

THE MODELS OF CALCULATION OF EXTERNAL COST FROM ROAD TRAFFIC ACCIDENTS

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Summary: Road traffic accidents are serious public problem that encroaches whole society. Primarily the impact of traffic accident experiences straight forward participants of accident. In another sequence impacts and most of all costs are accepted by the whole society. Costs connected with road traffic accidents are estimated beyond 2 - 4 % the gross domestic product in general. It is absolutely necessary to try to determine level of costs, analyse the impacts and consequently possible chances for improvement of situation. The consequences of traffic accidents can be horrendous, and people indicate a high willingness-to-pay (WTP) to reduce the risk of being a victim of a traffic accident. Road traffic accidents impacts and their evaluations can be primarily divided into two parts: direct and indirect impacts. Very often is calculation (models) of external cost based on the value of statistical life (VOSL). The aim of this paper is to present models for calculation of accident costs which is used in the EU member states.

Key words: external cost, models of calculation, accidents

INTRODUCTION

The road accidents are one of the most critical problems being faced by people, countries, govern etc. at present time. Apart from the humanitarian aspect of reducing road deaths and injuries in developing countries, a strong case can be made for reducing road crash deaths on economic grounds alone, as they consume massive financial resources that the countries can ill afford to lose. The deaths of persons and serious economic loss caused by road accidents demand a continuous attention in accordance with the spectacular growth in road transportation. It is now realized that better and more efficient techniques of accident information management system are required. This is one of the main factors responsible for road accidents in many metropolitan cities. The increasing number of road accidents is imposing considerable social and economic burdens on the victims and various direct and indirect costs to individuals and government. The automobile boom is becoming a curse in disguise by killing and injuring millions of people all over the world (1). The traffic movements on city roads have been compounded by frequent interruptions, resulting in drastic reduction in speed, leading to congestion and accidents. Road accidents cause injury, death, loss of property and damages to vehicles. All these involve a monetary loss to the economy (3). When roads are improved, road accident rate will come down. This results in quantifiable benefits to the economy. Though the overall death rate has declined and expectation of life has gone up, the death risk on roads has considerably increased. It must of

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course be borne in mind that in developing and emerging nations, road safety is one of the many problems demanding its share of funding and other resources. Even within the boundaries of the transport and highway sector, hard decisions have to be taken on the resources that a country can devote to road safety. In order to assist in this decision-making process it is essential that a method be devised to determine the cost of road crashes and the value of preventing them (2).

1. THE ANALYSIS OF THE EXTERNAL COST OF ACCIDENTS

1.1 The models of calculating external cost of accidents

From the general point of view the traffic accidents can be said to have three types of cost:

- costs of loss of human life 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 the total social costs of traffic accidents. We assess the cost of loss of a statistical life and of injuries of different severity in a meta study of numerous WTP surveys. From this the cost of the loss of a statistical life is significant. It is subject to debate whether production loss and the relatives' welfare loss due to the accident should be included. The accident cost should be divided into internal and external costs. The external part can be calculated as a part of accident costs in road transport based on the facts that the different road user groups play an unequal part in accidents where two or more vehicles are involved. All accident costs are classified according to type of vehicles involved and whether costs are external or internal. Self-inflicted accidents are always considered internal (5).

In this part we introduce the most frequently used models, which are used for calculation of external cost of accidents. The models of calculation are mainly based upon the following simplified formula:

$$[\text{External cost}] = [\text{unit cost}] * [\text{degree of harm}] * [\text{intensity}] * [\text{transport volume}] \quad (2).$$

Next three formulas represent three basic considerations of impacts of accidents (1,3,8,9).

1. HCC – Human capital cost

- life period lost x average output per victim
- life period lost × average output per victim – future consumption
- value of willingness to insure the life
- value of court award for accident

$$HCC = Ex * P - Ex * C \quad (1)$$

E_x = Expectation of life at age x ; x being the average age of accident victim; P = Productivity at age x ; C = Consumption at age x .

2. Accident cost

$$AC = RC + HSC + GD + ND * AF \quad (2)$$

RC = Resource cost = (Damage to roads + Damage to vehicle + Court overheads + Medical expenditure and overheads + Police overheads + other incidental expenses; GD = Average gross damage amount paid to the accident victim by the insurance company; ND = Average net damage amount for particular type of vehicle; AF = Adjustment factor for ND . Damage amount paid include the cost of spare parts and labour charges. Cost of spare parts has tax component, which has to be excluded to arrive at economic cost.

$$AF = SPC + LC / SPC + T + LT + CL \quad (3)$$

Values of AF for different vehicles have been computed from the data collected from automobile dealers. CL = Consequential losses after accident: the vehicle remains idle and is not used for commercial purposes. Goods in the vehicle may get spoiled and vehicle may undergo further damages. Insurance companies do not cover these consequential losses. It was estimated that consequential loss may amount to 40% of the gross damages amount paid by insurance companies. SPC is the Spare Parts Cost exclusive of taxes, T is the Tax components and LC is the labour Cost.

$$EC = ND * AF + SC + CL \quad (4)$$

3. EC – Economic cost of damage to the particular type of vehicle

Accident cost is a complex problem covering various domains of socio-economic, political, legal, medical and administrative features. The systems dynamics in its extensive forms can take all these aspects. But the model suggested in this study is a sample form to analysis of road accident costs. Many assumptions have also been made in this study. Most crucial issue in the accident cost estimation is non-availability of data and the cost factors are not static. The cost factors like annual income of victims and the value of money are changing day by day. In this study both the factors have been considered.

4. P_{bc} - Average probabilities of each type of road accident

$$P_{bc} = \lambda_{bc} * q_c \quad (5)$$

Marginal external accident costs are caused by an extra vehicle-kilometre exposing existing road users to a greater risk of an accident. It is assumed in the base model that existing road users do not react to this greater risk by driving more safely. A simple mathematical model represents the average probabilities of each type of road accident. It is

assumed that all accidents occur between two vehicles. For any one kilometre of travel by vehicle of type b, the probability, P_{bc} of an accident with a vehicle of type c is proportional to the number of c vehicle-kilometres travelled, q_c where λ_{bc} is a parameter.

1.2 The value of statistical life

Humans cannot be bought for any price. However, with a limited supply of resources or infrastructural capital (e.g. ambulances), or skill at hand, it is impossible to save every life, so some trade-off must be made. Also, this argumentation neglects the statistical context of the term. It is not commonly attached to lives of individuals or used to compare the value of one person's life relative to another person's. It is mainly used in circumstances of saving lives as opposed to taking lives or "producing" lives. Like mentioned before such a comparison between a human life and any tangible value may occur, for example as part of a cost-benefit analysis of variants of security planning. Economists often estimate the value of statistical life by looking at the risks that people are voluntarily willing to take and how much they must be paid for taking them. These types of studies, which look at a person's actual choices, are known as revealed preference studies. Another method economist can use to estimate the value of statistical life is by simply asking people (perhaps through questionnaires) how much they would be willing to pay for a reduction in the likelihood of dying, perhaps by purchasing safety improvements. These types of studies are referred to as stated preference studies. The value of statistical life (VSL) is a very controversial topic that is essential to optimize government decisions. Value Still Life (VLS) is derived from the willingness to pay (WTP) for reducing the risk of death. VSL is the economic value that measures the tipping point when society as a whole is willing to pay (WTP) to reduce the statistical risk of death (11).

1.3 Models of calculation of statistical value of life

Most people consider the value of human life as infinite and incomparable with other different values, so the determination of the value of human life may seem unethical (10).

VSL determine by:

$$VLS = \frac{\partial WTP}{\partial R} \quad (6)$$

R...risk of life harm

The issue of valuation of human life is addressed using a few basic models (6,8,9,10):

- the standard model
- the dead-anyway effect and the wealth effect
- risk aversion and background risks
- multiperiod models

1. Standard model VSL

The standard single-period VSL model is taken as the most suitable. The individual maximizes his (state-dependent) expected indirect utility which is given by:

$$VSL \equiv pu(w) + (1 - p)v(w) \quad (7)$$

p ...the probability of surviving the period

$u(w)$... the utility of wealth (w if he survives the period)

$v(w)$... the utility of wealth (w if he dies)

The value of statistical life does not measure what a person is willing to pay to avoid certain death, nor what he is willing to face.

2. The dead-anyway effect and the wealth effect

The expression obtained for the VSL is useful for identifying two standard effects. First, the dead-anyway effect describes how VSL increases with baseline risk, i.e., how VSL decreases with survival probability. Intuitively, an individual facing a large probability of death has little incentive to limit his spending on risk reduction since he is unlikely to survive. Second, the wealth effect describes how VSL increases with wealth. The intuition for the wealth effect is two-fold. First, wealthier people have more to lose if they die. Second, the utility cost of spending is smaller due to weakly diminishing margin utility (risk aversion) with respect to wealth

3. Risk aversion and background risks

It is often suggested that the VSL obtained from compensating wage differential studies underestimates the average VSL in the population because those who choose to work in hazardous industries are less risk averse. This suggestion, however, requires a more precise specification about what we mean by less risk averse. For state-independent utility functions, it is usual to define risk aversion by the coefficient of curvature of the utility function. ECKHOUDT AND HAMMITT (4) consider the standard model and examine the effect of an increase in risk aversion in the sense of Arrow-Pratt of the utility contingent on being alive. They show that more risk aversion increases the VSL when the marginal utility of bequest is zero and in a few other situations.

4. Multiperiod models

We have presented so far a single-period model. In more realistic multiperiod models, individuals have preferences over probability distributions of the length of life and over consumption levels at each period of life. We illustrate this using the simplest two-period model:

$$VSL \equiv \max_c u(c) + \beta pu(r(w - c)) \quad (8)$$

- β... discount factor,
- r... interest factor,
- c... consumption in period 1.
- p...survival probability from period 1 to period 2.

Observe that there is no bequest motive, and that an individual surviving period 1 will die for sure in period 2.

2. RESULTS AND DISCUSSION

Above described models were used and within years 2011 and 2013 we collected data and information. According to given multiperiod model we calculated the annual costs incurred as a result of road traffic accidents in Czech Republic. Persons and property on the roads cause economic cost of over 2,4 milliards EUR. This represents almost 2% of Czech GDP, prices taken from year 2010. The total calculated economic costs of accidents at the cost of personal injury in 2010 accounted for a total of € 14.04 milliards, including € 4.64 milliards in fatalities, serious injuries to € 7.83 milliards and € 1.57 milliards to slightly injured. Overall, this represents a 45% share of the total costs. The share of the cost of damage was 55%, which represents a cost amounting to € 16.96 milliards.

CONCLUSION

Road accidents result in losses beyond the scope of market value. The loss of value in domestic work and the informal economy are not reflected in the official national product statistics. Humanitarian costs are the consequences of injuries that lead indirectly to loss of resources. An accident can cause such psychological impairments in people involved in accidents and their relatives. As a result, a limited capacity incurred up to the disability.

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