External Costs of Road Traffic Accidents

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Abstract: This paper presents the main conclusions of the author’s doctoral thesis, which deals with the problems of the quantification of the social and primarily the external costs of road traffic accidents. It describes an original model of the calculation of the marginal external costs of road traffic accidents, taking into account the fault of their participants.

Key words: External costs, marginal costs, road transport, accidents, fault, insurance

1. Introduction

The external costs of transport are treated in many publications (see e.g. [1], [2]) and especially the external costs of road traffic accidents obviously represent an important problem, but the first serious models of them appeared as late as in the nineties of the 20th century ([3], [4]).


This is why the author in his doctoral thesis [8] tried to create a more general model of external costs, which would take into account the fault of the accident participants and which is described in the following chapter.

2. A new model of external costs

Now we shortly describe our model of external costs:

First the total (or social) costs $TC_m$ of accidents with traffic mode $m$ involved can be expressed in the form:

$$TC_m = (a+b+cV) + (cA+d).A_m,$$

where

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\( a, b, c_V \) ... cost items related to the numbers of accident victims \( V \), (for simplification of notation) a vector with components corresponding to distinguished degrees of injury severity, e.g. killed, seriously and slightly injured, then \( V=(V_k, V_s, V_l) \), \( a=(a_k, a_s, a_l) \) etc.

\( a \) ... willingness-to-pay (WTP) of injured victim

\( b \) ... ditto of victim’s relatives and friends,

\( c \) ... system external cost (taken by the rest of the society, i.e. net production loss, medical and administration costs), here further divided (\( c=c_V+c_A \)) into

\( c_V \) ... system externality component related to injury (net production loss and medical costs),

\( c_A \) ... system externality component related to accident (administration costs),

\( d \) ... material damage,

\( A_m \) ... number of accidents involving the mode \( m \) (e.g. passenger cars, cyclists etc.).

The marginal private costs \( MPC_m \) (as a function of the traffic volume \( Q_m \)) we consider in the following form (supposing that no external cost rise for the health and the property of the accident victim in fault):

\[
MPC_m(Q_m) = (a+b) \cdot v \cdot r_m + d \cdot \theta_m \cdot r_m ,
\]

(2)

where

\( v \) ... average numbers of victims related to the accident \( (V=A_m \cdot v) \), further divided into responsible (index \( r \)) and innocent (index \( n \)) ones \( (v=v_r + v_n) \),

\( r_m \) ... risk of the traffic mode \( m \) \( (r_m=A_m/Q_m) \),

\( \theta_m \) ... share of the mode \( m \) on the material damage.

The marginal external costs \( MEC \) (related to traffic volume) we now obtain from the general expression for external costs

\[
MEC = MSC - MPC
\]

(3)

by substitution from equations (1) and (2):

\[
MEC_m(Q_m) = \frac{\partial TC_m(Q_m)}{\partial Q_m} - [(a+b) \cdot v \cdot r_m + d \cdot \theta_m \cdot r_m].
\]

(4)

After simple conversions and introduction of the risk elasticity \( E_m \) (with respect to the traffic volume \( Q_m \))

\[
E_m = \frac{\partial r_m}{\partial Q_m} \cdot \frac{Q_m}{r_m}
\]

(5)

we obtain the following final expression for the marginal external costs:

\[
MEC_m = [(a+b+c_V) \cdot v + (c_V \cdot v_r + c_A) + d] \cdot r_m \cdot E_m +
+ [(a+b+c_V) \cdot v_n + c_V \cdot v_r + c_A + d \cdot (1 - \theta_m)] \cdot r_m
\]

(6)

This formula is fairly simplified assuming the zero value of the elasticity (i.e. the number of accidents directly proportional to the traffic volume):

\[
MEC_m = [(a+b) \cdot v + c_V \cdot v + c_A + d \cdot (1 - \theta_m)] \cdot r_m
\]

(7)
So we get an acceptable expression - the external costs (related to vehicle-kilometre travelled) consist of the WTP components \((a, b)\) of innocent (non-responsible) victims, the total system externality \((c)\) and share of material damage of other accident participating modes.

### 3. Discussion

The assumption of zero risk elasticity is equivalent to the constant risk or the linearity (direct proportionality) of the number of accidents and the traffic volume. Although we still know very little about these “accident” functions, the data (e.g. [7]) show decreasing risk, i.e. its non-positive elasticity. So the term \((7)\) gives an upper estimate for external costs.

In the presence of the third party liabilities insurance it can be argued that many cost items from the expression \((7)\) are already internalised (except e.g. system external costs). But this is true only either in the average for a mode (i.e. the whole group of chosen road traffic participants), or in the case of variable insurance premium (calculated i.a. on the base of distance travelled, so called “Pay As You Drive” insurance), which is used for the present only by a few progressive insurance companies.

Unfortunately we meet the lack of accident data concerning the fault of the victims in the official police road accident databases, because the fault is sometimes not immediately obvious and must be found out in an administrative process. These data can also be partly obtained from the insurers.

Finally, most of decisions are done under uncertainty. A better approach should consider the fact that people do usually not decide according to the expected value of damage, but rather of its expected utility and even more complicated principles depending on e.g. the risk aversion.

### 4. Conclusions

Our model of calculation develops the preceding ones by natural incorporating of the role of the fault on the external road accident costs.

Apparently there still stay many questions to answer concerning the problems of the external cost of accidents. Although the problem of external cost was properly enlightened in its general form already in the famous paper of Coase [9], the particular problem of the external costs of road traffic accidents remains in the author’s opinion the challenge for the transport researchers, economists and statisticians of the 21st century.

### Literature


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