concept

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English summary

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English summary

All activities in the transport sector are based on infrastructure - a network of roads, airports, railways, ports etc. The investment cost of the infrastructure, together with the costs of operation and maintenance, must be financed in one way or another, by tax payers or by users.

Based on economic welfare theory, which arguments can be used to impose a fee on the motorists for the use of the infrastructure? In the report, we discuss the *financing argument* (Part I) when the alternative is tax funding, and taxation leads to an efficiency loss; and the *congestion argument* (Part II) when traffic exceeds capacity. As an introduction we also look at more traditional arguments - in a situation where it is possible to finance infrastructure through non-distortionary taxation, and traffic is within the limits of capacity so that there is no congestion.

We use the road sector as a starting point, but the arguments could be used for other types of infrastructure too.

The traditional argument

User fees must be justified by the *use* of the infrastructure – the marginal costs. The optimal fee is the one that ensures that the users' marginal willingness to pay equals the social marginal costs.

There are, in principle, three user-related costs (marginal costs):

- The first and usually most important cost (at least in the road sector) are the users' direct cost related to travel time, the costs of fuel, vehicle wear etc. These costs are covered by the users themselves. They are internalised by the users and provide no argument for an additional fee.

- The second category of costs is related to road wear, i.e. the costs of maintenance caused by extra traffic. These costs are not internalised by the users and they hence provides an argument for introducing a fee.

- The third category of costs is those associated with negative external effects such as noise and pollution. To make users internalise these costs, a fee might be justified.

This could be illustrated through an example. We are considering building a bridge over a fjord to replace a road around the fjord. On each side of the fjord there is a suburb and city respectively. Today's traffic is 2 000 vehicles per day, and the total user costs (travel time, fuel, vehicle deterioration etc.) are 120 kroner per trip. We know the demand function of the motorists and if using the new bridge is free, user costs will be 60 kroner, and traffic will be 2 600 vehicles per day.

We will however assume that every vehicle leads to road wear equal to 3.33 kroner per trip. This suggests that a toll equal to 3.33 kroner should be imposed on the motorists. If we also assume that the noise cost that the motorists inflict on the surroundings could be expressed as a monetary value equal to 10 kroner per trip, the optimal toll increases to 13.33 kroner. The total user cost is then 73.33 kroner, and the traffic will be slightly less than 2 500 vehicles.

User fees in excess of the level discussed above is, however, common in the Norwegian road sector. This report discussed the two main arguments for that.

Tolls as a source of finance – when taxation leads to an efficiency loss

In the preceding section we assumed that it was possible to finance the infrastructure through non-distortionary taxation. However, most tax systems lead to efficiency losses, i.e. they affect the resource allocation in society negatively. That means that collecting 1 krone through taxes costs more than 1 krone to society. In Norway the Ministry of Finance has decided that the average cost of public funds used in cost-benefit analyses should be 0.2 per krone.

This means that the bridge could be regarded as a tax base on par with other tax bases and requires a toll could be collected. Every krone of profit from the toll collection reduces the need to collect other taxes. On the other hand, tolls lead to a dead weight loss when marginal willingness to pay differs from marginal costs. This efficiency loss must be compared to the efficiency loss as a result of general taxation.

In Part I of the report, the optimal toll, i.e. the toll that maximises social surplus, is estimated. Social surplus is the sum of three parts:

- Consumer surplus – defined as the difference between the consumers' willingness to pay and the user costs.
- The producer surplus - the surplus for the operator of the road. This surplus is multiplied with 1.2 as it reduces the need to collect taxes.

- Net external effects

When the toll exceeds the level which was optimal without distortionary taxes, the consumer surplus is reduced as some motorists now choose not to use the road. The producer surplus, on the other hand, is increased when the toll increases (as long as it does not exceed the monopoly price). What happens to the external effects depends on the size and balance of the positive and negative external effects.

With the use of the example, we show that at a cost of public funds equal to 0.20 per krone, the optimal toll is 47 kroner compared to 13.33 when the cost of public funds is zero. The result is total user cost equal to 107 kroner. The assumption of a non-zero cost of public funds has, in other words, dramatic implications.

Distributional effects are ignored in the example. In principle it is possible to include distributional effects in the analysis. The richer a motorist that uses the road is, the higher the toll should be.

Tolls in congested conditions

Travel time is an important part of the direct user costs. It is hence relevant to investigate how congestion implicates the optimal toll.

In a congested situation, one extra vehicle will contribute to increased congestion which means that the travel time costs increase for *all* motorists. This is a special case of negative externalities. When a motorist considers whether to enter a road network, he (or she) will only consider the *average* cost of congestion. He will not consider that the travel time (and costs) increases for all the existing motorists. To ensure that he takes these negative externalities into consideration a toll equal to the difference between the social marginal costs and the private marginal cost at the optimal level of traffic must be imposed.

The report also discusses cases where the optimal toll cannot be realised - and where a second best toll must be considered. An example of this is when a toll only could be imposed on a certain road in a network of roads. In such cases, motorists may choose untolled roads. This type of distortionary effects may have both private and social costs. In this second-best case, the toll is lower than the optimal first-best toll. In the report we show how this can be derived.

The report also discusses a result that in the literature is known as the Mohring and Harwitz theorem (1962). The theorem states that under certain conditions, an optimally designed and optimally priced road may generate tolls which cover both the investment costs and the costs of maintenance of infrastructure. The assumptions include constant returns to scale with respect to investment in increased road capacity, the ability to vary the road capacity continuously and unchanged user charges when road capacity and traffic changes by the same factor. The theorem originally assumed identical motorists, but it has later been shown that it also applies to cases where motorists have different valuation of travel time. The toll must be based on a weighted average of various motorists' valuation of travel time, where the weights are the number of trips during the period for those who still use the road after toll is imposed. The optimal congestion toll can further vary over a day, so that those traveling in the peak have to bear a greater share of the infrastructure costs.

So far we have used examples of how the external costs (noise, emissions, congestion etc.) are negative, but road investments may also have positive effects on the rest of the economy and which the motorists may not take into consideration. A source of these positive external effects is reduced travel times which may lead to larger and more integrated labour markets which may increase productivity and economic growth. More people commuting to work are an indication of positive externalities from road investments. Increased traffic may hence lead to two opposite effects. First, congestion and other negative externalities is an argument for a toll that internalises the cost. Secondly, positive externalities may justify a subsidy of driving to and from work. The optimal toll must take both effects into account.

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