Forecasting fatalities in times of recession

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Outline

- Background and objectives
- Individual country models
  - Structural time-series models with interventions
- Exploratory analysis
  - Annual change, panel data
- Integrated model
  - Panel time-series models
Outline

• Background and objectives

• Individual country models
  – Structural time-series models with interventions

• Exploratory analysis
  – Annual change, panel data

• Integrated model
  – Panel time-series models

Forecast plots
Latent Risk Model Greece recession

Long term
Short term
Short + long term
Background and objectives

- Annual or occasional changes in economic indicators may be associated with road safety changes.
- During the last few years, road traffic fatalities exhibit important reductions in several countries.
- These reductions may not be fully justified by policy efforts alone, and may be partly attributed to the global economic recession, affecting mobility.
Literature review

• Economic slowdown may lead to reduction in accidents and fatalities

  – Early 70’s petrol crisis / reduced speed limits (Tihansky, 1974)
  – Early 80’s economic recession (Wagenaar, 1984; Hedlund et al. 1984; Reinfurt et al. 1991)
  – Late 00’s recession in the US / annual changes in unemployment rate and CPI (Kweon, 2011)
The effects of recession

Plot of GDP in Greece

Plot of fuel consumption in Greece

Plot of fatalities in Greece
Structural time-series models with interventions

For more information on this section:
Latent Risk Model

- **Structure**
  - Input:
    - Exposure
    - Fatalities
  - Model components:
    - Mobility
    - Risk

  $\text{Fatalities} = \text{Mobility} \times \text{Risk}$
  $\log \text{Fatalities} = \log \text{Mobility} + \log \text{Risk}$

- **Thus:** Relation expected between Exposure and Fatalities.

Bijleveld et al. 2008
Without modeling recession (Greece)

GDP Greece

Fatalities Greece
Modeling recession (Greece)

Forecast plots
Latent Risk Model Greece recession

Forecast plots
Latent Risk Model Greece recession

GDP Greece

Fatalities Greece

Year


The two scenarios side-by-side

- Forecast Fatalities Greece
- Lower (2.50%) forecast
- Upper (97.50%) forecast

Year vs. Fatalities per year for the forecast scenarios in Greece.
Short term

Exploratory analysis of panel data / annual changes of fatalities and GDP

For more information on this section:
Yannis, G., E. Papadimitriou and K. Folla (2012). Effects of GDP changes on road traffic fatalities. IRTAD Meeting, Amsterdam, 18-19 October 2012
Data and analysis methods

- Data for 27 European Union countries have been extracted from the IRTAD database (1975-2010)
- **Dependent variable: the annual percentage change in the fatality rate**
- **Main explanatory variable: the annual percentage change of GDP per capita**

- A mixed effects modelling technique has been applied
- Logarithmic form of the model
- Fixed effects: groups of countries
- Random effects: Autoregressive covariance structure to capture the time series effect
Fatality rates “follow” GDP

Spain (correl: 0.61)

United Kingdom (correl: 0.53)

Finland (correl: 0.45)
Data exploration - groups of countries

- **Northern / Western:**
  A decreasing trend in the fatality rate spans the entire period

- **Central / Eastern:**
  The fatality rate shows more fluctuation, and the effect of the changes in political regimes of the early nineties is striking

- **Southern:**
  The decrease started somewhat later, following an initial increasing trend
GDP annual change – Road fatalities annual change

NORTHWESTERN EUROPE

EASTERN EUROPE

SOUTHERN EUROPE

LN(F/P)c
GDPc

GDPin
GDPde

LN(F/P)c
GDPc

GDPde
GDPin

GDPin
GDPde
## The current recession

<table>
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<th></th>
<th>Fatalities</th>
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<th>GDP per capita</th>
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<tbody>
<tr>
<td>Belgium</td>
<td>1071</td>
<td>944</td>
<td>942</td>
<td>840</td>
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<tr>
<td>Czech Republic</td>
<td>1221</td>
<td>1076</td>
<td>901</td>
<td>802</td>
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<td>Germany</td>
<td>4949</td>
<td>4477</td>
<td>4152</td>
<td>3648</td>
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<td>Estonia</td>
<td>196</td>
<td>132</td>
<td>100</td>
<td>79</td>
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<tr>
<td>Ireland</td>
<td>338</td>
<td>280</td>
<td>238</td>
<td>212</td>
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<td>Greece</td>
<td>1612</td>
<td>1553</td>
<td>1456</td>
<td>1281</td>
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<tr>
<td>Spain</td>
<td>3823</td>
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<td>2714</td>
<td>2478</td>
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<td>France</td>
<td>4620</td>
<td>4275</td>
<td>4273</td>
<td>3992</td>
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<td>Italy</td>
<td>5131</td>
<td>4725</td>
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<td>3934</td>
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<td>Lithuania</td>
<td>740</td>
<td>499</td>
<td>370</td>
<td>300</td>
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<td>Hungary</td>
<td>1232</td>
<td>996</td>
<td>822</td>
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<td>Netherlands</td>
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<td>677</td>
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<td>679</td>
<td>633</td>
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<td>5437</td>
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<td>3907</td>
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<td>Portugal</td>
<td>974</td>
<td>885</td>
<td>840</td>
<td>845</td>
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<tr>
<td>Finland</td>
<td>380</td>
<td>344</td>
<td>279</td>
<td>272</td>
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<td>Sweden</td>
<td>471</td>
<td>397</td>
<td>358</td>
<td>266</td>
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<tr>
<td>United Kingdom</td>
<td>3059</td>
<td>2645</td>
<td>2222</td>
<td>1905</td>
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Macro panel data
Data and methodology

• Data collection
  – Source: IRTAD database
  – 35 European countries
  – 1975-2010

• Macro panel data
  – N number of countries and T number of years are small to medium size,
  – of the same order of magnitude (30)

• [vs micro panel data]
  – large N (>100) and small T (<10) (multi-level models)
Macro panel data

Three types of relationships (homogeneous)

- Short term between the first differences (short run par.)

\[
\log FAT_{it} - \log FAT_{it-1} = \%FAT_{it} = a_i + b \%GDP_{it}
\]

- Long term between the levels (cointegration) (long run par.)

\[
\log FAT_{it} = a_i + b_i t + \beta \log GDP_{it}
\]

- Combination of dynamics: Error correction model (ECM)

\[
\log FAT_{it} - \log FAT_{it-1} = a_i + b(\log GDP_{it} - \log GDT_{it-1}) + C(\log FAT_{it} - a_i + b_i t + \beta \log GDP_{it})
\]
Summary of preliminary results

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<th>z-test</th>
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<td></td>
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<tr>
<td>I GDP</td>
<td>0.74</td>
<td>23.07</td>
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<th>CCEMG Pesaran</th>
<th>coef</th>
<th>z-test</th>
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<tr>
<td>Intercept</td>
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<td>1.4</td>
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<td>I GDP</td>
<td>0.458</td>
<td>2.23</td>
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<tr>
<td>t</td>
<td>0.018</td>
<td>0.015</td>
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<tr>
<td>I FAT2</td>
<td>0.928</td>
<td>5.57</td>
</tr>
<tr>
<td>I GDP2</td>
<td>-0.971</td>
<td>-2.51</td>
</tr>
</tbody>
</table>

![Graph showing estimated coefficients and p-values]
Summary of preliminary results

- Careful with interventions and country linear trend

- Preliminary analysis
  - Significant overall effect (0.46)
  - Significantly >0 for 12 countries (UK, FR, NI, DK, PL ...) and <0 for CZ only
  - When non significant, 11 countries >0 and 8 <0

- Next steps:
  - Per population
  - Add interventions
Discussion and Conclusions
From correlation to causation

- A number of possible impacts of economic recession are suspected to contribute to the impressive reductions in fatalities:
  - **Fewer vehicle-kilometers**: increased fuel prices, decrease of recreation mobility, less heavy goods vehicle traffic
  - **Less speeding**: increased fuel prices, more economical and environmentally friendly driving, low drivers’ morale
  - **Less risky driving**: fewer young, inexperienced or elderly drivers afford vehicle ownership and travel
Discussion

- At periods of economic recession there may be important road safety “benefits”, i.e. important reductions in fatalities.
- Once the socioeconomic conditions improve, fatalities may temporarily increase, “correcting” for the effect of external factors (GDP change).
- The monitoring and quantification of the effect of changes in economic growth on road safety may assist:
  - in the prompt identification of such situations
  - in the interpretation of road safety improvements or deteriorations
  - in the adjustment of expectations as regards future developments.
Next steps

- In a few years, where more data will be available, it will be possible to fully assess the effects of the current economic recession on road safety, and validate whether it fits the pattern suggested by the results of the present research.

- More advanced statistical methods for panel time series analysis will certainly provide improved estimates of GDP annual changes on road fatalities:
  - Fixed or random country effects
  - Correlations between effects (i.e. country groups)
  - Taking into account previous interventions on GDP and fatalities
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