Introduction - Background

Road accidents constitute a major social problem in modern societies, with road traffic injuries being estimated as the third leading cause of death globally.

Particularly in low and middle-income countries, road traffic injuries are twice those in high-income countries and still increasing.

- 7th Decade of Action: need to strengthen global and national efforts for causal reduction through evidence-based approaches.

Main objective

- Develop a global road safety model based on global road safety data, which may serve as a road safety decision making tool for three types of policy analysis, i.e., intervention benchmarking and forecasting analysis.

Methodology

- A conceptual framework of five layers of the road safety system is suggested, and a dedicated database was developed with various road safety indicators for each layer (e.g., fatalities and injuries, performance indicators, road safety measures, economy, and background).

- A two-step modeling approach was implemented: the research first estimating the composite variables and then their introduction in a generalized linear model correlating them with road safety outcomes.

Research challenges

- The relationships between indicators and road safety outcomes are complex and in some cases random.
- The problem is multi-dimensional and transferability of known causalities in a global context is not recommended.
- Existing knowledge on road safety causalities is incomplete and comes mostly from industrialized countries.
- There is lack of detailed historical data on several indicators and road safety outcomes at international level.

Modelling Approach

Two-step approach of statistical modeling:

- Estimation of composite variables (factor analysis) in order to take into account many indicators of parallel cause.
- Correlating road safety outcomes with indicators through composite variables by developing a regression model with explicit consideration of the dimension.

Model specification

- Logarithmic distribution: \( Y = \text{Log}(	ext{Fatalities per Population}) = \beta \times (GDP) + \gamma \times (\text{Economy and Management}) + \zeta \times \text{(Transport Demand and Exposure)} + \mu \times (\text{Road Safety Measures}) + \eta \times (\text{PI}) + \epsilon \), where \( \text{Composite Variables} \)

Database

- Very limited data availability due to lack of data on certain indicators.
- Limited number of cases, limiting the sample size for the model.
- Multiple issues with data quality and sources.
- Lack of comparable data across countries.

Estimation of Composite Variables

- The factor analyses were implemented on each of the layers of the road safety systems, constrained to yield one factor per layer:
  - Economy and Management
  - Transport Demand and Exposure
  - Road Safety Measures
- Performance Indicators

- For fatalities and injuries indicators, the fatality rate per population was selected as main dependent variable.

Generalized Linear Model Development

The optimal performing model for the purposes of the analysis:

- The dependent variable is the logarithm of the fatality rate per population for 2013.
- The main explanatory variables are the respective logarithm of fatality rate in 2010 and the respective logarithm of GDP per capita for 2010.

- The model provides overall forecasts of short-term developments, which might be extrapolated in the future.

- The model includes many indicators which are correlated, thus testing combinations of "similar" interventions is recommended.

- The model may not fully capture the effects on countries with very particular characteristics.

- Development countries are expected to be more sensitive in the testing of interventions than developed ones.

- The lack of a global road safety database with detailed and comparable data certainly compromises the effort to develop a global road safety model.
- A new wave of historical data may allow to further validate and adjust the model, as well as to make more accurately account in the underlying trends by estimating future developments on the basis of longer historical trends.
- Further changes in programs and measures implemented in the various countries will need more accurate estimations on effects, improving the transferability of estimates in other countries as well.
- It is suggested to closely monitor global developments in data availability and accuracy, so that the data are kept updated with continuous effort on improving the model with more and more accurate data.

Conclusions – Discussion

- The model developed took into account several challenges and particularities of road and population-related data.
- The task of road safety forecasting on the basis of policy scenarios, i.e., combining an explanatory approach on road safety with the time dimension at global level, was a challenge on its own, and there is no similar example in the literature.

- Data and analysis methods have some limitations which should be kept in mind:
  - Fatality data are in some cases estimated numbers, and in all subject to under-reporting.
  - Missing values were addressed by imputation.
  - The available data for several indicators were not detailed

- The optimal use of the model depends on the type of recommendations and the subject.
- The model is limited to the analysis of short-term developments, which might be extrapolated in the future.

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