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## Models for Estimating Human Capital Losses due to Traffic-Related Deaths

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### Abstract

The article provides new approaches to estimating the losses caused by traffic-related deaths with the income-based method of measuring the human capital. We developed an economical and mathematical model for measuring the human capital which was lost in traffic accidents during a reporting period. The model is based on estimation of human capital according to the yield curve with regard to age and level of education. The article describes the benefits of the proposed method which bridges a gap between estimating the production losses as losses of the state and social losses caused by road traffic deaths. The calculation results show higher loss estimates - a price which is to be paid by the country for road fatalities of its citizens - than what is stated by the official reports based on existing techniques.

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### 1. Introduction

About 35,000 people die annually in Russia in road accidents, more than 70,000 become disabled. Large cities (with more than 300,000 people) account for 65% of the total number. In 2009 the number of road traffic fatalities

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amounted to 26,084 people, in 2009 – 26,084 people, and in 2015 – 23,100 people. Economical damage caused by road accidents is commensurate with the domestic expenses on health care [Federal Council (2013), Rosstat (2010)].

According to the procedure for estimating and calculating the social and economical damage due to road accidents, the losses are constituted of the following:

- losses as a result of death or injury of people;
- losses as a result of damage of transport vehicles;
- losses as a result of damage to the goods;
- losses as a result of damage to roads [Ministry of Transportation RF (2001)].

The damages of transport vehicles, roads and goods can be easily estimated (the estimation mechanism is readily available, the norms are updated according to the inflation rates and the lost or damaged can be fully recovered), whereas the estimation of losses due to death or injury of people requires a different approach and estimation mechanism. We refer here to estimation of non-material, irreparable damage which has both economical and social nature. We should consider the potential which a casualty has not fulfilled and which, therefore, shall be regarded as a foregone income and lost economical effects.

## 2. Main text

Estimation of death-related losses normally includes economical and social and economical losses. The former group includes losses related to decommissioning of a person from production activities, the latter - to losses incurred by the state for paying pensions, rendering medical services as well as losses due to death of children. So death of a person is regarded only in a production, economical context, while the social aspect is interpreted in terms of the load on the state. Traffic-related death of children is also rated among losses of the state. Besides, the damage is measured on the basis of direct and consequential losses for the economy. "Losses to the economy related to temporary or lifetime decommissioning of a person from production activities, derangement of production communications and moral losses" [Ministry of Transportation RF (2001)] are classified as consequential losses. The interpretation of losses in terms of production only narrows severely the basis for estimation of losses due to traffic-related deaths and is therefore disputable. It is clear that moral losses are hard to be estimated and formalized, but this does not imply that the efforts for integrating the social component and moral aspect into the estimation of the damage shall be abandoned altogether.

For damage estimation we suggest using the concept of human capital which is a combination of knowledge, skills and experience applied for the sake of a person himself and society [Christian (2012)]. Family, society and state contribute to the accumulation of human capital, so death of a person as a holder of human capital inflicts damage to family, society and state. Once the estimation of human capital losses in traffic accidents is applied, the imperative of the state in estimating the losses can be safely discarded [Boarini et al. (2012)].

The amount of human capital can be estimated according to the income of a worker. The theory of measuring the human capital gave an origin to different approaches according to which the estimation can be either expenses-based with regard to building the human capital, or income-based depending on the amount of human capital of an individual [Odintsov and Nedbailo (2010), Bazanov (2015)]. It is more practical to use the income-based method for the model of human capital losses due to traffic-related deaths, because the information about distribution of salary is available over the entire life time, while statistical data on distribution of expenses for accumulation of human capital is much harder to obtain because it is difficult to make a full list of such expenses [Stroombergen et al. (2002), Xiaodong et al. (2015)].

The measurement of accumulated human capital implies a period of time covered by the estimation. To estimate human capital losses, we will need to calculate the value of human capital within the working time from 22 to 60 years ( $H_t$ ), as well as from the time when the working career was started to the time of road traffic death ( $H_m$ ). Since the economy of Russia has major differences in salary among industries, we will distinguish 28 enlarged professional groups and calculate the accumulated human capital for each professional group. Because of the major differences in salaries of workers with different level of education (statistical importance of these differences have been confirmed more than once), we will calculate the value of accumulated human capital for each of the three levels of education separately: for graduate, undergraduate and vocational education ( $H_B, H_{HB}, H_{CH}$ ).

By doing so we obtain a family of curves of human capital accumulated within the entire life cycle:

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