the company car. This means that the user experiences a marginal price per km that is equal to zero. For the employer, this fringe benefit construction is interesting because it is a cheap way to provide extra income to a group of employees. The marginal tax rate paid by these employees is 60 per cent. In many cases, the company car construction is advantageous for both the company and the employee compared with the situation where the individual would have to pay for buying and maintaining a car.

The alternative is that employees own the car themselves and use it for business purposes. The fiscal authorities allow a compensation of about 29 Eurocents per km in this case. Higher compensations would become part of taxable income. This figure of 29 Eurocents is based on the average costs of car use. The costs per km are much lower, however: about 13 Eurocents. The conclusion is that compensation of car-kms is an inexpensive way for employers to increase the income after taxation for employees. The consequence for employees is that every km travelled for the firm has a net price of -13 Eurocents, which will obviously not stimulate car users to reduce their volumes of car-kms driven. Approximately 24 per cent of all cars are apparently used from time to time for company purposes (most of them only occasionally).

In the Netherlands, about 34 per cent of all cars are involved in business-related trips. These cars are apparently responsible for all business kilometres, about 50 per cent of all commuting kilometres and about 35 per cent of all other kilometres driven. Due to the structure of the income tax, the variable costs of these trips are artificially low.

8.2. Commuting

Commuting is another area where fiscal arrangements have an adverse effect on the pricing of mobility. Within the Dutch fiscal system, commuting costs are - within certain limits - deductible from income tax. The background of the deductibility is that commuting costs are considered to be part of “professional expenses” which are tax deductible. The effect is, of course, that the incentive for employees to move to a dwelling closer to the workplace is reduced. A possible historical explanation may be that, after World War II, the housing market was so tight in many places that workers could not find a place of residence near their work. The deductibility has been a subject of political debate for many years. The proposal for a partial abolition of the tax deductibility of commuting costs even led to the resignation of the Dutch Government in 1989.

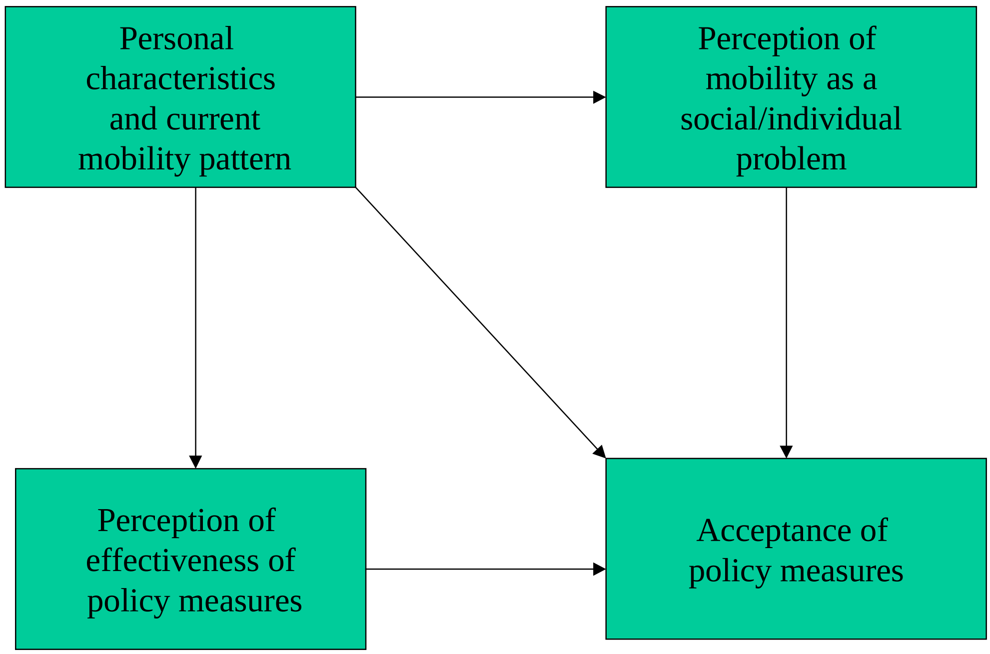
In the present system, the deduction possibilities are highest in the case of the use of public transport, but car travel commuting costs are also deductible up to a distance of 30 kms. The consequence is that commuters who travel by car are not faced with variable costs of about 13 Eurocents per km but only 9 Eurocents.

Most of the commuting trips occur during the morning and afternoon peak hours, when the marginal costs of transport are relatively high (external congestion costs for the car; high costs for the public transport suppliers, since the peak period determines the total capacity needed). We find that the income tax leads to a strange distortion: via a fiscal measure, transport costs are reduced during the peak, which is exactly the time period during which these costs are highest.

9. SOCIAL ACCEPTANCE OF PRICING MEASURES[3]

For an analysis of the support for transport policy measures, we will make use of a model as described in Figure 2. Our main point of interest is the acceptance of (or support for) particular policy measures in the field of transport. This acceptance will depend on the perception of the seriousness of transport problems, where both an individual and a social component can be distinguished. Another factor influencing the acceptance of the measures is their perceived effectiveness. Finally, in the model we distinguish various individual features and the current mobility pattern of the individual as determinants of the other variables. In particular, we would expect that the present income level will play a determining role in the evaluation of transport problems and policy measures because of its impact on the value of travel time.

Figure 2. **A conceptual model of factors influencing the acceptance of policy measures**



A broader discussion of issues related to pricing and public acceptability is given in Jones (1998). In the present section we will report the results of a number of surveys on the social acceptance of transport policy measures carried out in the Netherlands in the years 1992 to 1995. Table 9 contains a short description of the surveys.

Table 9. **Surveys of the acceptance of transport policies in the Netherlands**

Survey	Theme	Year	Respondents	References
1	Congestion, Safety, Environment	1992, 1994, 1995	700-1 100 inhabitants per year	Veling (1994), Rienstra *et al.* (1999)
2	Congestion	1995	1 327 car drivers	Verhoef *et al.* (1997)

The most complete coverage of the model described in Figure 2 is given by the first survey. Therefore we will focus our presentation on this survey and, where appropriate add results from Survey 2.

9.1. Perception of transport issues as an individual or social problem

In Tables 10a and 10b we give some results on the perceptions of congestion and safety problems from a social and a private perspective, based on Survey 1. It appears that, as far as safety is concerned, the majority of the respondents *individually* experience traffic safety problems (59 per cent; see column 4). However, only 41 per cent consider traffic safety as a *social* problem. In the cases of congestion and pollution the relationship is reversed. For example, 48 per cent of the respondents experience congestion problems on expressways, but 69 per cent of the respondents consider congestion on expressways as a social problem.

Table 10a. **Perception of traffic safety in residential areas as a private versus social problem, 1992-95 (%)**

	Safety is not considered as a social problem	**Safety is considered as a social problem**	**Total**
Safety is not considered as a private problem	28.7 (70.1*)	12.3 (29.9*)	41.0
Safety is considered as a private problem	29.7 (50.4*)	29.3 (49.6*)	59.0
Total	58.5	41.5	100.0

* These figures add up to 100% per row.

Table 10b. **Perception of expressway congestion as private versus social transport problem, 1992-95 (%)**

	Congestion is not considered as a social problem	**Congestion is considered as a social problem**	**Total**
Congestion is not considered as a private problem	20.3 (39.1*)	31.6 (60.9*)	51.9
Congestion is considered as a private problem	11.2 (23.2*)	36.9 (76.8*)	48.1
Total	31.5	68.5	100.0

* These figures add up to 100% per row.

How strongly are individual and social perceptions of transport problems related? Tables 10a and 10b show that there is a strong correlation. For example, of those respondents who say that they experience safety problems, 50 per cent consider traffic safety as a social problem. For those who do not personally experience safety problems, this percentage is only 30 per cent. Similar results are found for congestion problems. For those who do not personally experience congestion problems on highways, 61 per cent of the respondents report that they consider congestion as a social problem. For those who do experience congestion problems themselves, this percentage is as high as 77 per cent.

From these tables, we infer that the perception of certain transport problems (congestion, safety) as a social problem is shared by substantial parts of the population. Also among those parts of the population who do not experience these problems themselves, quite a number of people consider these problems as a social problem. But it is clear that the individual experience certainly shapes the social perception.

When we take into account other factors to explain the perception of problems (for a detailed account, we refer to Rienstra *et al.*, 1999), we find that the transport issues are particularly considered as problematic among the following categories of people:

- younger people;
- women;
- people with higher education;
- residents of large cities;
- people with higher incomes.

The last result is in agreement with the notion that the value of time (which depends on income) is an important determinant of welfare losses due to congestion. Another result is that (not surprisingly) commuters and car owners more frequently experience individual transport problems than other respondents. However, they are less inclined to consider these problems as *social* problems. Thus, although the private experience of problems certainly influences the public perception, commuters and car owners seem to relativise their problems to some extent when they consider their problems from a social perspective.

In a study based on Survey 2, Verhoef *et al.* (1997) found similar impacts of age, education and income on the perception of transport problems, in this case, congestion problems. Thus, younger people, people with higher education and those with higher incomes tend to take congestion more seriously than other people. Additional factors influencing the perception of congestion problems found in this study are the travel motive and the length of trips (people on business trips have higher perceptions of the seriousness of congestion problems). This closely ties in with research results on travel behaviour, according to which values of time in business trips tend to be higher than for other trip purposes.

9.2. Perception of the effectiveness of policy measures in transport

Some results on Dutch residents' perceptions of the contribution of policy measures to the solution of transport problems, based on Survey 1, can be found in Table 11. The perception of safety related measures, such as improving drivers' education, more surveillance, etc., is quite positive. For example, some 92 per cent of respondents believe that better education of drivers does contribute to the solution of traffic safety problems.

Table 11. **Perception among Dutch residents of contribution of policy measures to transport problems, 1992-95**

Policy measure	Share of respondents who believe that policy contributes to the solution of transport problem (%)
Congestion:	
-30% increase in EU petrol taxes	37.2
-road pricing	53.4
-improve public transport	79.8
-car pooling	92.5
-telematics introduction	81.5
Safety:	
-better driving education	92.4
-more intensive surveillance	90.3
-low speed design of residential areas	88.6
Environment:	
-improved car technology	95.0
-30% increase in EU petrol taxes	43.3
-doubled parking tariffs	32.5
-more bicycle lanes	80.1

For the other problem fields (congestion and the environment) the respondents are usually less optimistic. An extremely negative view is noted towards an increase in EU fuel prices as a solution to congestion and environmental problems. Thus respondents appear to expect little from financial instruments to solve transport problems. There are several explanations for this result: respondents believe that transport demand is inelastic so that taxation only leads to higher revenues for the Government. Another explanation is that respondents have a tendency to give strategic answers: they indicate low expectations of effectiveness for policies they do not like. This tendency may be the result of a conscious misrepresentation of their perception of effectiveness, but not necessarily so. Still another explanation would be that respondents anticipate that unpopular policy measures will not materialise and hence will not contribute to the solution of transport problems. Very positive results are found for the possible contribution of technology to the solution of transport problems. Also policies encouraging environmentally-friendly transport modes contribute considerably, according to the respondents.

Thus we arrive at the conclusion that, in the respondents' view, demand for car traffic is very inelastic in terms of its own price, whereas it is very elastic in terms of the quality of other transport modes. This leads to very optimistic views on the effectiveness of pull measures (improvement in the supply of alternative transport modes) and to negative views on the effectiveness of push measures (higher costs of car use). This is a rather uncomfortable conclusion, since modelling exercises with transport policies give rather different results. For example, Bovy (1991) reports that, according to model-based studies in the Netherlands, pull measures are rather ineffective as a means to reduce car traffic, whereas push measures are more effective. Thus, there is scope for some effort to improve the understanding of the general public in this respect.

9.3. Acceptance of policy measures

The results of Survey 1 on the support for transport policies are presented in Table 12. High support is found for safety-related measures compared with congestion and environmental policy measures. When we compare various types of measures (fiscal, technical, etc.), fiscal measures receive a low level of support. However, it is interesting to note that road pricing is valued more positively than an increase in fuel taxes. The explanation is probably that road pricing is a more focused type of instrument so that it will not affect all drivers and all trips. High support is found for technological solutions and for pull measures (encouragement of alternative transport modes).

Table 12. **Support among Dutch residents for transport policy measures, 1992-95**

Policy measure	Share of respondents who (strongly) support policy measure (%)
Congestion:	
• 30% increase in EU petrol taxes	20.1
• road pricing	36.9
• improve public transport	76.4
• car pooling	93.5
• telematics introduction (the car driver has to pay the costs)	77.0
Safety:	
• better driving education	89.7
• more intensive surveillance	85.2
• low speed design of residential areas	82.7
Environment:	
• improved car technology	90.9
• 30% increase in EU petrol taxes	24.5
• doubled parking tariffs	18.3
• more bicycle lanes	95.0

When we take into account the individual characteristics of respondents, we find that the following types of persons tend to give strong support to the policy measures:

- older persons;
- highly educated persons;
- residents of large cities;
- people who do not have a driver's licence;
- people who do not own a car;
- high income earners;
- people who perceive transport issues as an individual problem;
- people who perceive transport issues as a social problem.

Concerning the latter two variables, it is interesting to note that the impact of the *social* perception appears to be significantly larger than that of the *individual* perception (see Rienstra, *et al.*, 1999). This confirms the theoretical notions proposed in the public choice literature (Mueller, 1989) that respondents do attach weight to the perceived general interest in their decisions.

In a study on road pricing among car drivers, based on Survey 2, Verhoef *et al.* (1997) found that support for road pricing is highest among respondents with the following features:

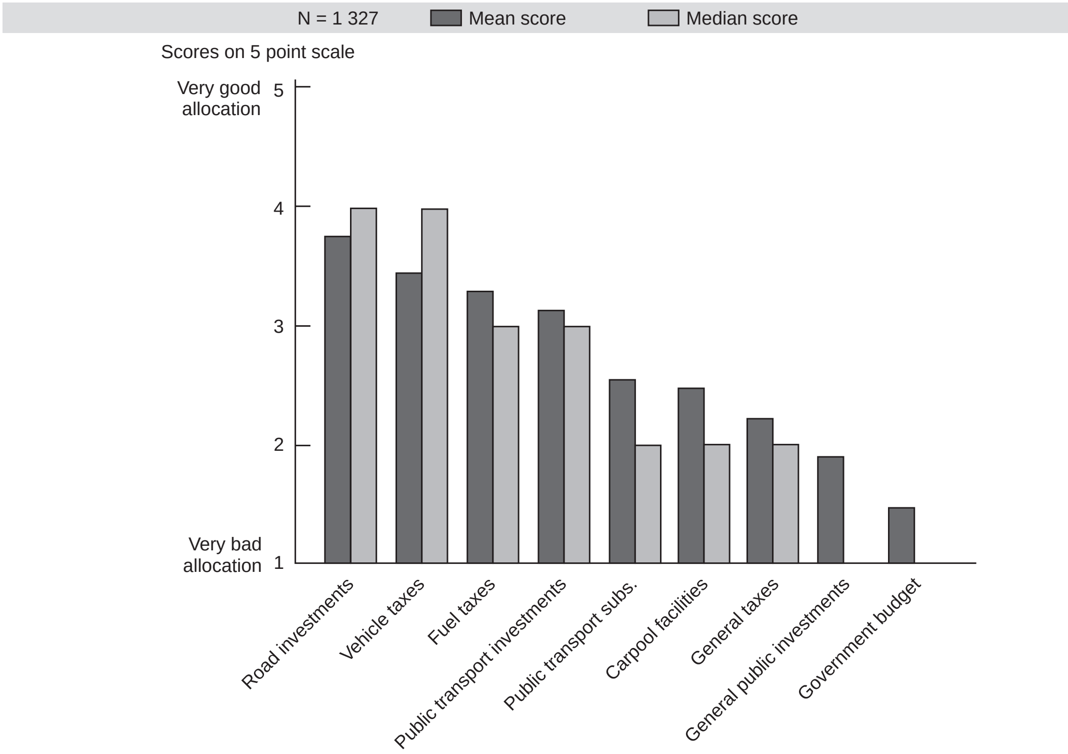
- those in single person households (a possible explanation is that their time budget is tight);
- those who travel long distances by car;
- drivers who experience a big time loss due to congestion (this is the by far most significant factor);

– drivers who consider carpooling or public transport as feasible alternative transport modes;
– those who perceive congestion as a social problem;
– those who receive compensation for the road price from their employer.

In this list, again, a mixture of private and public interests is found.

A well-known feature of road pricing is that it has a negative impact on the welfare position of most of the drivers. Those drivers who choose a travel alternative are forced to abandon their most preferred choice; those drivers who continue to travel during the peak period have the advantage that it takes less travel time, but they have to pay a price for it. Obviously, the welfare position of the drivers may improve when the Government redistributes the toll revenues. However, much depends on the way in which the revenues are redistributed (see Figure 3).

Figure 3. **Road users' opinions on various allocations of revenues raised with road pricing**



Drivers strongly favour expenditure which is directly beneficial to road transport (additional road investment, reductions in vehicle or fuel taxes). Moderate support is given to improvements in transport alternatives (investment in public transport, subsidies to public transport, carpool facilities). According to the opinions of car drivers, the least favourable allocation of the receipts would be a general reduction in taxes, an increase in government expenditure or an unspecified increase in the government budget. As explained in Verhoef *et al.* (1997), certain patterns can be found in the opinions of car drivers on the best way to allocate the money. For example, low income earners are more positive about general and fuel tax reductions; drivers who expect to get compensation from the employer are more positive about road investment. Thus a clever mixture of alternative uses of the revenues would be needed to maximise support for the introduction of road pricing.

10. CONCLUSIONS

The externalities of transport not only depend on the number of kilometres driven, but also on factors such as road type, time of day, car type and on driving behaviour such as speed and acceleration. The present pricing system of car use and ownership in the Netherlands is such that the degree of differentiation is small, except for the car type aspect. Thus there is a clear mismatch between the differentiation in external costs and in pricing. A considerable share (55 per cent) of all car-related taxes in the Netherlands relates to car ownership. The rest (45 per cent) is paid for car use. The structure of the tax system is only vaguely related to the differentiation in the external effects. The tax system is not very helpful, especially for the rapidly developing problem of congestion.

The marginal external costs of road use in the Netherlands are estimated to be relatively high in urban areas. In intercity transport they are somewhat lower, because noise nuisance and accidents are less of a problem in lower density areas. Congestion is certainly not negligible in intercity transport in the Netherlands: its polycentric structure with many cities at relatively short distances means that intercity traffic is often mixed with transport within metropolitan areas so that congestion is also important here.

Variabilisation has been a main objective during the past twenty years or so in the Netherlands. For intercity road transport, potential tools are fuel taxes, congestion pricing or a kilometre charge. The potential of the fuel tax is limited in this respect as long as neighbouring countries have lower fuel prices. Spatial differentiation of fuel taxes within the country to solve the border problem has large negative side effects. Congestion pricing has been on the political agenda for over 10 years, but it was not easy to mobilise social and political support up to now. A kilometre charge has been proposed recently as an alternative measure, but its merits depend strongly on the question of how differentiated it can be. A flat charge will probably be rather ineffective in alleviating the external effects of road transport.

The treatment of transport costs as a deductible in the income tax leads to major distortions: a low variable cost for commuting, a zero variable cost for the company car and a negative cost in the case of private car use for business purposes. The conclusion is that discussions on fair and efficient pricing should not only address the issues concerning the differentiation in the present taxes on car ownership and car use, but also the removal of distortions caused by the structure of the income tax.

Tolling has been a rather unimportant part of infrastructure pricing and financing policies in the Netherlands during the last fifty years. The number of tolled links was small and mainly of a rather local nature. More recently, the increasing congestion on the highways has stimulated the political debate so that in the present situation the interest in tolling is increasing.

Social acceptance of pricing measures is relatively low: a main reason being that the perceived effectiveness of pricing measures to reduce congestion is low compared with measures to increase the quality of other transport modes (see Table 11). This leads to overly optimistic views on the effectiveness of pull measures (better transport alternatives) and to negative views on the effectiveness of push measures (higher costs of car use).

Social acceptance of pricing measures strongly depends on the way the receipts are used. From surveys, it appears that the receipts are used for road investment: the acceptance is much higher compared with uses such as a general reduction in taxes. This is also confirmed by the way the negotiation processes between national and local governments has developed.

NOTES

1. Another point that deserves attention is that the average speed of road transport is still increasing in the Netherlands. Part of the paradox of increasing congestion and increasing average speed can be explained by the fact that travel distances increased considerably and travel speeds clearly increase with distance (cf. Rietveld *et al.*, 1999).

2. MuConsult finds that the kilometre charge induces some households with one car to sell their car. This is a somewhat surprising result, because one would expect that among the groups of households that might sell their car, the group with a small annual kilometrage would be overrepresented. An increase in the variable costs and a decrese in fixed costs would be favourable for this group. Therefore, one might have expected that the variabilisation would have induced the opposite effect, i.e. that some households without a car would start to own one.

3. This section is partly based on Rietveld and Verhoef (1998).

ANNEX

DETAILS ON MARGINAL COSTS OF ROAD TRANSPORT IN THE NETHERLANDS

Table A1. **The structure of marginal and average social costs of non-local road transport in The Netherlands in Eurocents per vehicle-km**

Transport mode	Marginal costs: safety	Marginal costs: noise	Marginal costs: emissions	Marginal costs: infrastructure	Average costs: infrastructure	Total
Passenger cars:						
- petrol	1.5	0.2	1.3	1.7	1.8	6.5
- diesel	1.5	0.2	1.5	1.7	1.8	6.8
- LPG	1.5	0.2	1.2	1.7	1.8	6.4
Bus:						
- diesel	6.2	1.2	11.8	3.4	3.9	26.0
- LPG	6.2	1.2	6.3	3.4	3.9	21.0
Freight (diesel):						
- vans	1.9	0.3	2.3	1.6	1.8	7.9
- medium	3.8	0.6	3.7	2.3	3.7	14.0
- large	3.8	1.2	8.3	4.6	6.4	24.0

Notes:
- Average costs computed as annual fixed costs of infrastructure provision divided by total volume of vehicle-kms.
- Car technology based on Euro-1 emission norms.

Source: CE (1999).

Table A2. **Marginal and average social costs of local road transport in The Netherlands in Eurocents per vehicle-km**

Transport mode	(2) marginal costs	(3) marginal + average costs	(4) marginal charge	(5) marginal + average charge	(6) (2)-(4)	(7) (3)-(5)
Passenger cars:						
- petrol	8.0	9.8	5.7	11.7	2.3	-1.9
- diesel	9.8	11.6	2.2	7.2	7.6	4.3
- LPG	7.7	9.6	0.4	4.8	7.3	4.8
Bus:						
- diesel	57.0	61.0	-179.0	-178.0	237.0	240.0
- LPG	30.0	34.0	-192.0	-192.0	221.0	225.0
Freight transport (diesel):						
- vans	11.2	13.0	3.9	7.0	7.3	6.0
- medium	27.0	31.0	5.8	6.9	21.0	23.6
- large	45.0	52.0	16.3	18.6	28.9	33.1

Notes:
- Does not include congestion costs and costs of travel time.
- Does not include private costs of car ownership (insurance, interest, instalment) and fuel costs (only fuel taxes are included).
- Average costs computed as annual capital costs of infrastructure construction divided by total volume of vehicle-kms.
- Car technology based on Euro-1 emission norms.

Source: CE (1999).

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OTHER CONTRIBUTIONS

During the Round Table, several participants submitted written contributions. These contributions are reproduced below as complementary information.

ITALY

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NOTE ON INFRASTRUCTURE CONCESSION REGIMES AND TRANSPORT POLICY

1. The first issue concerns the general problem of defining a natural monopoly and contestable services: in general, transport infrastructure has a strong, natural and legal monopoly, while transport services are fully contestable. Therefore, infrastructure has to be regulated (concession being the main form of regulation) while services can be open to competition. Within this conceptual framework -- which also presents several "special cases" and exceptions -- a wide range of alternative policies is possible. An intermodal, intercountry comparison would be useful, in order to better define objectives and constraints, but above all to underline the need for *consistent* approaches, given the absence of a definite European policy on concession regimes for transport infrastructure.

2. A second urgent and relevant issue concerns the regulation of infrastructure access: "grandfather rights" is the present general rule for airport slots, even if this rule severely reduces the competition introduced in several large air markets. If, under pressure from the incumbents, this rule spreads to other markets in the process of liberalisation – such as railway services in Europe, but freedom of access is a relevant issue for ports, too – the consequences can be very disappointing, cancelling the potential benefits of the service liberalisation to the final users.

3. Infrastructure regulation also deals with the thorny issue of the "minimal efficient dimension": regulation theory states that the size of the natural monopoly has to be reduced to a point below which significant diseconomies of scale emerge, in order to guarantee the best possible balance of power between the regulator and the regulated. This issue in turn is relevant for opening up the concessions to competition *for* the market (concessions are monopolistic rights that can be granted for a given period under competitive bidding procedures). What is the minimum efficient dimension for rail and highway networks? What is the efficient limit for airport merging and where a cartel problem arises? In general, what are the relations between concession (and regulation) regimes and service liberalisation?

4. The State intervenes in transport infrastructure, both as a regulator and with financing tools. The main issue here is known, thanks to ECMT elaboration, as the "optimal number of tills" (see the debate with L. Thompson of the World Bank on railway regulation). A better fine-tuning of objectives and tools favours the "multiple tills" solution. A more realistic view of the capability of public actors, particularly if transaction costs and transparency needs are also considered, inclines toward simpler solutions. This issue is particularly important for railways and airports, but ports and highways are facing similar problems, too.

5. Project financing strategies (PPPs, etc.) are currently in special favour. Nevertheless, the long time-span of the concessions related to these strategies generates problems of "special" relationships that develop between public and private subjects outside any competitive pressure (contract renegotiations, etc.). Innovative approaches are needed in order to minimise the risks of losing, in the long run, the advantages gained from the private participation at the start of the project.

SLOVAK REPUBLIC

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ELECTRONIC TOLL COLLECTION - ROAD PRICING ON SLOVAKIAN MOTORWAYS

1. Toll systems in Europe

Since 1992, several studies have been made of problems relating to road pricing in the Slovak Republic. The main areas addressed were the economic theory of road pricing, road pricing policy, institutional issues and the scope for offering franchises to operators from the private sector. Toll systems are widely used on the motorway networks of five EU Member States and four other European countries. Four countries, including the Slovak Republic, use a vignette system to charge users on the basis of vehicle weight or period of validity. Examples of tariffs charged within Europe are given in Table 1 below.

Table 1. **Basic tolls and vignette prices in selected European countries**

Country	**User Charging System**	**Type of organisation (number)**	**Basic tariff ***
France	Tolls	Private operator (9)	0.062 EUR/km
Italy	Tolls	Private operator (22)	0.047 EUR/km
Spain	Tolls	Private operator (11)	0.086 EUR/km
Portugal	Tolls	Private operator	0.052 EUR/km
Greece	Tolls	Private operator	0.023 EUR/km
Slovenia	Tolls	State enterprise	0.030 EUR/km
Croatia	Tolls	Private operator	0.044 EUR/km
Hungary	Tolls	Private operator (3)	0.054-0.095 EUR/km
Switzerland	Vignette	State enterprise	from 22.44 EUR/year
Slovak Republic	Vignette	State enterprise	9.16-91.60 EUR/year
Czech Republic	Vignette	State enterprise	25.85-216.2 EUR/year
Austria	Vignette	State enterprise	5.15-879.30 EUR/year

* Based on official rates of exchange in February 1999 and the SKK/EUR exchange rate for October 1999.

Transport policymakers in the Slovak Republic recently decided to examine the possibility of charging motorists for the use of motorways and asked Dopravoprojekt a.s. (Bratislava) to determine the most appropriate form of road pricing mechanism. The company recommended the use of direct tolls rather than a vignette system, which is simply one of several alternatives available. Vignette systems are unfair in that they do not uphold the basic right of users to pay for a service solely in terms of the distance travelled. Given this shortcoming, the countries that have signed an association agreement with the EU and that apply a vignette system are currently considering changing to a different system.

The general question of the benefits to be gained from introducing a toll system depends upon the basic tariff charged, since the latter can be used to calculate revenues and to determine the technical and organisational requirements. The first conclusion drawn from the study by Dopravoprojekt was that, in the specific context of the Slovak Republic, an Electronic Toll Charging System (ETC) offered the best solution in terms of:

1. Motorway network and type;
2. Type of charging system – open versus closed;
3. Toll-collection technology;
4. Institutional environment;
5. Socioeconomic trends and their implications.

The final decision must take all factors into consideration; however, ETC does offer a number of advantages over conventional toll-collection technologies (cash, smart cards requiring large, well-lit toll gates) and the vignette system, in that it:

- is compatible with market economy principles, namely, payment for extra services;
- is relatively fair;
- increases total revenue;
- allows direct verification of payment;
- does not delay users by requiring them to stop.

2. Comparison of vignette and toll systems in the Slovak Republic

The Slovak Republic operates a vignette system on its motorway network, as in the case of Switzerland, Austria and the Czech Republic. Revenues from the sale of vignettes are collected by the Government and are used, in part, to subsidise investment in road infrastructure. The following conclusions may be drawn from the experience gained by these countries in the operation of such a system:

- Income from the sale of vignettes is not sufficient to meet the original objectives of the system;
- The sale of vignettes does not create a large administrative burden and provides immediate income;
- The administrative costs entailed in managing a vignette system are low (compared with toll systems);
- Vignettes are perceived as intrinsically unfair in that there is no direct link between the service provided by the operator and the actual use made of the motorway by motorists (in terms of both time and distance);

- The system is relatively inefficient in that the purchase of vignettes depends upon the good will of users;
- Verification of vignette use poses numerous problems. The police force is responsible for enforcing the system but is administered by a separate Ministry; in addition, existing legislation on co-operation (between the police, regional administrations and highways authorities) is unclear;
- There is limited scope for improving the system.

Vignettes have been used for road pricing in the Slovak Republic since 1996 and are valid either for a year or for shorter periods of time (15 days). The price of vignettes varies according to vehicle weight and engine rating. Vehicles are divided into three categories: below 3.5 tonnes, below 12 tonnes and over 12 tonnes. Previously, all vignettes were annual. Total revenues from sales of vignettes during the period 1996-98 are given in Table 2 below.

Table 2. **Revenue from sales of motorway vignettes**

	1996		1997		1998	
Face value of vignette	**Number sold**	**SKK millions**	**Number sold**	**SKK millions**	**Number sold**	**SKK millions**
SKK 200	294 788	58 958	389 209	77 842	433 015	86 603
SKK 400	111 554	44 621	198 348	79 339	199 348	79 738
SKK 1000	10 414	10 414	15 985	15 985	18 043	18 043
SKK 1500	18 844	28 266	24 617	36 925	26 177	39 265
SKK 2000	26 535	53 071	38 657	77 315	41 065	82 131
Total	462 136	195 330	710 483	287 405	717 648	305 780

Source: Slovakian Road Fund, Bratislava, 1999 (1 EUR=42.8 SKK, November 2000).

The increase in revenue can be calculated on the basis of the new vignette pricing structure introduced in 2000. A study by the Transport Research Institute, Zilina, has shown that the introduction of vignettes valid for different periods of time, priced according to Table 3, would generate higher levels of revenue, as shown in Table 4.

Table 3. **Recommended price structure for vignettes**

	Option 1 -- tariff (SKK)			Option 2 -- tariff (SKK)	
Category	**10 days**	**2 months**	**Annual**	**15 days**	**Annual**
< 3.5 t	100	250	1 000	150	1 000
< 12 t	400	1 500	6 000	500	6 000
> 12 t	1 000	3 000	10 000	1 300	10 000

Source: Transport Research Institute, Zilina, April 1999.

Table 4. **Forecast revenues from sales of vignettes according to vehicle category and term of vignette**

	Option 1 -- income (SKK)			Option 2 -- income (SKK)	
Category	**10 days**	**2 months**	**Annual**	**15 days**	**Annual**
< 3.5 t	70 000 000	22 750 000	420 000 000	112 500 000	470 000 000
< 12 t	144 000	975 000	48 000 000	227 500	50 700 000
> 12 t	7 200 000	3 600 000	650 000 000	6 895 000	659 200 000
Total	77 344 000	27 325 000	1 118 000 000	119 622 700	1 179 900 000

Source: Transport Research Institute, Zilina, April 1999.

As mentioned earlier, one of the major drawbacks to this system is verification of payment. Traffic police in the Slovak Republic have limited powers of enforcement (checking road users, imposing and collecting fines). The fines applicable to the different categories of vignette are currently too low (below 3.5 t = 2000 SKK; below 12 t = 5000 SKK; above 12 t = 6000 SKK).

The benefits to be gained from changing from a vignette system to a toll-based system in the Slovak Republic are as follows:

- Road users are already accustomed to paying for access to motorways;
- The pricing structure for tolls is transparent;
- Tolls will not be seen as an infringement of civil rights;
- Tolls will be legally regulated;
- Greater choice of technologies and financing arrangements for toll systems.

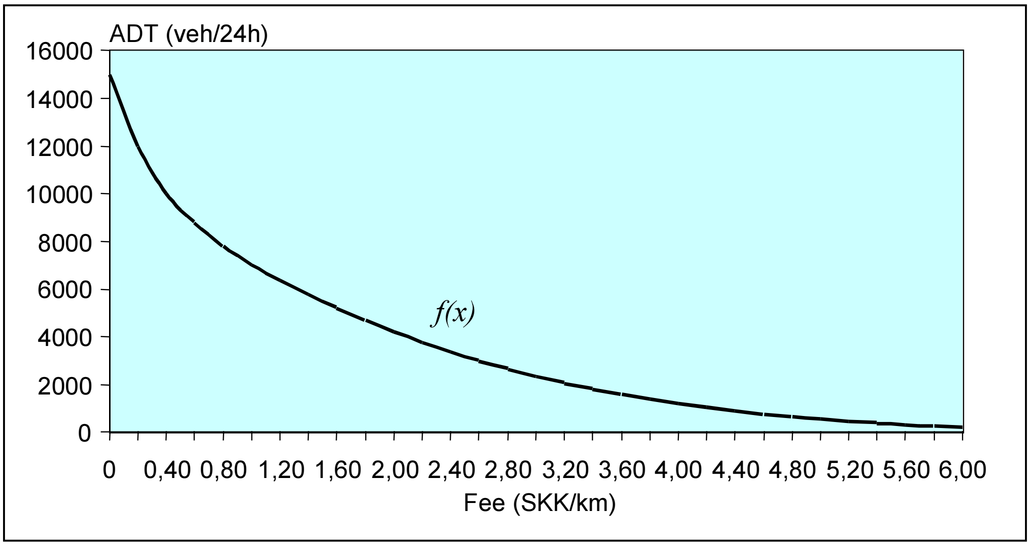
3. Technical solutions for Slovakian motorways

The ***design and layout of the motorway network*** in the Slovak Republic poses a number of specific problems, particularly in terms of intersections and geographical location. *The installation of conventional toll gates at existing intersections requires large-scale investment and poses a number of technical problems.* Motorway link roads to interchanges in the Slovakian road network consist of four-way junctions allowing access to both carriageways of the motorway. Due to the topography of the country, the main traffic corridors are routed through the Vah and Hron valleys with the result that the motorways are crossed by both Class I and II roads. Most interchanges on the Slovakian motorway network therefore consist of diamond or cloverleaf junctions. Toll gates are customarily installed on single-flow arms of interchanges. This means that the highway network must be connected to the motorway network rather than simply crossing it. The next disadvantage of the Slovakian motorway network is the high density of interchanges, with the result that the distance between toll gates in a conventional toll system is very short. The average distance between interchanges in foreign motorway networks is approximately 15-25 km. The introduction of tolls on Slovakian motorways in 2003 would require conventional toll gates at 35 interchanges (out of a total of 85). This would result in 20 sections of 10 km, 14 of 10-20 km and only one of over 20 km. One solution would be to redesign motorway crossings, but this option is ruled out by the nature of the terrain (mountains and valleys, as mentioned earlier). In view of this, a conventional toll system (cash, smart card) would be prohibitively expensive and it would therefore be cheaper to install an ETC system rather than attempting to accommodate all motorway interchanges and link roads. Motorway design does not affect the use of ETC in that ETC tollgates simply consist of portals spanning the carriageways. ETC toll gates do not require the use of additional land. Another problem facing the introduction of a toll system in the Slovak Republic is the high quality of the ***alternative roads*** running parallel to and alongside motorways (given their location in valleys). The existence of alternative roads allows traffic flows to be partially diverted from the motorway network. The experience of Hungary is interesting in this respect (although tariffs in that country pose another type of problem).

4. Relationship between traffic volume and overall revenue from tolls

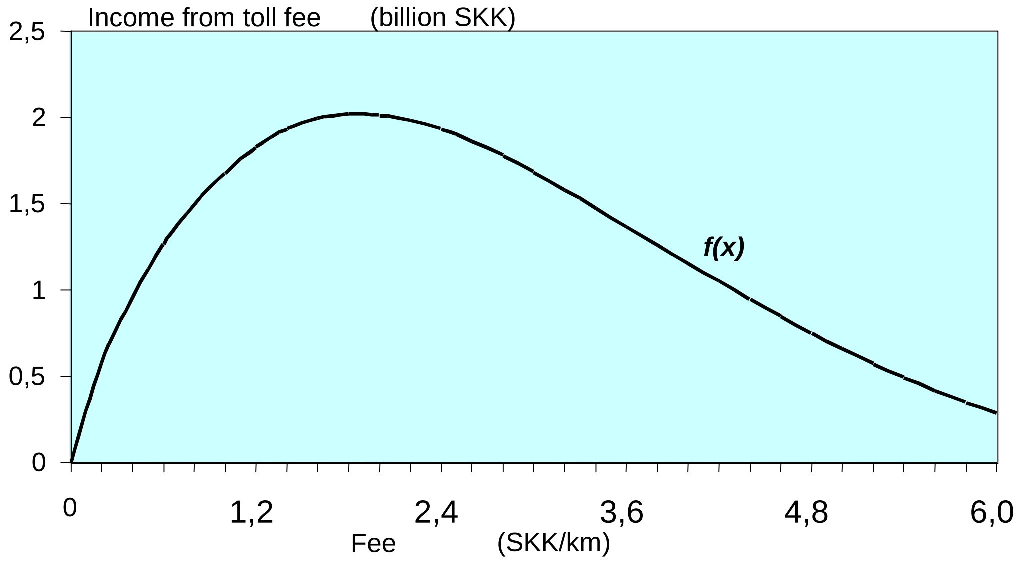
The approach usually adopted is to match tolls to traffic volumes (see Figure 1). However, it is important to assess the volume of traffic that will be diverted from motorways to alternative roads following the introduction of tolls, which is particularly critical in this instance due to the high quality of Category I roads in the Slovak Republic. It is therefore necessary to determine the relationship between the volume of potentially diverted traffic and toll prices.

Figure 1. **Traffic volume as a function of total level of tolls (example)**



A vast traffic-counting survey would be needed to determine this relationship. Figure 1 directly represents traffic volume according to toll levels. This relationship is illustrated in Figure 2.

Figure 2. **Revenue as a function of total level of tolls (example)**



No values have been assigned to this curve, which simply represents a relationship based on substantial operating data from Hungary (a transitional economy) and data from France and other countries operating toll systems.

5. Pricing and introduction of tolls on Slovakian motorways

Introducing new forms of road pricing in a country such as the Slovak Republic, which has a weak and unstable economy, is a relatively complex process that requires careful analysis of the risks involved and of the potential benefits and drawbacks. Dopravoprojekt examined three possible approaches to initial toll pricing.

The first approach is demand-based and assumes that all costs are paid for by the user. The user fee therefore covers all fixed, variable and external costs. This approach is widely used and the result for 1 v-km is as follows:

- **Fixed costs = 0.50 SKK/v-km (0.011 EUR);** this is a determining factor because it represents the share of investment costs and the share of outstanding excise duties;
- **Variable costs = 0.22 SKK/v-km (0.005 EUR),** which represent maintenance, repair and administration costs. These are the minimum charges which motorists should pay;
- **External costs = 0.05 SKK/v-km (0.001 EUR),** which include costs incurred outside the transport sector (accidents, environmental damage, policing, etc.)

These costs amount to an average total of **0.77 SKK (0.017 EUR) per vehicle-km** (both cars and lorries).

The second approach consists in comparing the cost to the user of driving on a motorway with that of driving on an alternative road. The upper limit of the toll charge is determined by the difference between the two, namely, the savings in terms of wear on the car, fuel and travel time. Data relating to traffic volume, flow characteristics, journey modes, different levels of toll charges, driving in congested conditions on alternative roads and several modes of fluid-flow driving were input into a calculation model. The time saving was determined to be very low, amounting to no more than 65.5 SKK/h (1.5 EUR) and the saving in terms of vehicle wear was also found to be low [1 km = 1.00 SKK (0.02 EUR)]. The breakdown of total savings amounted to 76% on travel time, 16% on fuel and 8% on costs. In the case of lorries, the breakdown was as follows: 1 km = 3.20 SKK (0.07 EUR), with savings of 58% on fuel, 27% on time-related costs (car allowances, wages, other expenses) and 15% on operating costs (repairs, lubricants, tyres, etc.). This straightforward calculation was made to determine the validity of the assessment method.

The calculated savings for cars (1.00 SKK/km) and lorries (3.20 SKK/km) can serve as a basis for determining toll levels that will encourage drivers to use the motorway. The model included a partial saving for the user, given that if the user were to pay the entire saving in tolls there would be no incentive to use the motorway. Two toll variants were calculated on the basis of the above:

- **Variant A** – toll charge equal to 50% of the potential saving, i.e. 0.50 SKK/km for cars and 1.60 SKK/km for lorries;
- **Variant B -** toll charge equal to 70% of the potential saving, i.e. 0.70 SKK/km for cars and 2.20 SKK/km for lorries.

In Variant A, the average toll is slightly lower than the amount calculated by means of the first method, which includes fixed, variable and external costs (the weighted average for cars and lorries is approximately 0.72 SKK).

Table 5. **Comparison of basic statistics**

Country	**Surface Area (km^2)**	**Density per km^2**	**Population (milions)**	**Rate of economic activity (%)**	**Unemploy-ment rate (%)**	**GDP (national currency billions)**	**Retail price index****
Slovak Republic	49 012	109	5.36	61.4	13.1	A 516.8 B 106.9	272.2
France	551 500	105	58.15	45.3	-	A 7 662.4 B 111.5	111.6
Italy	301 268	86	51.64	40.3	12.0	A 1 771.0* B 127.8	127.7
Spain	505 992	77	39.21	40.8	22.9	A 15 591 B 111.5	128.6
Portugal	91 982	107	9.92	48.8	7.1	A 5 614 B 111.5	127.1
Greece	131 957	105	58.15	-	10.0	-	192.0

A = current prices (absolute data). * *Source:* Statistical Yearbook of the Slovak Republic (1997, 1998).
B = current prices (1990 = 100). ** as a % (1990 = 100).

The third approach (using the same variants) relates toll charges to cost-of-living indices. The cost-of-living index for the Slovak Republic was compared with those for other countries which have operated toll systems for a number of years. Table 5 compares population and economic data for several countries.

The parameters selected are GDP, as a measure of the country's economic strength, and the cost of a 1 600 km trip by motorway. The cost of the motorway trip is calculated on the basis of a toll rate of 0.50 SKK/km compared with an annual vignette fee of 800 SKK per vehicle of less than 3.5 t. The results are shown in Table 6.

Table 6. **Comparison of GDP with cost of a given motorway trip**

Country	**SKK/km**	**Toll for 1 600 km (USD)**	**Per capita GDP (USD)**	**Share of per capita GDP (%)**
Slovak Republic	0.50 var. A 0.70 var. B	26.93 37.70	3 240	0.80 1.16
France	2.70	145.30	21 677	0.67
Italy	2.05	110.30	20 187	0.55
Spain	3.75	201.84	13 489	1.50
Portugal	2.30	123.44	7 298	1.69
Greece	1.0	53.80	8 584	0.63

Road users' ability to pay can be determined from the relationship between the toll charges in a given country for 1 600 km of motorway driving and the annual per capita income of its inhabitants. This factor, based on the spending power of inhabitants, can then be used to assess the share of motorway traffic, as shown in Table 7.

Table 7. **Comparison of annual income with motorway tolls (per km)**

Country	**Annual per capita income (in national currency)***	**Toll charge per 1 600 km (in national currency)**	**Toll charge per 1 600 km as a % of annual per capita income**
Slovak Republic	60 144	800 variant A 1 120 variant B	1.33 1.86
France	118 333	711.8	0.60
Italy	24 702 191	174 792	0.71
Spain	1 401 187	24 500	1.75
Portugal	1 004 804	18 437	1.83
Greece	1 263 357	12 753	1.01

**Source*: Statistical Yearbook of the Slovak Republic (1997, 1998), DORSCH Consult.

The above comparisons suggest that the total sum of the toll charge in Variant A, namely, 0.50 SKK/km for cars and 1.60 SKK/km, is commensurate with income levels in developed EU Member States. This level is relatively high, however, when compared with the ability to pay of the Slovakian population. In view of this, the target date for the introduction of tolls on Slovakian motorways will have to be delayed until after 2003.

6. Toll system in the Slovak Republic

The basic premise underpinning a toll system is that the user pays according to the distance travelled on the motorway. There are a number of advantages and disadvantages to toll systems, among which:

- Toll systems are fair and in accordance with the EU White Book (Transport). Their use is recommended as a means of improving road infrastructure;
- Toll systems apply to all users and revenues are therefore transparent;
- Toll revenues are used to cover complex costs;
- The use of conventional technology (toll gates) results in delays to users (which can be remedied through the use of ETC systems);
- Toll systems entail additional construction costs.

The assessment of the impact of tolls on Slovakian motorways must take account of their impact on traffic flow patterns before and after their introduction. The size of the toll is therefore a major factor in the change of road pricing policy in the Slovak Republic.

The target date for the introduction of tolls in the Slovak Republic is 1 January 2005, in accordance with a decree issued by the Slovakian Government, in order to allow time for:

- the necessary legislation to be enacted;
- introduction of administrative and technical procedures;
- operators to learn how to use sophisticated technology;
- construction work;
- acceptance in public opinion.

7. Evaluation of the economic effectiveness of toll systems

The overall evaluation addresses three areas:

- Investment and additional initial expenses;
- Operating costs;
- Toll revenue.

Toll revenues are given in 1999 prices. Tolls are expected to rise in line with inflation and this assumption has been incorporated in cashflow estimates. Estimated revenue (without allowing for inflation) is therefore as follows:

Table 8. **Estimated revenue from tolls**

	Optimum	Maximum
2003	1 518.53 SKK million	2 004.73 SKK million
2010	3 611.44 SKK million	4 971.54 SKK million
2020	5 340.34 SKK million	7 536.76 SKK million
2030	5 907.33 SKK million	8 567.39 SKK million

The estimated cashflow takes account of investment costs, operating costs and revenue from tolls. Net Present Value (NPV) is an optimising parameter used to determine economic efficiency factors for the toll system for the purposes of comparison with the vignette system.

This is a dynamic efficiency assessment method that takes account of changes in the value of money over time. It provides an indication of the total current value of an asset in terms of the return on the investment over a given period of time (usually starting one year before the investment is made). NVP also provides an indication of the return on investment. This method is suitable for use in comparing projects with different investment requirements, as in the case of toll and vignette systems. The best project will be that with the highest NVP value.

The cashflow forecasts cover the period 2001-2030. The first two years are spent on construction and installation of the toll collection system. Tolls start to be collected from 2003 onwards (in accordance with the initial design basis). The 8.8% discounting rate applied to cash streams is that applied by the National Bank of the Slovak Republic in 1999.

The inflation rate was calculated on the basis of forecasts by the Forecasting Institute of the Slovak Academy of Science for the years up to 2010. The inflation rate in subsequent years is assumed to be 3%. Cashflow and NVP were also calculated on the basis of a 30% difference in toll increases. The NVP for the toll system is as follows (SKK millions):

Table 9. **NVP for toll system**

	100% of rate of inflation	**70% of rate of inflation**
Optimum toll tariff	54 971.73	44 785.45
Maximum toll tariff	78 278.68	63 786.99

8. Comparison of toll and vignette systems

In order to determine growth in revenue from the vignette system over the period 2003-2030, account was taken of the following factors:

- Increase in car ownership levels;
- Growth of the number of cars;
- Extension of the motorway network.

The growth indices applicable to vignette sales are as follows:

2003/2000 ....1.062;
2010/2003 ....1.464;
2020/2010 ....1.391;
2030/2020 ....1.070.

Estimated revenue from vignette sales (irrespective of price rises) is as follows:

Year 2000 .... 1 299.52 SKK million;
Year 2003 .... 1 380.09 SKK million;
Year 2010 .... 2 021.06 SKK million;
Year 2020 .... 2 811.29 SKK million;
Year 2030 .... 3 008.08 SKK million.

The NVP was also calculated for the vignette system (SKK millions):

Table 10. **NVP for vignette system**

	100% of inflation rate	**70% of inflation rate**
Vignette system	29 728.89	25 013.14

Figure 3 compares revenues from tolls at both tariff levels with revenue from the vignette system. A similar comparison is made in Figure 4 according to cashflow, i.e. income after deduction of investment and operating costs.

Figure 3. **Comparison of revenues from toll and vignette systems**

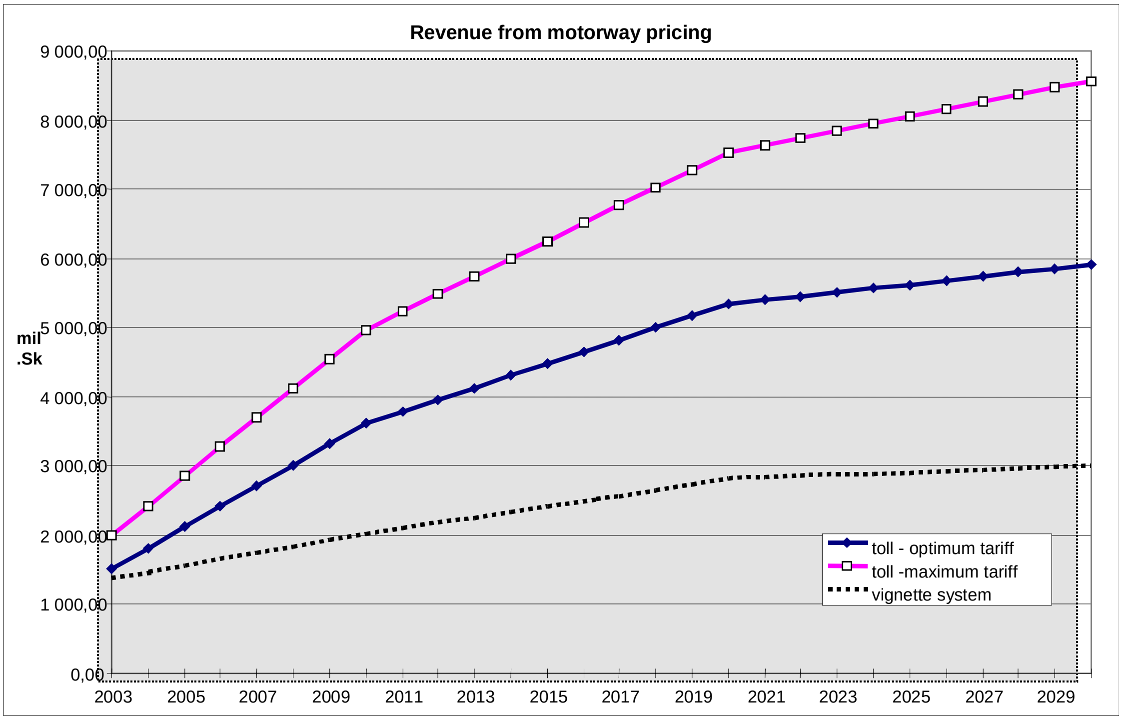
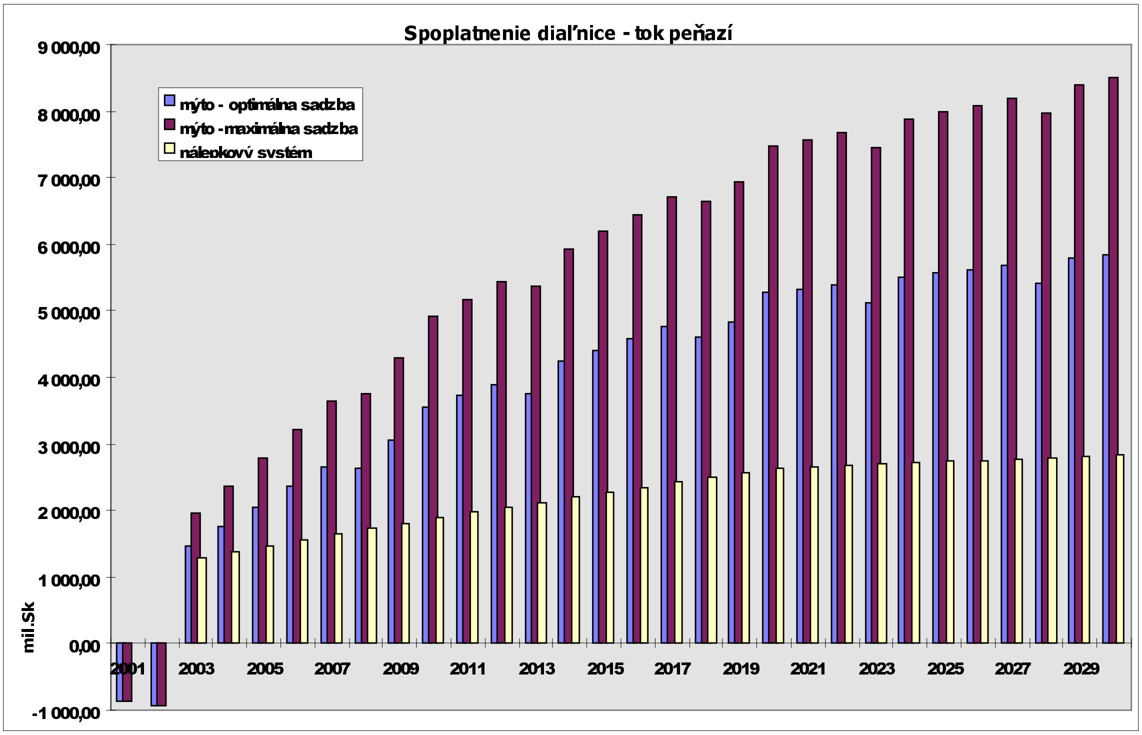


Figure 4. **Revenues from tolls and vignettes**



SUMMARY OF DISCUSSIONS

SUMMARY

INTRODUCTION

Tolls themselves are basically not a new issue. They existed in ancient times and their theoretical bases go back as far as Adam Smith. However, one can say that the purposes of tolls have been many and varied over time. Originally levied as transit duties, they were later a means of financing and maintaining roads, before coming to be seen as a means of internalising external costs and then as a tool for managing demand. Currently, there are two main reasons for introducing tolls: the usual financing needs, which is an objective in most countries, and seeking more efficient infrastructure use through optimum pricing, i.e. marginal social cost pricing. Nevertheless, the introduction of tolls may not be advisable in all circumstances. We must take care not to too readily confuse "tolls" and "optimum", in contrast to the economists' view. The lack of public acceptance for tolls also poses real problems.

The following is a summary of the discussions at the Round Table, which centred on the eight topics listed below.

1. General points;
2. Objectives in application of economic instruments;
3. Economic instruments available;
4. Internalisation of external costs in general;
5. Rationale for application of road tolls;
6. Public acceptance;
7. Technical introduction of tolling;
8. Collateral effects.

1. GENERAL POINTS

Adequate provision and operation of interurban road infrastructure is a complex problem, involving multiple objectives and constraints, for which various economic instruments are available.

No single instrument is best fit to handle all those objectives, and the best mix of instruments for any particular case depends on the hierarchy of the objectives as well as on the characteristics of the situation at hand.

2. OBJECTIVES IN APPLICATION OF ECONOMIC INSTRUMENTS

The three main objectives are:

a) Financing of construction, operation and maintenance of the road network;
b) Internalising external effects of road transport;
c) Providing quality of service to the user, while ensuring efficiency of the system (fighting congestion).

In parallel, there are two more objectives frequently found, the first of which is almost universal, the second being more often defended by environmentalist NGOs:

d) Generate some financial resources for redistribution to other sectors through the general budget;
e) Use transport taxes and charges to limit traffic growth, or possibly even reduce its volume.

In all cases, the road transport sector should cover at least its internal and external costs at the network level. The balance between road revenues and expenditure was an issue that was hotly disputed in the course of the Round Table. Some experts held that every country earned more in revenues from the road sector than they spent on it, and that there was therefore no reason why financing should be a problem. Their contention is that revenues generated by the road sector are several times higher than investment spending on the sector. In their view, the response to congestion should be to increase infrastructure capacity, as there is no economic justification for limiting capacity by a monopoly on supply. Others contended that if accidents, pollution and other external effects, such as congestion, are taken into account, road revenues cover no more than 70 to 80 per cent of spending. Seen in this light, road does not generate more income for governments than it costs them and the objective of governments should be to limit the nuisances caused by traffic: one way of doing so was rational charging for the use of road space. At any rate, one compelling argument is that charging to balance road spending and road revenues completely disregards the need to finance the statutory functions of the State, such as justice or education. In view of this, there was no need to be "sensationalist" about any ostensible road surplus.

3. ECONOMIC INSTRUMENTS AVAILABLE

The main economic instruments available for the generation of revenue are:

a) Vehicle-incident taxes:
    i) on purchase and registration;
    ii) for annual circulation/access to the network, possibly with two different instruments, one for the general network and another for motorways;
b) Fuel taxes;
c) Tolls.

All of these are price components, but the effectiveness of the signals they send to the consumer increases when the distance to the point and time of consumption is smaller.

4. INTERNALISATION OF EXTERNAL COSTS IN GENERAL

General internalisation of external costs through vehicle purchasing taxes is possible (although hardly effective at the current levels) but could be improved through annual circulation taxes if these have a base level determined by combustion volume and fuel type, and a *supplement strongly linked to actual emissions, as measured on the annual inspections that vehicles are submitted to*.

a) Improvement of emissions by new cars is best achieved through technical regulation;
b) Linking annual taxes to actual emissions is not only more clearly perceived by drivers, it also induces more effective fleet rejuvenation.

5. RATIONALE FOR APPLICATION OF ROAD TOLLS

There is no strong reason for a general recourse to interurban motorway tolls, as vehicle taxes and fuel taxes can frequently meet the financing needs for this type of infrastructure and still cover all the external costs generated by this type of transport, plus a contribution for redistribution to other sectors of the economy, through the general budget.

In many cases, it will be more efficient to increase supply (capacity) to the motorway infrastructure than to restrain demand through tolls, but there will be cases where there is no political will or physical possibility to increase capacity either for circulation along the corridor or for reception at the (mostly urban) destinations.

However, some circumstances might justify the application of tolls to interurban road tolls:

a) *If the overall extension and quality of the motorway network is considered well behind what it should be* for adequate support of the national economy and thus requires high financing resources, toll collection can help cover costs, thus allowing anticipation of the conclusion of the motorway construction programme, with one special concern: the level of the toll should not be so high that it restrains mobility in a developing economy, and this might require some contribution from the State budget to the investment. If there is no room for this contribution to occur in line with the investment, a combination of real and shadow tolls might be the solution;

b) If there is *a significant part of foreign vehicles using the motorway network without having paid vehicle taxes or fuel taxes in the transit country*, some form of contribution from these vehicles is fair, although this may be easier to collect through vignettes than through traditional tolls;

c) If there are *parts of the network where the costs are perceived by the drivers as especially high*, due to heavier congestion or environmental sensitivity, tolls may be an efficient instrument to internalise those "additional" (i.e. higher than in other parts of the network) costs. However, this should be done with special care in two directions:

   i) If these special costs occur with a strong peak factor, a time-modulated toll should be introduced (and adequate solutions for a flexible management of the modulation adopted);
   ii) If congestion occurs not only on the motorway but also on the road network around it (for instance, in a densely-occupied corridor or in a large periurban agglomeration), a traditional toll might only divert vehicles away from the motorway onto those (even more) congested roads, thus leading to a recommendation for an area-wide toll, possibly km-based;
   iii) Since these two circumstances can occur jointly, a time-modulated km-based charging scheme would be appropriate in such cases.

Close attention should be paid to any conflicts that arise between the need for finance and social equity and the need for finance and regional development or ease of access to isolated areas. In the first instance, it is important to develop alternatives to the infrastructure that is to charge tolls and, in the second, to ensure tariff re-balancing. What counts is to take an overall approach that looks at the entire network. This comprehensive approach includes all forms of taxation: fuel taxes, for instance, are too high on intercity routes, but not high enough to deter people from using the car for urban travel.

If there is a political will to introduce road tolls, it is essential that financial and legal experts are involved from the outset with the economists and engineers, to ensure that it will not happen that the tolling system design finally is unable to be applied at the intended targets or with the intended application of the revenues.

6. PUBLIC ACCEPTANCE

An important issue related to the introduction (but also to aggravation or change of incidence) of tolls is that of *acceptance by the public*. There are two types of public acceptance:

1. Selfish acceptance by individuals or interest groups, considering how they are affected by them;
2. Moral acceptance by individuals or opinion groups, considering what they think is fair. Equity aspects are especially important for this second type of acceptance, although it is much more relevant for urban road pricing.

The most important aspects to consider for acceptance of pricing measures are as follows:

a) Alternatives must exist to road tolled sections, and not be degraded in parallel with introduction of the tolling scheme (citizens must not consider themselves captives of a government strategy);
b) Application of the revenue collected should, to a significant extent, be towards improvement of the tolled components or of the alternatives (road or other modes);
c) Tolling should be applied to new components or to previously existing components where some guarantee of service is introduced;
d) As much as possible, total driving costs on previously existing sections should remain constant, only with a transfer from fixed to variable costs (from the users' point of view);
e) On first introduction, toll levels and overall complexity of the scheme should be relatively low, and later be gradually adjusted over time, as acceptance and understanding no longer constitute a problem;
f) If equity problems are identified, they should be treated carefully, as the dimension of non-accepting groups can easily be made much larger than those who are directly affected by them;
g) Wide information and communication about the objectives and rules of the tolling scheme are crucial;
h) Ideally, tolls are a means of varying charges for different periods, times, routes and levels of congestion. Tolls can be fine-tuned, while fuel taxes are a much cruder instrument. There may be strong opposition to tolls, if the aim is to reduce congestion in a geographical area that, because of population density, will continue to be congested. The only way to win acceptance of tolls in this case is to prove that they reduce pollution.
i) As a general rule, the public expects a great deal from the improvement of public transport, although in actual fact it is not very effective in solving transport problems. Conversely, the public's expectations of tolls are low despite the fact that they are a promising alternative. Tolls can be graduated to suit conditions: at rush hours, for example. It has been demonstrated that variable tolls have an impact on behaviour, as short-term elasticities are high. Nevertheless, if they are to be used to full advantage, the objectives must be clearly explained, measures to ensure fairness must be introduced and travel characteristics must be thoroughly understood prior to introducing them. Responsiveness to reactions is also a requirement.

7. TECHNICAL INTRODUCTION OF TOLLING

Adequate *technical introduction* of traditional tolling measures is no problem, but km-based charging is still in its infancy. Privacy concerns can be properly solved by use of a system in which there is an on-board unit, with a smart-card where all sensitive information is stored, supplemented by external (road-side or satellite) equipment, for checking purposes and defence against fraud.

a) Interoperability of these systems is highly desirable, especially for HGVs, and should be achieved within a few years, following on-going work in multilateral groups;
b) One interesting possibility for introduction of km-based charging would be through voluntary adoption of the corresponding equipment to be used for electronic payment on traditional tolled motorways, with added value for the hauliers adhering to the programme, like tracking-and-tracing information, and possibly some discounts on the toll levels.

As there is a progressive transfer from fixed costs to variable costs for road transport users in Europe, gradual harmonization of fixed costs across countries must be achieved.

8. COLLATERAL EFFECTS

There may be an argument on the negative impact of higher road-use costs for European global competitiveness, but if the idea is more towards variabilisation than increase, there should be no big problems arising. In any case, there are many other artificially high prices hindering competitiveness of European firms much more significantly.

CONCLUSIONS

Implementing tolling systems is not easy: for economists, the best solution is to base them on marginal social development costs, an approach which equates road pricing to a variant (one which internalises external costs) of traditional economic analysis. The public or, more accurately, road users see them as yet another form of taxation, i.e. as an additional tax that they would rather not pay! Policymakers are caught in the middle. Their dilemma is that they see the need for more finance, as well as the need to manage demand and counter the numerous negative impacts of transport. Nevertheless, as the Round Table showed, tolls are not advisable in every case, mainly because they pose problems with equity and the diversion of traffic to infrastructure that may already be heavily congested, but toll-free. In an economy that is heavily dependent on the inadequate infrastructure available to it, tolls can be a source of finance provided that they are not set too high, with the ideal perhaps being a mix of real and shadow tolls. Another proviso that we should add are the prospects that technology may open up: one distinct possibility is a network-wide electronic system that would charge by the kilometre at different rates depending on the infrastructure used and time of use. The result would be a charging system that could be much more finely tuned than existing systems - which use a combination of tax discs, fuel taxes and tolls - the crucial point being not to add to the fiscal burden on road transport, but to enable differential charging to suit the particular circumstance and, primarily, to make a distinction between urban and intercity transport.

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