Funding roads and the road damage externality

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Abstract
Road use creates numerous external effects; road damage, congestion, environmental damages and accidents. Charging for the use of roads, and especially heavy trucks, has been on the political agenda for many years and some countries in Europe has introduced kilometre based charges and other are considering to do so. These policy are often an unclear mix of pressing needs for general revenues and claims for more efficient use of roads. We focus here on the infrastructure cost, which together with congestion cost, surprisingly, has been the most difficult to find a theoretical sound base for political agreements.

The short-run marginal infrastructure cost associated with an additional vehicle can be divided into three components, i) the marginal cost of road wear, ii) the marginal cost of road damage and iii) the road damage externality (Bruzelius 2004). The first component relates to changed current or routine maintenance cost as the wear of the road increases due to an additional vehicle. The second is related to the cost of periodic maintenance as the deformation or damage to the road increases due to an additional vehicle. The final component is associated with the increased cost imposed on all other road users as the road quality deteriorates quicker with an additional vehicle on the road.

This paper focus on the two last components, ignoring the marginal cost of road wear. In the seminal work by Newbery (1988) it was shown that the marginal cost of road damage (ii) is equal to the average cost under some assumptions and the road damage externality (iii) is zero and can be ignored. Consequently, the expected short run marginal cost is equal to the average maintenance cost. This was labelled the Fundamental theorem. The Fundamental theorem has had a strong influence on transport policy. With a short run marginal cost equal to the average maintenance cost an efficient pricing policy can be introduced through a simple cost allocation model only focusing on maintenance expenditures. This is the backbone of the European Union legislation.

However, already in Newbery (1988) numerous caveats were raised around the probability of the underlying assumptions. This paper reveal the basic foundation of the Fundamental theorem and develop a set of new expressions for the marginal cost of road use. First, we develop a more general expression of the marginal cost of road damage (ii). Secondly, we show that a cost minimizing road authority will set the length of the pavement cycle so an implicit deterioration elasticity can be
derived. Finally, we develop a general expression for the road damage externality. If the road authority chooses an optimal pavement cycle, similar to the Faustman-Pressler-Ohlin cycle of forest harvesting, we show that the deterioration elasticity is implicitly decided and this elasticity will not support the assumptions of the *Fundamental theorem*. In addition, based on a general formulation of the road damage externality we show that with a cost minimizing road authority this externality cannot be ignored. Common for the analyses are that we use an infinitive time horizon with no technological development or growth in traffic volume. The infrastructure is in a steady state with continuously and equal pavement cycles. At a certain point in time the traffic volume increases and then falls back to the steady state. This ‘blip’ creates the marginal cost.

**References**


