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Forecasting fatalities in times of recession

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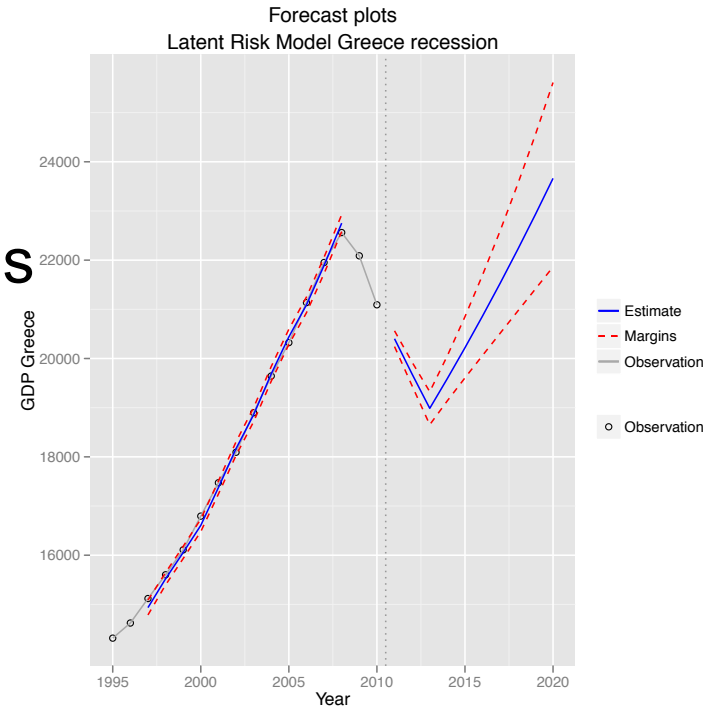
Outline

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



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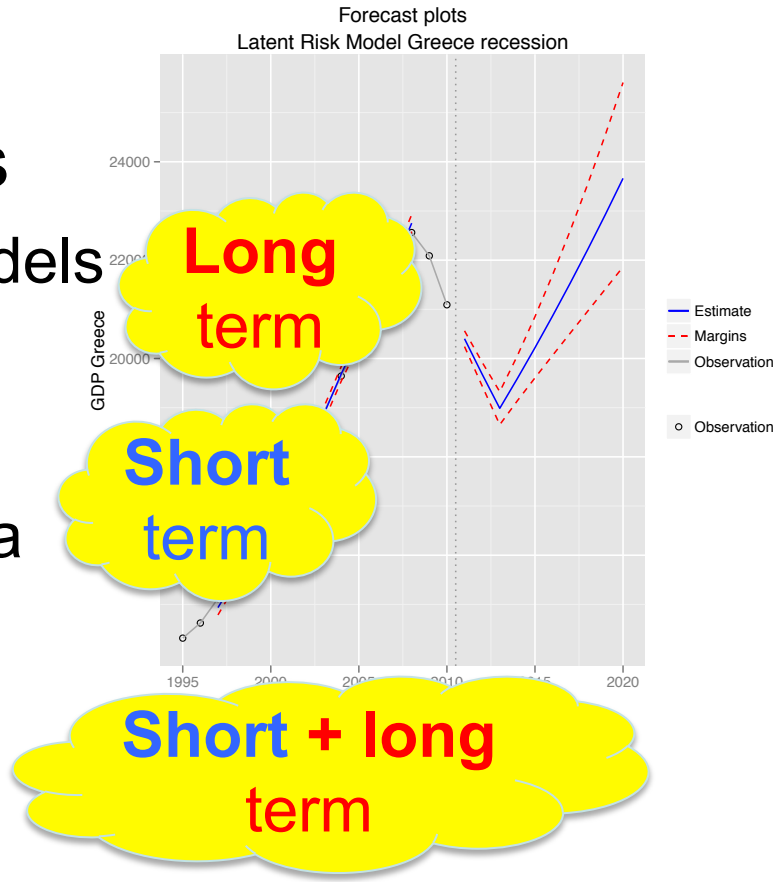

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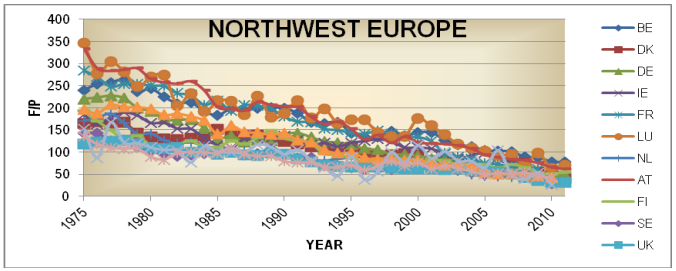
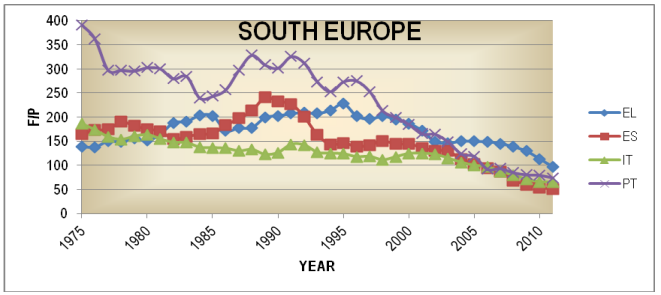
Background and objectives

- 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





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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)

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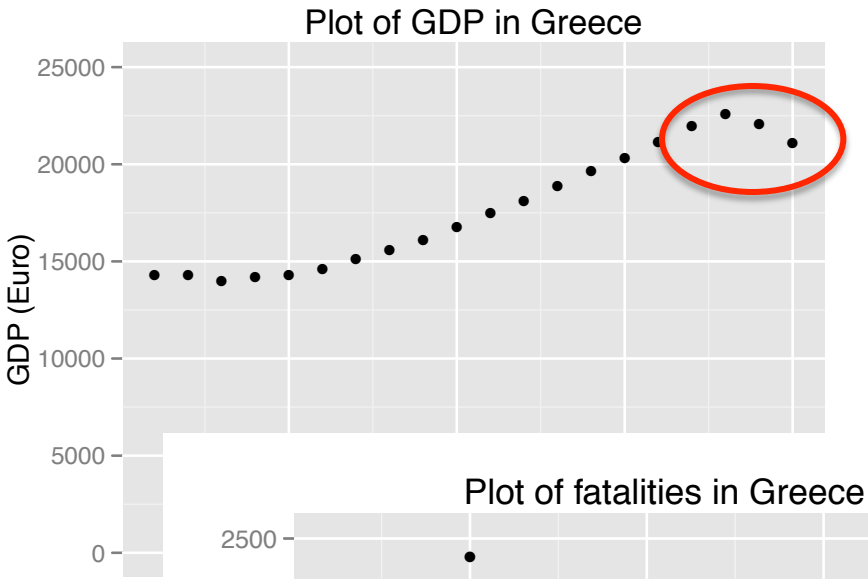
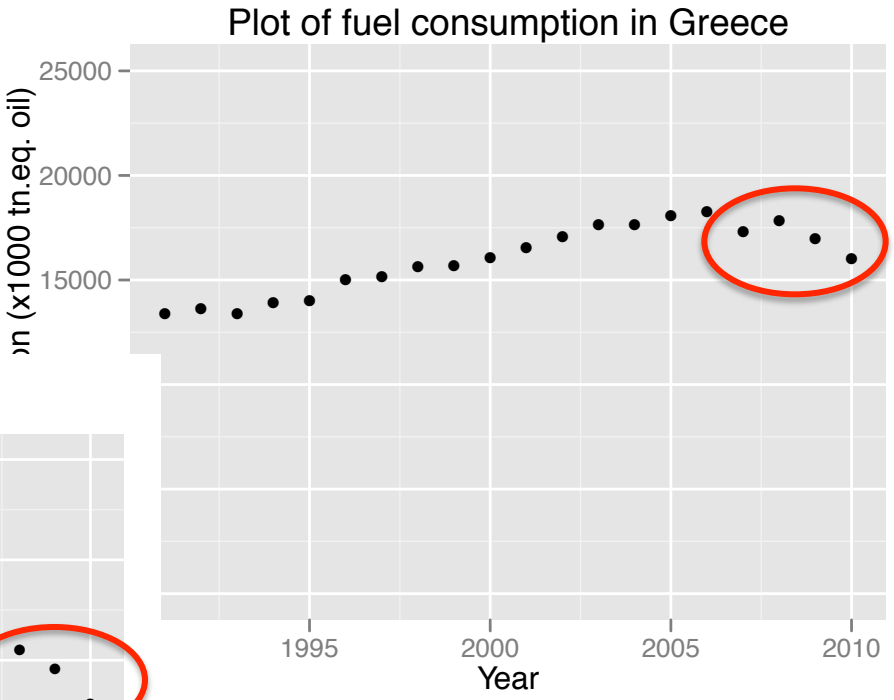
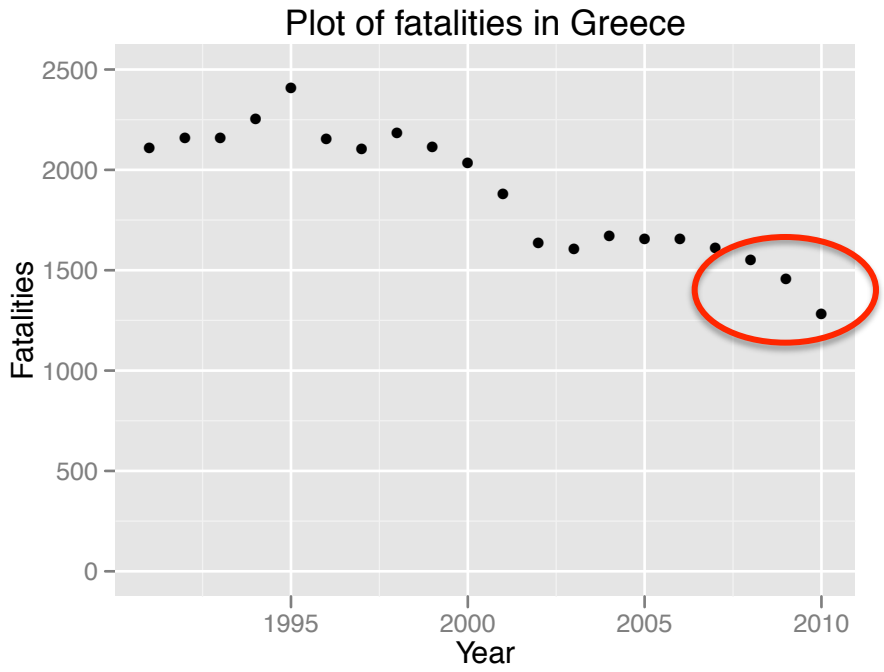
The effects of recession







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Long term

Structural time-series models with interventions

For more information on this section:

Antoniou, C. and G. Yannis (2013). Assessment of exposure proxies for macroscopic road safety prediction. Proceedings of the 92nd Annual Meeting of the Transportation Research Board, January 2013, Washington, D.C.

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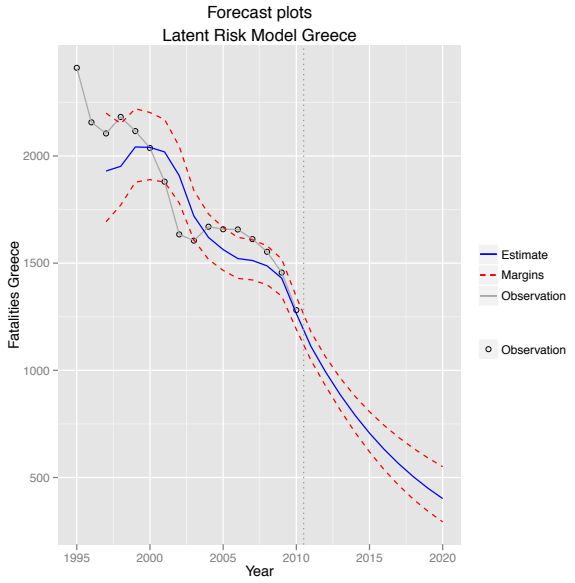
Latent Risk Model

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

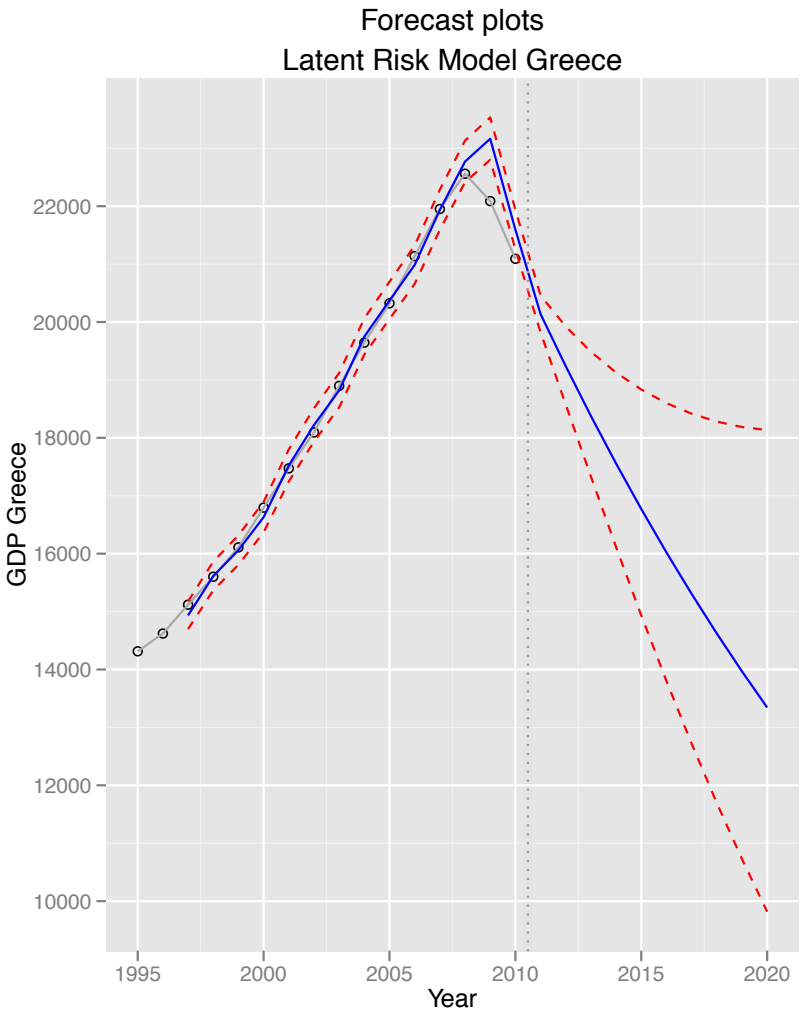
    Fatalities = Mobility * Risk

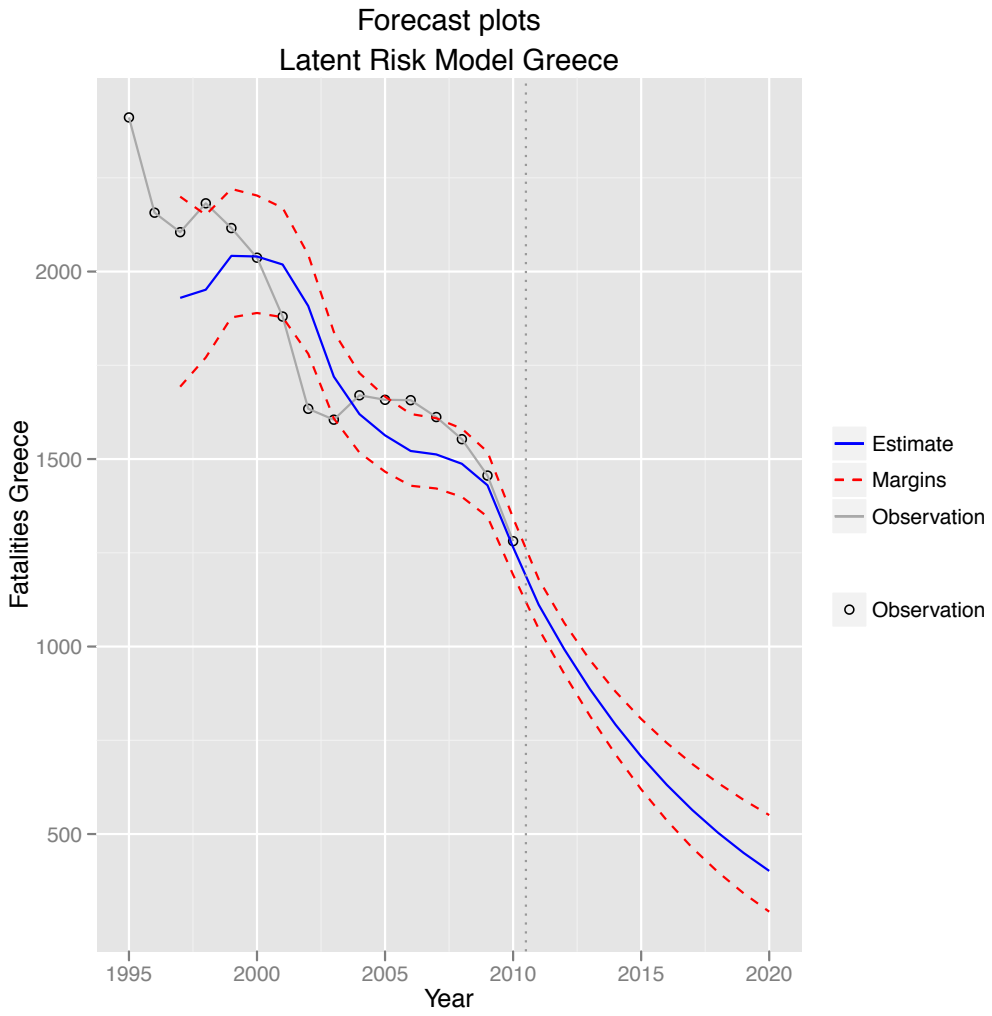
    log Fatalities = log Mobility + log Risk
- Thus: Relation expected between Exposure and Fatalities.



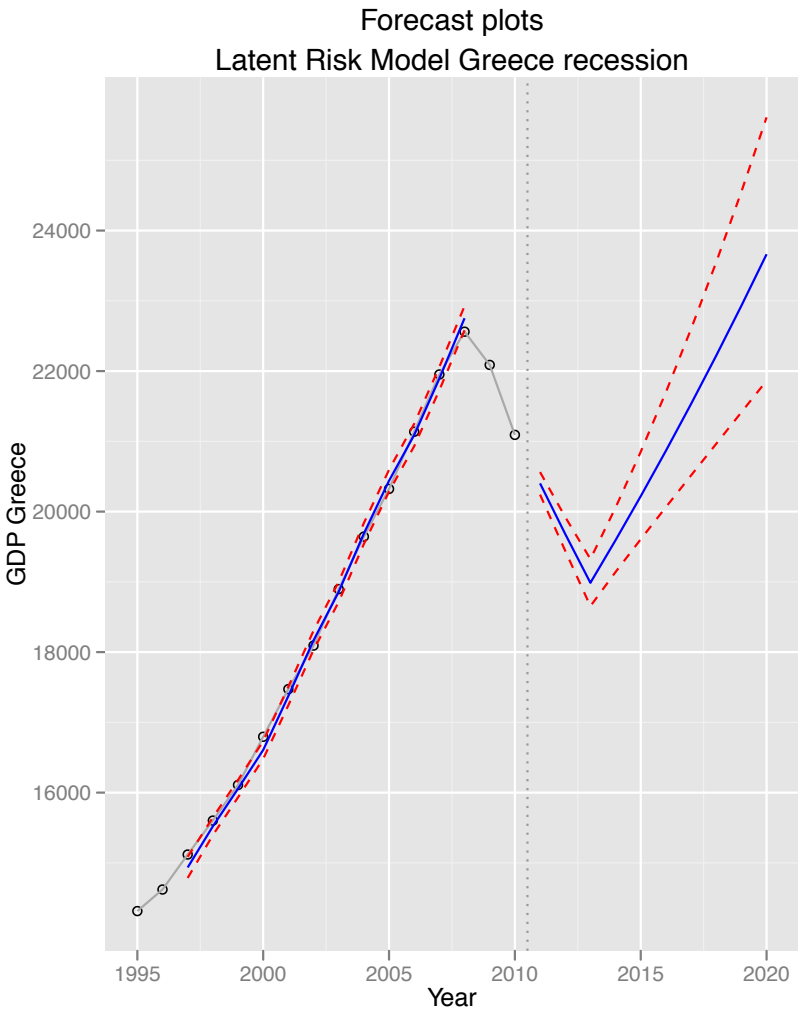
Bijleveld et al. 2008

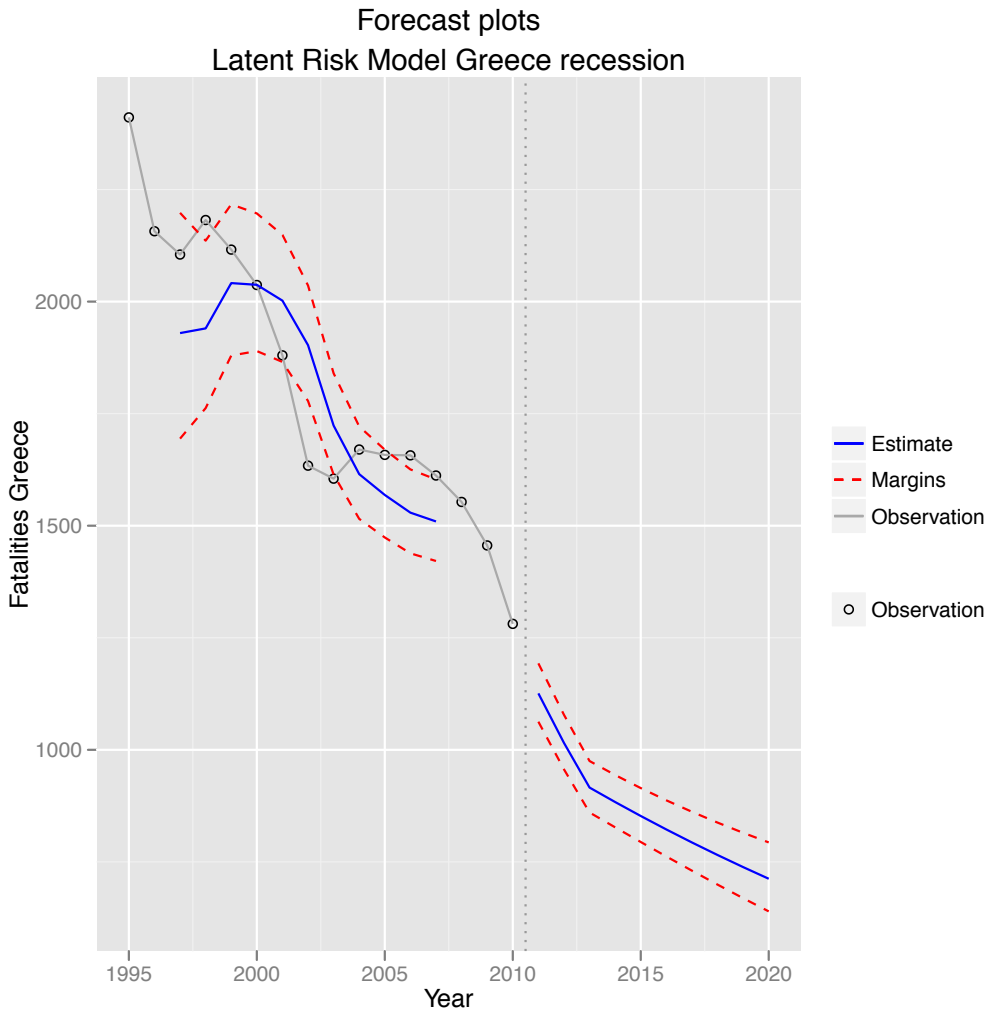
Without modeling recession (Greece)



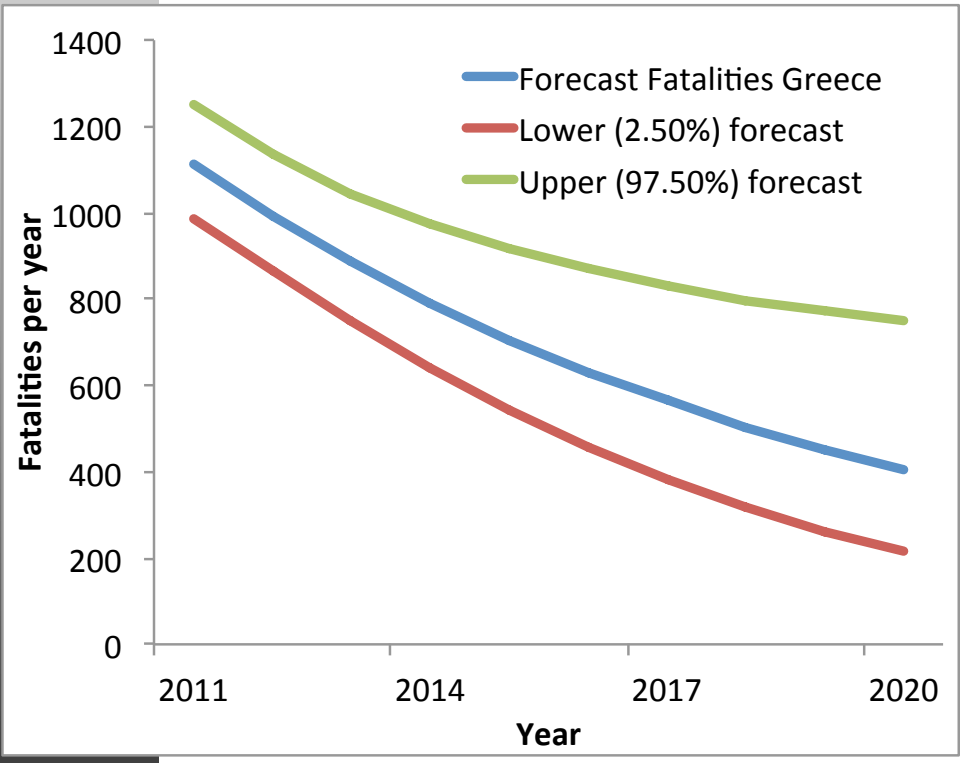


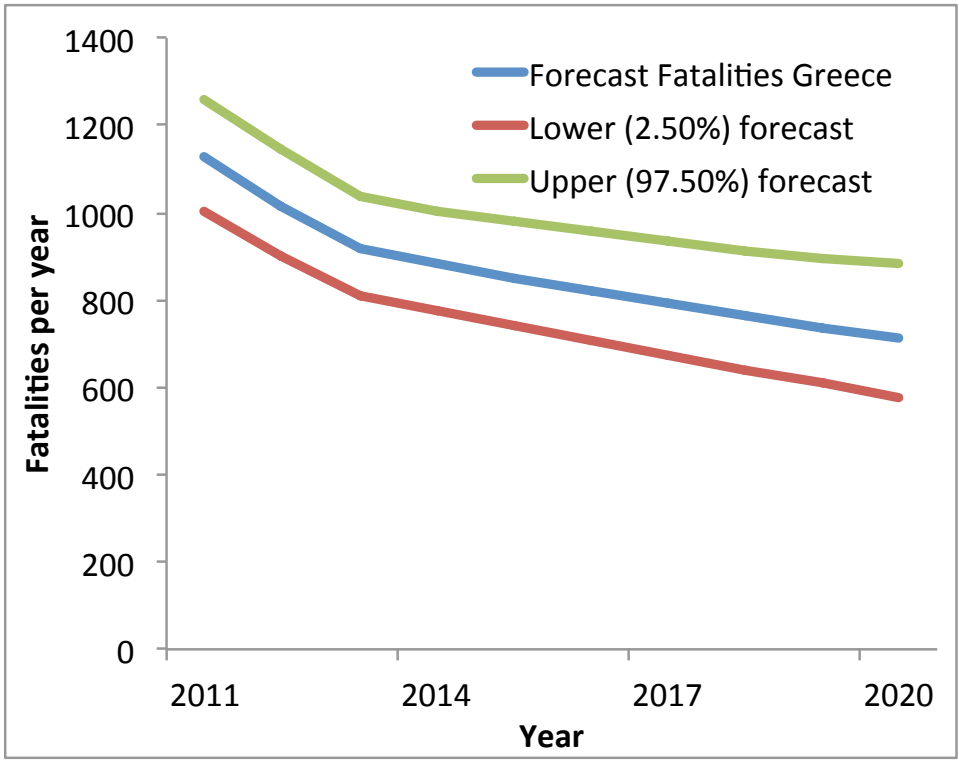
Modeling recession (Greece)





The two scenarios side-by-side





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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

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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

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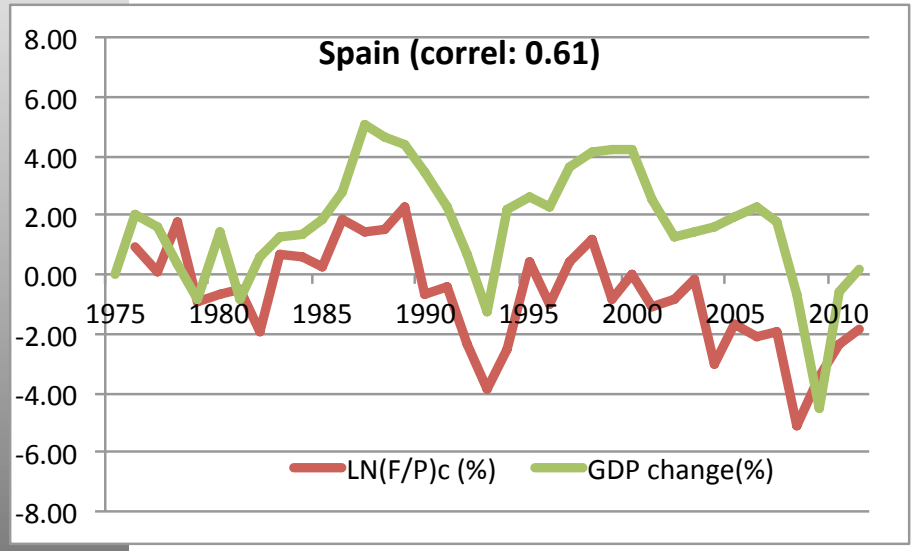
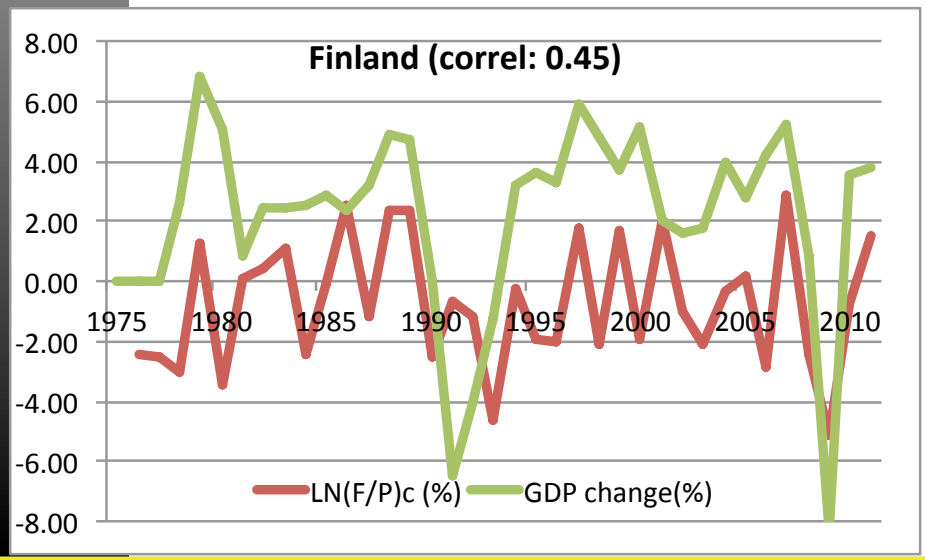
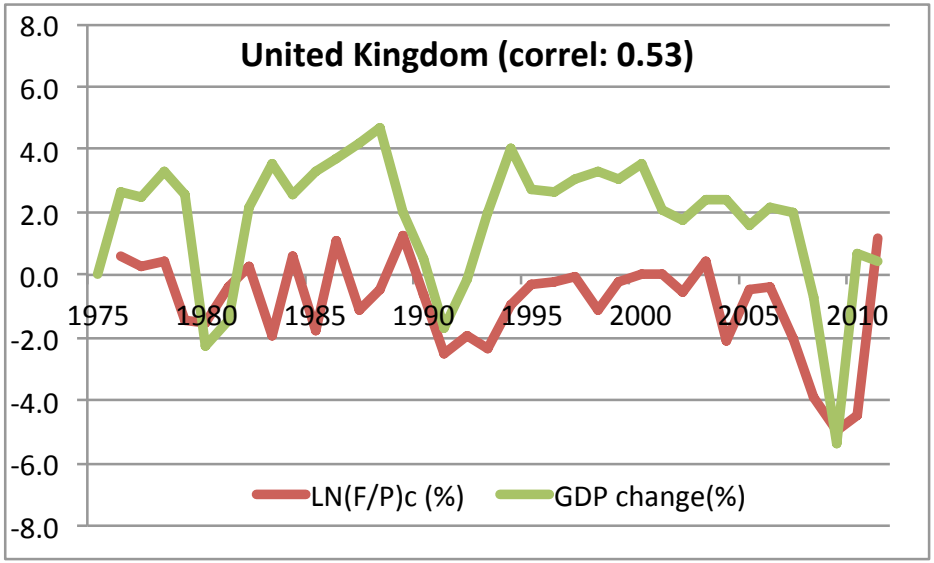
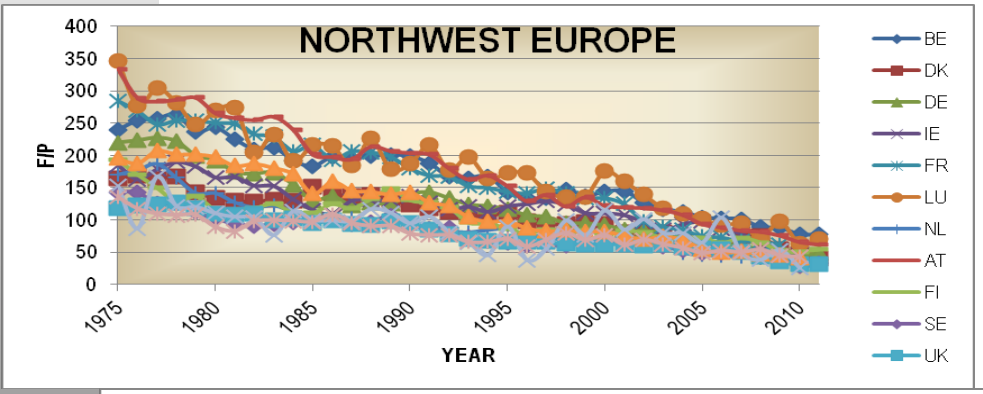
Fatality rates “follow” GDP

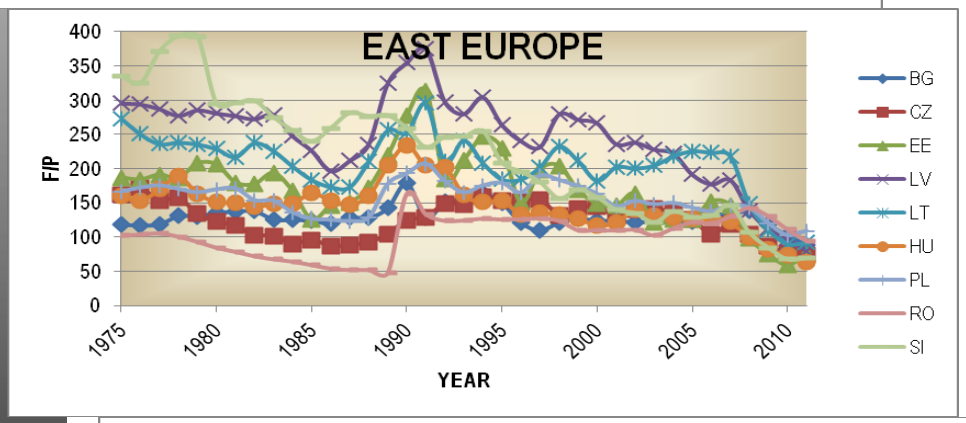


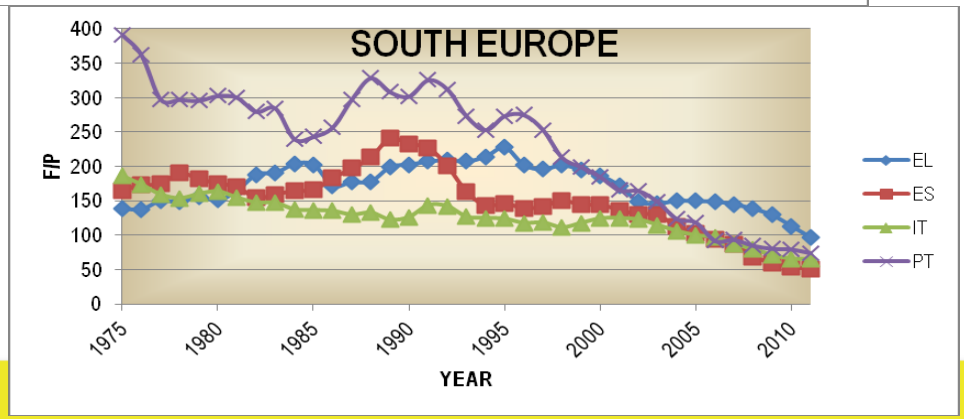




Data exploration - groups of countries







- Northern / Western:

  A decreasing trend in the fatality rate spans the entire period

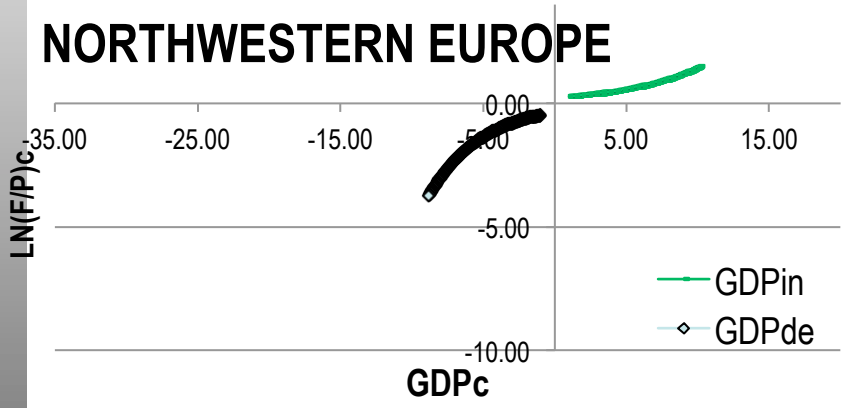
- Central / Eastern:

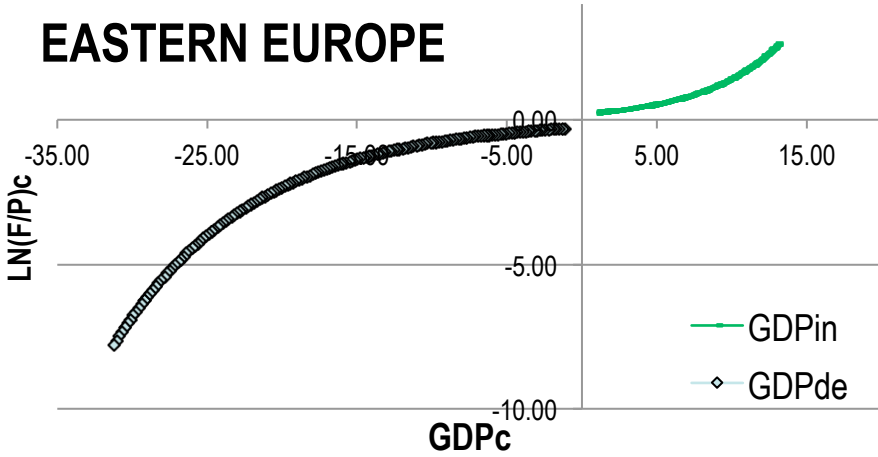
  the fatality rate shows more fluctuation, and the effect of the changes in political regimes of the early nineties is striking

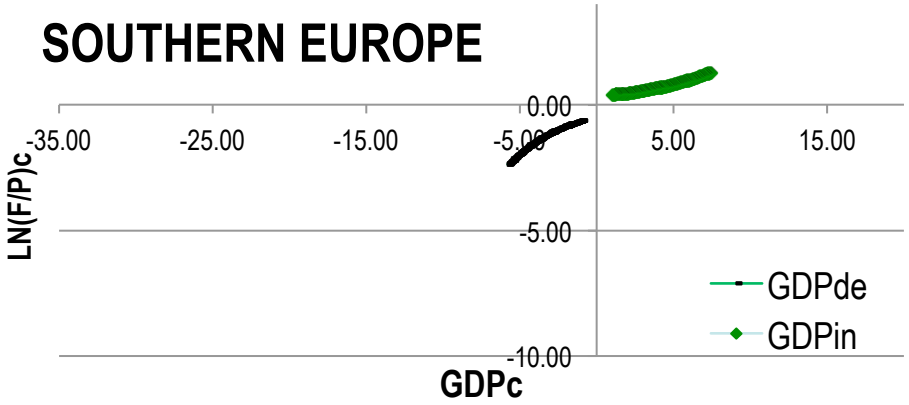
- Southern:

  The decrease started somewhat later, following an initial increasing trend

GDP annual change – Road fatalities annual change







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The current recession

	Fatalities					GDP per capita				
	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011
Belgium	1071	944	942	840	843	38.27	38.61	37.51	38.29	39.14
Czech Republic	1221	1076	901	802	769	13.80	14.15	13.58	13.91	14.29
Germany	4949	4477	4152	3648	4006	35.83	36.30	34.53	35.89	37.01
Estonia	196	132	100	79	101	12.48	11.92	10.33	10.58	11.31
Ireland	338	280	238	212	188	50.80	47.94	43.70	42.84	41.98
Greece	1612	1553	1456	1281	1100	24.79	25.01	24.46	23.34	22.16
Spain	3823	3100	2714	2478	2298	26.92	26.74	25.53	25.38	25.41
France	4620	4275	4273	3992	3969	35.11	34.88	33.73	34.05	34.42
Italy	5131	4725	4237	3934	3941	30.95	30.31	28.55	28.78	28.86
Lithuania	740	499	370	300	299	8.61	8.88	7.60	7.72	8.15
Hungary	1232	996	822	739	639	11.15	11.26	10.52	10.66	10.97
Netherlands	709	677	644	640	550	41.92	42.55	40.69	41.20	41.71
Austria	691	679	633	552	521	39.70	40.54	38.94	39.69	40.62
Poland	5583	5437	4572	3907	4164	8.95	9.41	9.57	9.94	10.36
Portugal	974	885	840	845	782	18.72	18.66	18.14	18.34	17.97
Finland	380	344	279	272	290	41.69	42.05	38.55	39.92	41.44
Sweden	471	397	358	266	311	44.22	43.87	41.47	43.70	45.55
United Kingdom	3059	2645	2222	1905	1998	39.29	39.02	36.90	37.15	37.32

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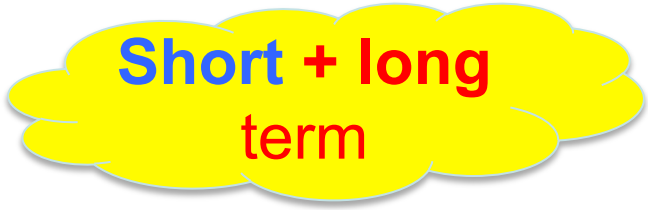

Macro panel data

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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)]

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Macro panel data
Three types of relationships (homogeneous)

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

$$\log FAT_{it} - \log FAT_{it-1} = \%FAT_{it}$$

$$\log GDP_{it} - \log GDT_{it-1} = \%GDP_{it}$$

$$\%FAT_{it} = a_i + b\%GDP_{it}$$

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

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

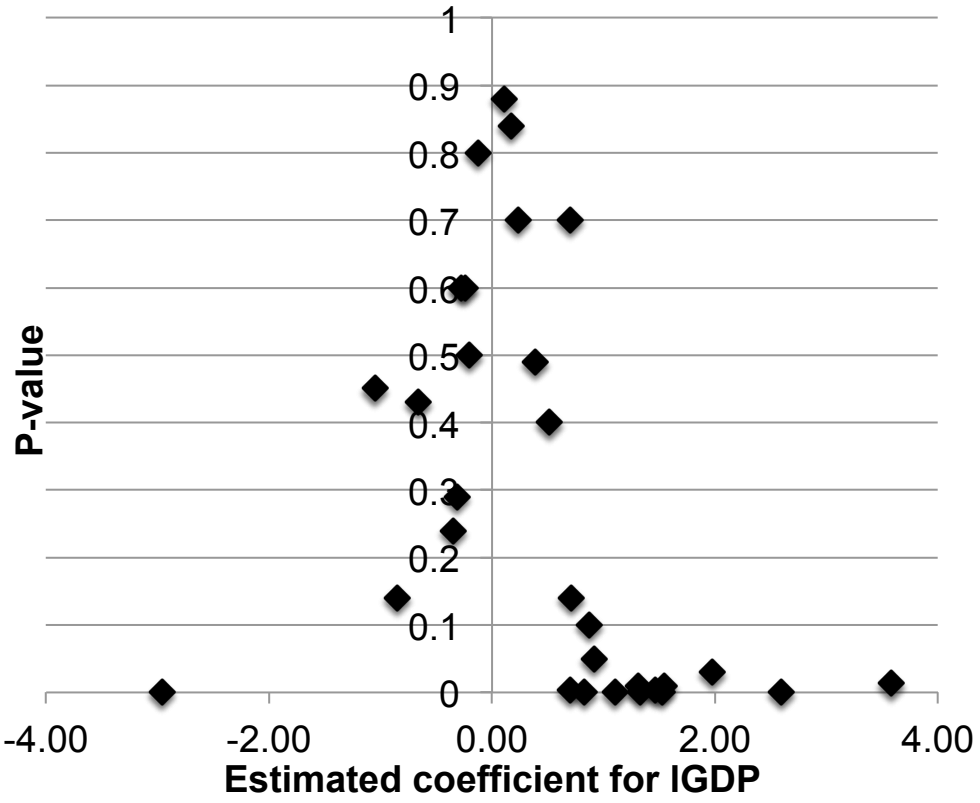
- Combination of dynamics: Error correction model (ECM)

$$\log FAT_{it} - \log FAT_{it-1} = a_i + b(\log GDP_{it} - \log GDT_{it-1})$$
$$+ C(\log FAT_{it} - a_i + b_i t + \beta \log GDP_{it})$$

Summary of preliminary results

MG		
(lFAT)	**coef**	**z-test**
lGDP	0.74	23.07

CCEMG Pesaran		
(lFAT)	**coef**	**z-test**
intercept	1.266	1.4
lGDP	0.458	2.23
t	0.018	0.015
lFAT2	0.928	5.57
lGDP2	-0.971	-2.51



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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, Nl, DK, PL …) and <0 for CZ only
  - When non significant, 11 countries >0 and 8 <0
- Next steps:
  - Per population
  - Add interventions

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Discussion and Conclusions

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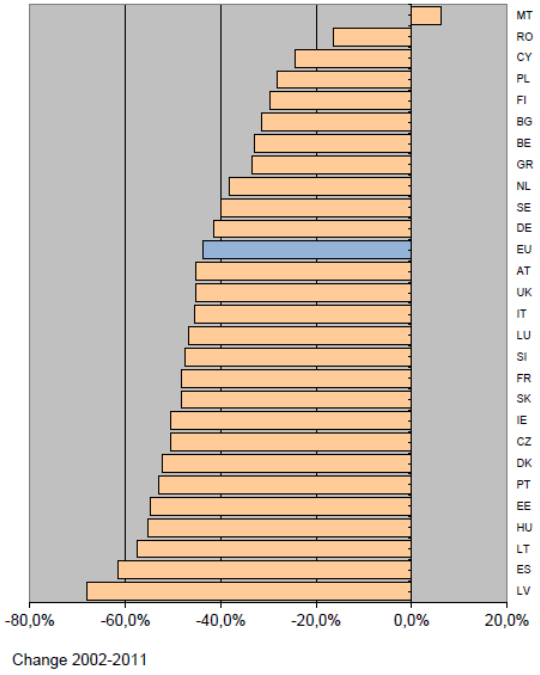
From correlation to causation

- 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



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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

Short + long term

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