State-space based analysis and forecasting of macroscopic road safety trends in Greece

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Basic road safety figures, Greece 2001-2011 (1/2)
During the last decade, road fatalities in Greece have decreased by 42%, whereas serious injuries decreased by 50%.

- The rate of fatalities per number of vehicles has decreased the same period by 63%.

- This high fatalities rate is also explained by the high increase of the vehicle fleet in Greece during the same period.

- Increase in Police enforcement was found correlated to the road fatalities decrease.
The analysis of macroscopic road safety trends has received a lot of attention in the literature. Using dedicated time series analysis techniques such as ARMA-type and state space modeling is recommended. These two types of models are not exclusive of one another as each type of model may also be written under different forms, and equivalences between well-defined specifications have been empirically demonstrated.

Reliable estimates of exposure (vehicle-kilometers) are not available for Greece. Suitable proxies, such as vehicles in circulation, GDP, or fuel consumption are considered.
Methodology (1/2)

- Seemingly unrelated time-series equations (SUTSE)
  - Simpler model
  - Also used as a diagnostic to determine whether more elaborate models would be useful

- Latent risk time-series model (LRT)
  - Without interventions
  - With interventions

- Model comparison
  - Non-nested models $\rightarrow$ Summary likelihood-based diagnostics unsuitable
  - Model quality tests (autocorrelation, heteroscedasticity, normality, transition correlations, ...)

Data used in this research were extracted from:
- the CARE database of the European Commission with disaggregate data on road fatalities,
- the Eurostat database with aggregate statistics on all sectors

Processing and analysis of these data took place within the Dacota EU co-funded research project (2010-2012)

These results will be soon available at the European Road Safety Observatory of the European Commission (www.erso.eu).
Data Considered

Interventions in the fatalities:
• 1986: financial crisis
• 1991: “old-car-exchange” scheme
• 1996: fatality recording change (24hr → 30 day)
Residual analysis for final LRT model

State Auxiliary Residual Q–Q Plots
Slope exposure

State Auxiliary Residual Q–Q Plots
Level exposure

Theoretical Quantiles
Greek Fatalities Veh.Fleet LRT with interventions (full, 4 obs)
Validation Results

Forecast plots
Greek Fatalities Veh.Fleet LRT with interventions (full, 4obs)

- Observations
- Estimate
- Margins

Year
- 1960
- 1970
- 1980
- 1990
- 2000

Fatalities Greece
- 0
- 500
- 1000
- 1500
- 2000
- 2500

Vehicles (x1000) Greece
- 0
- 1000
- 2000
- 3000
- 4000
- 5000
- 6000
- 7000
- 8000
Forecasting Results
Conclusion

- Multivariate state-space models were developed for the analysis and forecasting of macroscopic road safety trends in Greece
  - Inclusion of exposure measures
  - Modeling of interventions

- Validation and forecasting results are presented
  - Useful in confirming that there is no overfitting
  - Comparisons with final actual data (2009-2010) indicate that the models perform properly, even in unusual situations, like the current strong financial crisis in Greece.
Directions for further work

- Other functional forms and model specifications

- Additional parameters (e.g. GDP) to separate exogenous effects and isolate road safety trends

- Comparison across countries and regions
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