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Summary:

Marginal External Costs of Transportation in Norway

Transport activities, like other economic activities, will affect other persons or enterprises than the ones taking part in the activity. Such effects are called external, and consist of effects for persons and businesses that cannot themselves influence the activity through the market.

The present study aims to calculate the marginal external effects of transportation activities in Norway. The external effects included are:

- emissions to air
- noise
- accidents
- infrastructure wear
- congestion

A similar study was carried out in 1995 (Eriksen and Hovi 1995). Unlike the study from 1995, congestion costs are included in the present study. This is due to the fact that the methods of estimation have been improved.

One important aim of the study is to compare the marginal costs of transportation activities with traffic-related charges and taxes on transport activity.

The study has been initiated by the Norwegian Ministry of Transport as part of the input to the National Transport Plan 2003 – 2010. The Ministry of Transport and the Ministry of Fishery[1] and the Civil Administrations of Road, Air and Rail have financed it as a joint venture.

Methods

This study will focus on the *marginal external* costs of transportation activities. We study the effects of increasing the transport activity by one unit under a short time horizon, which implies that we are looking at the *short-term marginal costs*.

External effects depend upon several factors, which again depend upon each other. Taking emissions as an example, transport volume will have an effect on the size of emissions, which again will influence the concentration of dangerous substances in the air. This concentration will have an effect on sickliness and death rates. Unit cost for emissions depends upon the rates of death and sickliness.

Norwegian and international surveys have been used to assess the unit costs. Some of these will measure *willingness to pay* (WTP) to avoid a deterioration of the environment

[1] Responsible for harbours and costal shipping.

etc. Other surveys are based on *avoidance costs* or *the shadow price* of reaching a certain environment target.

Local emissions are closely related to *fuel consumption*. This is the case for regional emissions as well, but in some cases the relationship is more complicated. Driving conditions like the temperature of the engine plays an important role. For some substances the *distance driven* under varying conditions is the most important factor. The physical emissions to air from road traffic are calculated in the Norwegian "Road Emission Model".

Numerous different substances stemming from transportation activities influence local and regional environment. Since it is not possible to put a price on each of these components, we have chosen some components that are considered important, both regarding physical amount and damage effects. Of course it is a precondition that we have reliable cost estimates.

The substances included in the valuation are:

- Sulphur dioxide (SO2)
- Nitrogen oxides (NOX)
- Volatile organic components (VOC)
- Particles with diameter less than 10 μm in diameter (PM10)

For NOX and VOC assessments are based upon a study from ECMT under OECD. Partly this goes for particles too, but here we also rely on a study from The Norwegian Central Bureau of Statistics. Assessments of SO2-costs are based on a survey by The Norwegian Pollution Control.

Global costs are calculated as the shadow price of fulfilling the Kyoto treaty. These costs are calculated by means of a macro-economic model and may be interpreted as the charge on CO2-emissions that is necessary to make Norway fulfil the treaty. In *alternative A* all industrialised countries will have the same type of charge. In *alternative B* trading emission quotas is supposed to be allowed.

Noise in the physical sense is measured by the number of persons that are disturbed by noise – or assessed from the average sound level in decibels. For assessing noise costs we apply studies of WTP for reducing the subjectively felt noise to half. In the railway case we apply a hedonic price approach. Real estate prices are in a Norwegian study found to increase by 10 percent as the distance to the railway track is doubled within the distance of 100 metres from the track.

Congestion costs are calculated by means local transport models. At the two Norwegian transport research institutes, TØI and SINTEF, transport demand models for large Norwegian cities with a detailed network representation of roads and public transport supply are built and maintained. Road users are assumed to minimise travel cost or travel time, and the origin - destination matrix is supposed to be fixed. By adding a small number of cars in the models, the marginal congestion price may by calculated.

Traffic accidents can be said to have three types of cost:

- Costs of lost human lives and reduced health condition
- Lost income and expenses due to accidents
- Material costs

The parties that bear these costs are injured persons, their family members, vehicle owners, private third parties and the public sector. The costs for all these parties together make up the total social costs of traffic accidents. In *road* transport all accident costs are classified according to type of vehicles involved and whether costs are *external* or *internal*. Self-inflicted accidents are always internal. Accidents with two or more vehicles are split up in internal and external part according to size of vehicle.

For the other transport modes *railway, sea* and *air* most of the costs are internal. The external costs here consist of deaths and injuries of non-travellers and the part of traveller's death and injury costs that fall on relatives and on the public sector.

Infrastructure wear depends on traffic in a complicated way. Wear is a function of type of infrastructure, traffic volume, weight of vehicle, speed, vehicle type, etc. The form and parameters of such a model is not easy to determine. Therefore we have to base our calculations on extremely simplified assumptions.

All infrastructure costs are split into *fixed costs*, *transport related costs* and *volume related costs.* Suppose the level of maintenance is just sufficient to keep a constant standard of infrastructure. All amounts in the accounts should be split according to this. Then all traffic related maintenance cost should be divided upon all users of infrastructure according to traffic volume.

This is done for the road, railway and air sectors. Water transport is not seen to have measurable marginal infrastructure costs. For road transport the axle load factor is raised to the power of 2,5. For air transport operation, some of the costs for infrastructure services are included.

In calculating **marginal taxes and charges** only purely transport volume dependent charges are included. There is a distinction between regular charges and taxes to the government and charges that are meant as payment for public infrastructure services.

Results

These results are based upon alternative A for global emissions.

In proportion to passenger kilometres it is motorcycles that have the highest marginal external costs, mainly due to traffic accidents. For these the marginal external cost per passenger km is NOK 1.18. Also very high costs have passenger ships, with NOK 0.93, but here local pollution is the most important factor. The lowest costs have passenger trains and airplanes with NOK 0.17 and NOK 0.20 (appendix A, table 8).

In goods transport the small and medium sized vehicles have the highest marginal external cost per tonnekm, about NOK 1.95. Cargo ships have the lowest cost by 0.03 per tonnekm. Freight trains cost NOK 0.12 per tonnekm externally (appendix A, table 8).

When marginal external costs are compared to the amount of taxes and charges on the margin, it is seen that passenger cars and even to a greater extent other light petrol driven vehicles (combined-cars and small vans) pay more traffic charges than their external costs.

When charges for infrastructure use are included, air transport pay even twice its costs on the margin. This result is due to the fact that all investments and administration costs are included in these charges, in contrast to other sectors. Apart from air no other transport modes are close to paying the marginal external costs. (Appendix A, tables 10-14).

There are substantial differences in marginal external costs by population density. In average the cost are twice as high per vehicle kilometre in big cities as in other built-up areas and around five times as high as in rural areas. The differences are mainly due to very high congestion costs and local emission costs in big cities and high local emission cost in built-up areas compared to rural areas (appendix A, tables 17, 20 and 23).

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