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Policy-Driven Investigation of Sectoral Latent Information Regarding Global Road Fatalities

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Abstract

Road safety considerations correspond to an important element in the transport decision making and policy agenda, closely related to the increased valuation of human casualties in developed societies. Nevertheless, the expected raise of mobility, especially through private motorization, is putting a tough challenge on the decision/policy making that should be transferred from developed (in terms of road crash risk) and applied to developing (in the same terms) regions and countries. As reported in the relevant literature, the phenomenon of road traffic fatalities can be assigned to several factors that can be captured by several socio-economic factors. The current research aims on investigating the phenomenon of road traffic fatalities in a macro level and across the globe towards decision/policy making. For achieving this, a cardinal assumption investigated here relies on the fact that this complex phenomenon cannot be fully explained by a specific set of variables, giving raise to the assumption of unobserved, latent information. A solid methodological framework for incorporating observed and latent structures in a seamless manner, Structural Equation Modeling (SEM), is thus considered. As such, the objective of this study is to use an extensive database including socio-economic data (aiming on treating endogeneity), concerning 121 UN countries for the year 2013, within a SEM modeling framework. A robust approach was considered and useful results were produced, indicating that the proposed modeling framework is appropriate for estimating the road traffic fatalities.

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Keywords: Structural Equation Modeling; Global Road Fatalities; Model Selection; Latent Data Structures.

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1. Introduction

Due to the fact that internet provides a huge source for data collection and that road traffic fatalities are still a global phenomenon, in the current paper an explanatory analysis in a macro level, across the globe and towards decision/policy making was undertaken. In particular, a novel approach on estimating total national road traffic fatalities based on a database of 121 UN countries (restricted to UN countries with reasonable population for analytical purposes) is conducted for the year 2013, investigating the assumption that even within extensive socio-economic database unobserved/latent information still exists. The data that were collected capture relevant socio-economic factors, obtained from alternative global organizations. From these original data, an extensive database of 31 variables was created, covering all 121 UN countries. The experimental setup uses 8 data sets from the database; 4 for estimating the direct numbers of road traffic fatalities (Scenario 1); and 4 for estimating the road traffic fatality rates according to the number of registered vehicles (Scenario 2). It is noted that each dataset was preprocessed for collinearity, omitting overlapping information.

Several SEM models were estimated, identifying structural relationships among observed and latent variables (reflecting socio-economic sectors) with the dependent variable (numbers/rates of road traffic fatalities), in a systematic way reflected in each analysis scenario. The final specification of each SEM model was selected based on a backward stepwise regression analysis procedure, eliminating statistically non-significant variables at the 95% confidence interval. The results provide statistical information for each SEM model, according to four goodness-of-fit criteria (Akaike's information criterion, AIC; Schwarz Bayesian information criterion, BIC; goodness-of-fit index, GFI; and Root Mean Square Error of Approximation, RMSEA). The evaluation of the estimated models is based on the above described – widely accepted- goodness of fit criteria. In particular, the four goodness-of-fit criteria were used for selecting the appropriate SEM models that best 'fit' the data. Consequently, the selected models can be regarded as appropriate for estimating/'explain' road traffic fatalities for the 121 UN countries in 2013, and thus valuable for policy-making.

The remainder of this paper is structured as follows. Section 2 offers a background review of previous implementations of SEM. Section 3 presents the data collection procedure and data inflation (multicollinearity) treatment. Section 4 describes the SEM implementation and removal of not-statistically significant variables. Section 4 presents the ultimate model selection procedure. Section 5 offers conclusion remarks and highlights points of further research.

2. Background Review

Structural Equation Modeling (SEM) is widely used in several research fields, such as economy (Tahmasebi and Rocca, 2015), health (Lai et al., 2015), and road safety (Hassan et al., 2013). By segregating measurement errors from the true score of attributes, SEM provides a methodology to account for latent structures directly (Yuan and Bentler, 2006). In the present study, this specific property of latent structure models were utilized, for studying the relationship among an extensive database of socio-economic factors and the road traffic fatalities.

Focusing this brief literature review on SEM applications related to transportation, Zhou et al. (2015), analyzed the data by using SEM for examining pedestrians' self-reported violating crossing behavior intensions. Hassan and Abdel-Aty (2011), investigated drivers' responses under low visibility conditions and quantify the impacts and values of various factors related to drivers' compliance and satisfaction with variable speed limit and variable message signs instructions in different visibility and traffic conditions, covering two types of roadways. In the current research the relationship between socio-economic factors and road traffic fatalities was studied by the implementation of SEM not in an operational level, but rather on a macro level.

For implementing SEM analytical procedure in a sound manner, models should be tested and compared according to various goodness-of-fit criteria. In Hooper et al. (2008) a variety of fit indices were introduced that can be used as a guideline for avoiding erroneous SEM implementation. Preacher and Merkle (2012), discussed problems originating from sampling variability in selection indices and they also review model selection criteria and show, via simulation, that model selection decisions using information criteria (specifically the Bayesian information criterion) can be highly unstable over repeated sampling, even in large samples.