

# Forecasting fatalities in times of recession

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GRETTIA-IFSTTAR

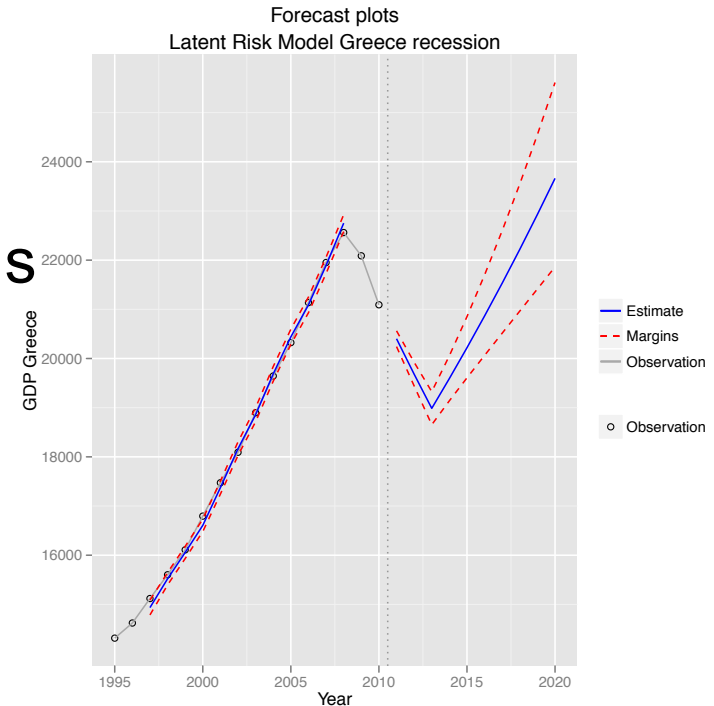


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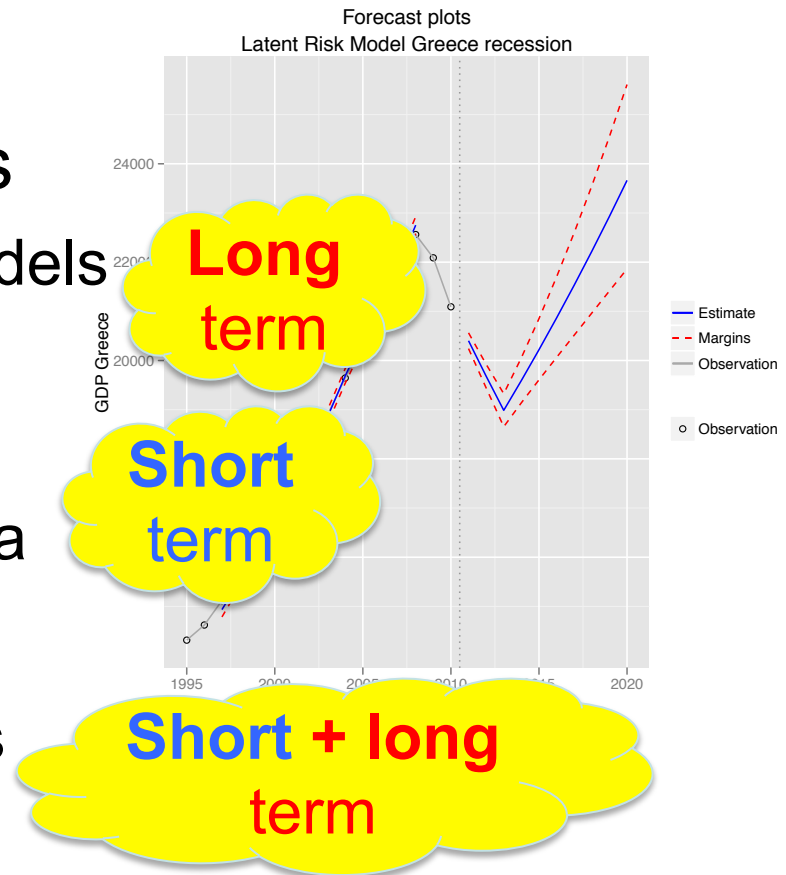
# Outline

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



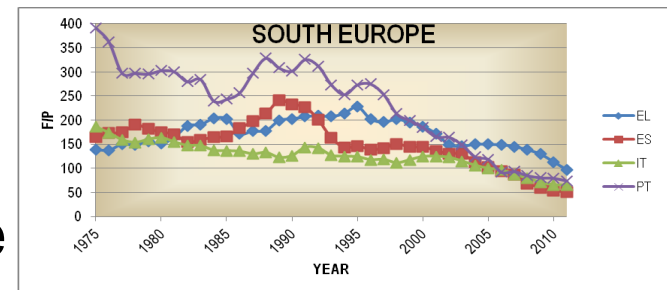
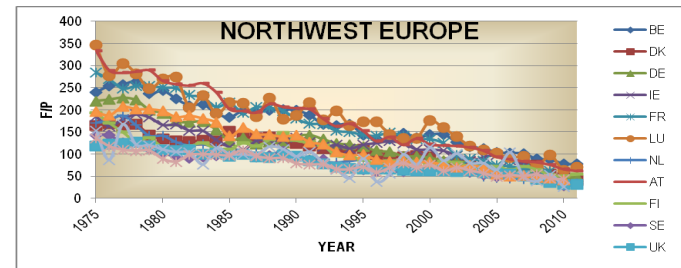
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# Background and objectives

- 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

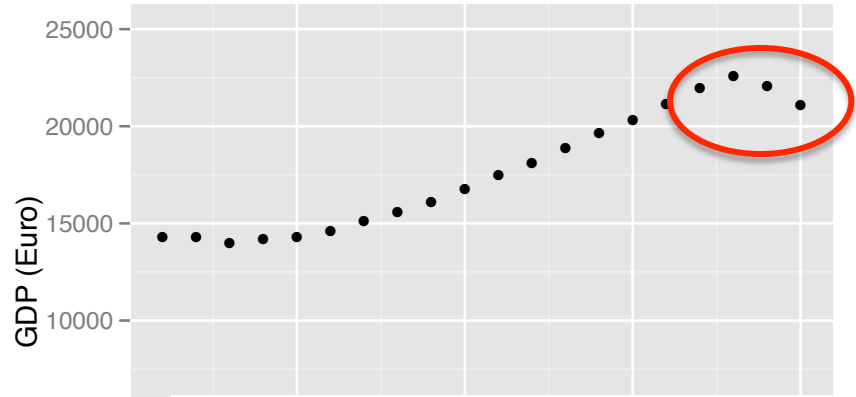


## Literature review

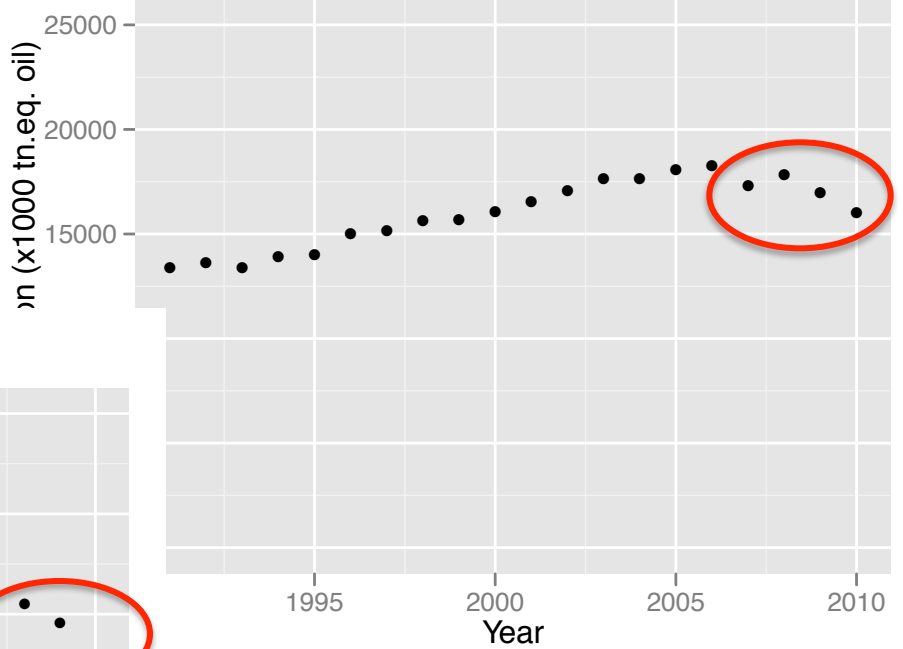
- Economic slowdown may lead to reduction in accidents and fatalities
  - Early 70's petrol crisis / reduced speed limits (Tihansky, 1974)
  - Early 80's economic recession (Wagenaar, 1984; Hedlund et al. 1984; Reinfurt et al. 1991)
  - Late 00's recession in the US / annual changes in unemployment rate and CPI (Kweon, 2011)

# The effects of recession

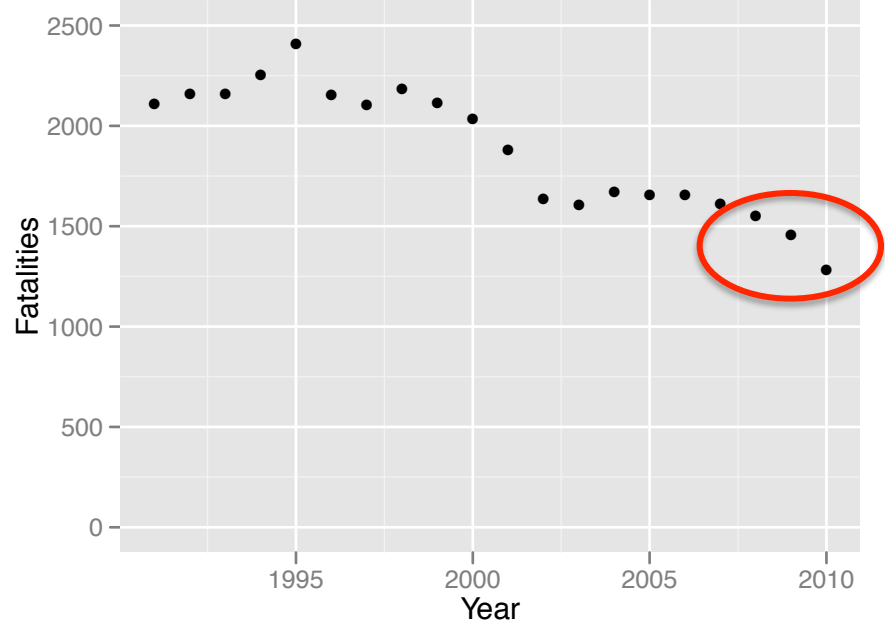
Plot of GDP in Greece



Plot of fuel consumption in Greece



Plot of fatalities in Greece





DaCoTA



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

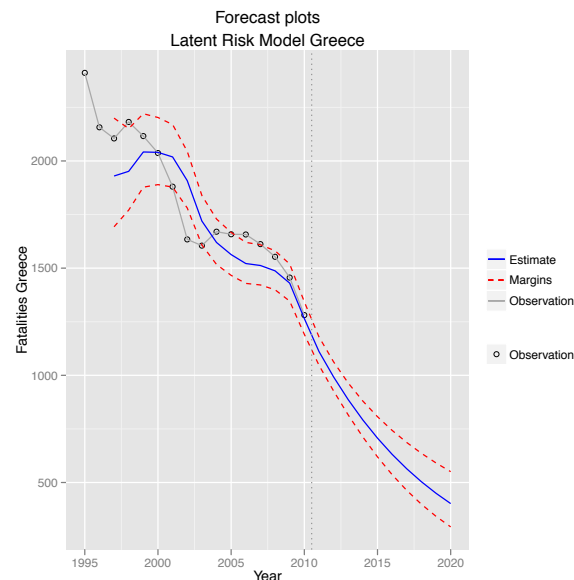
- Model components:

- Mobility
- Risk

$$\text{Fatalities} = \text{Mobility} * \text{Risk}$$

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

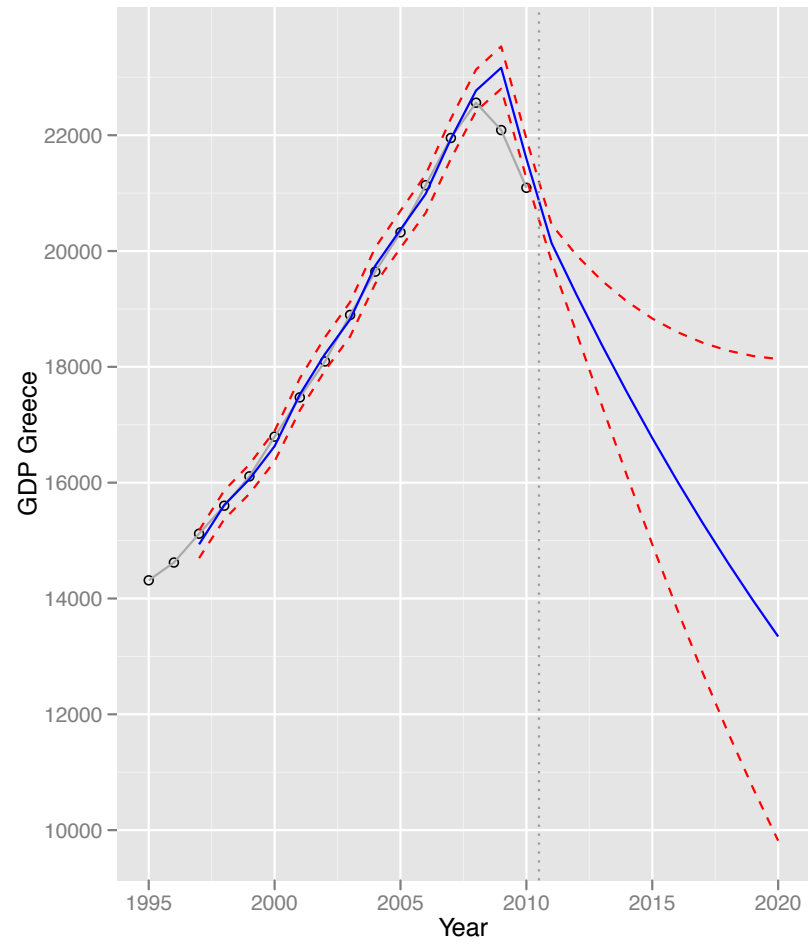
- Thus: Relation expected between Exposure and Fatalities.



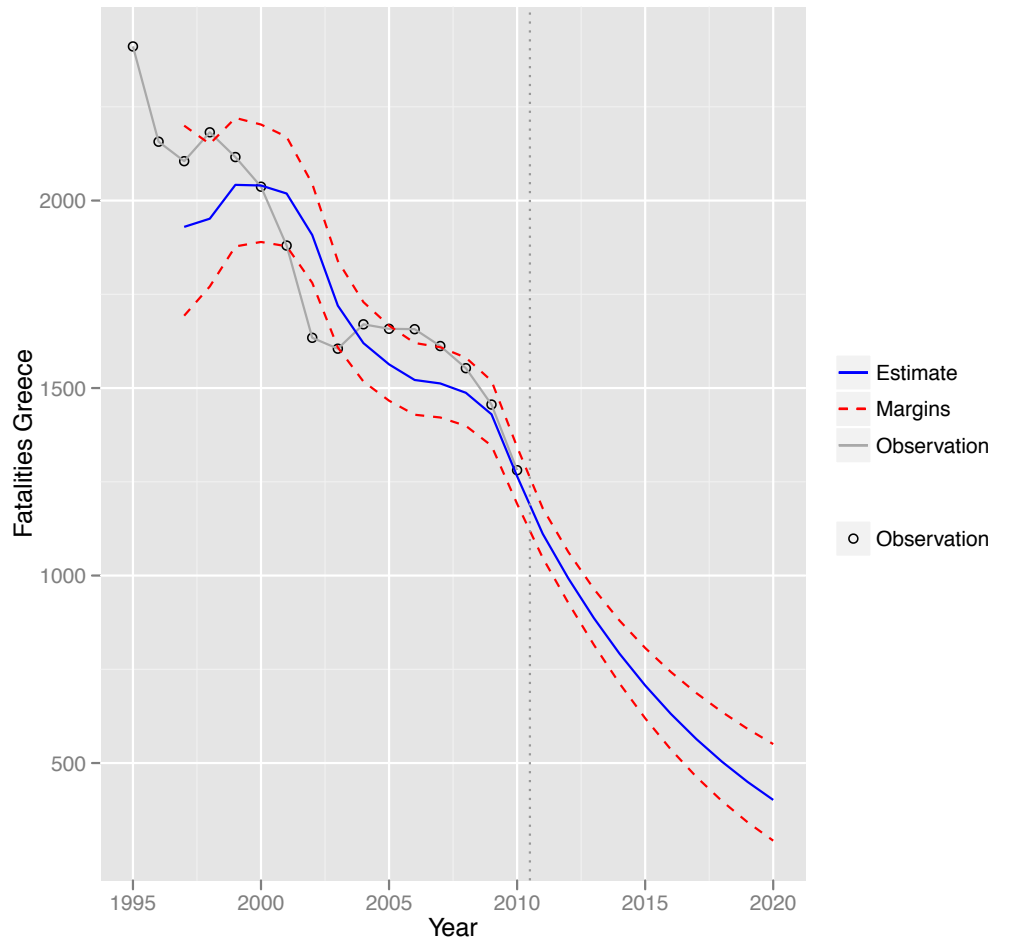


# Without modeling recession (Greece)

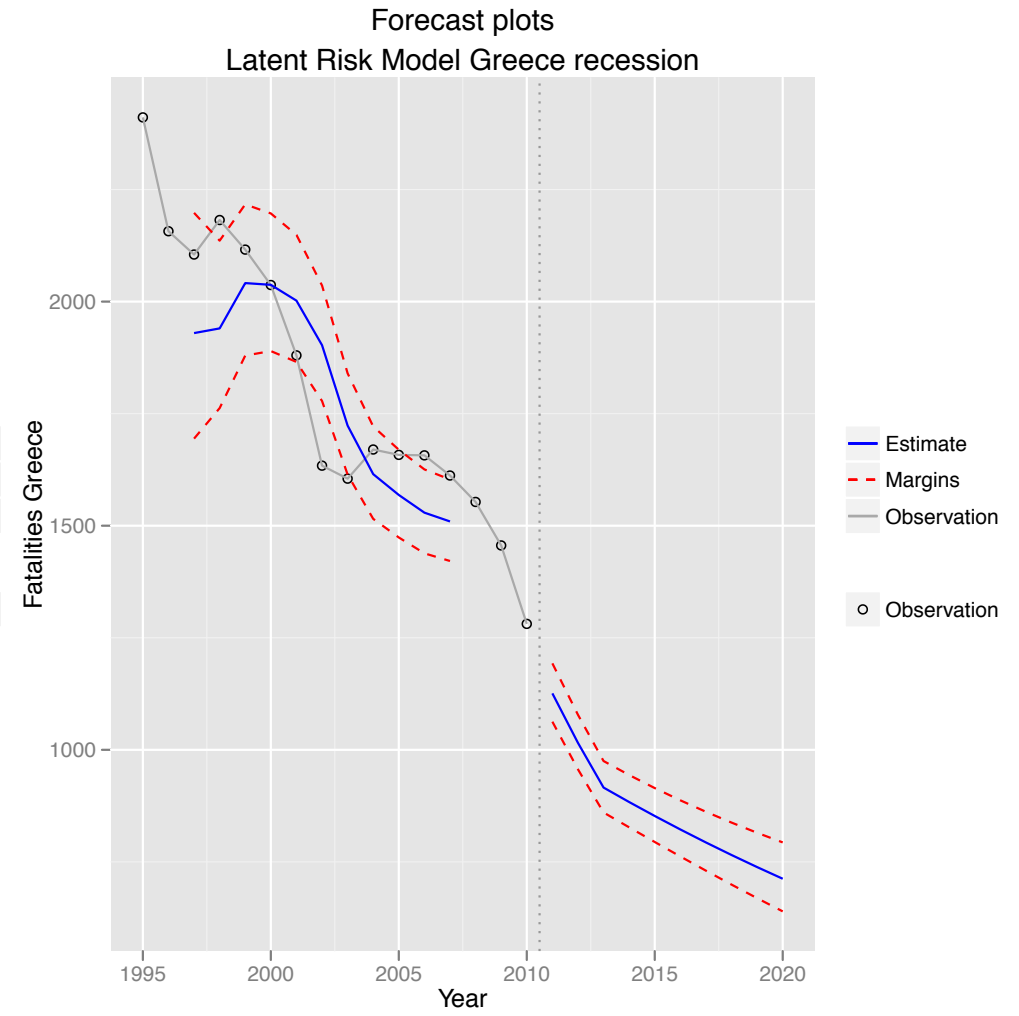
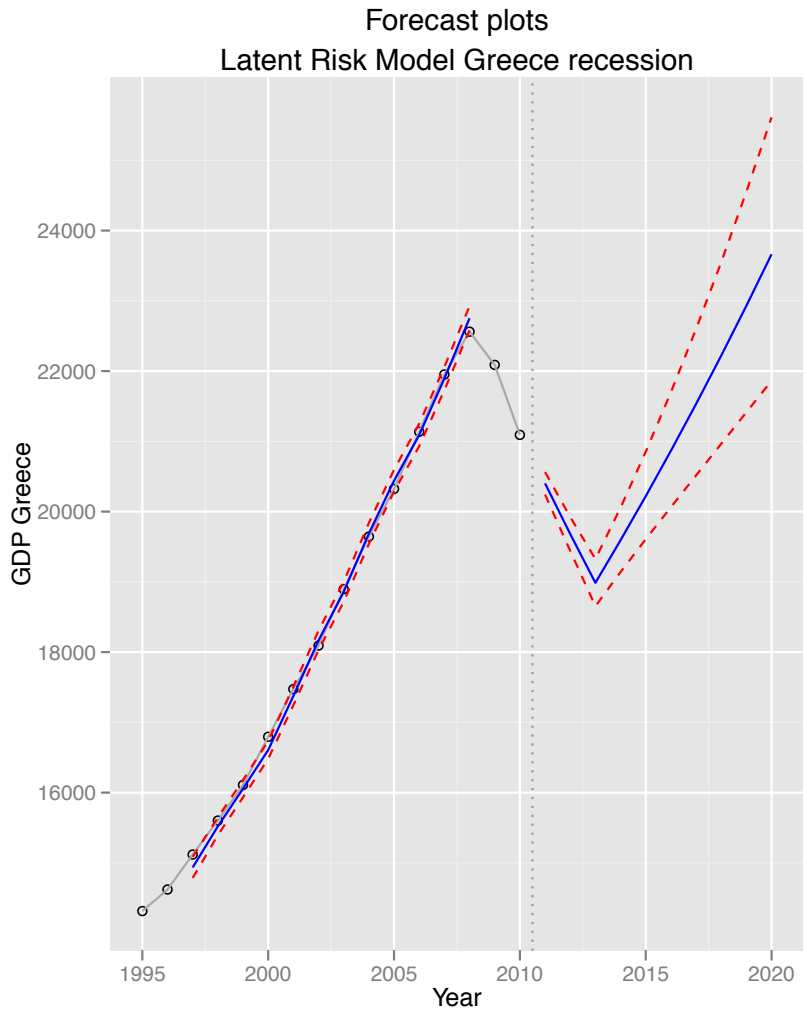
Forecast plots  
Latent Risk Model Greece



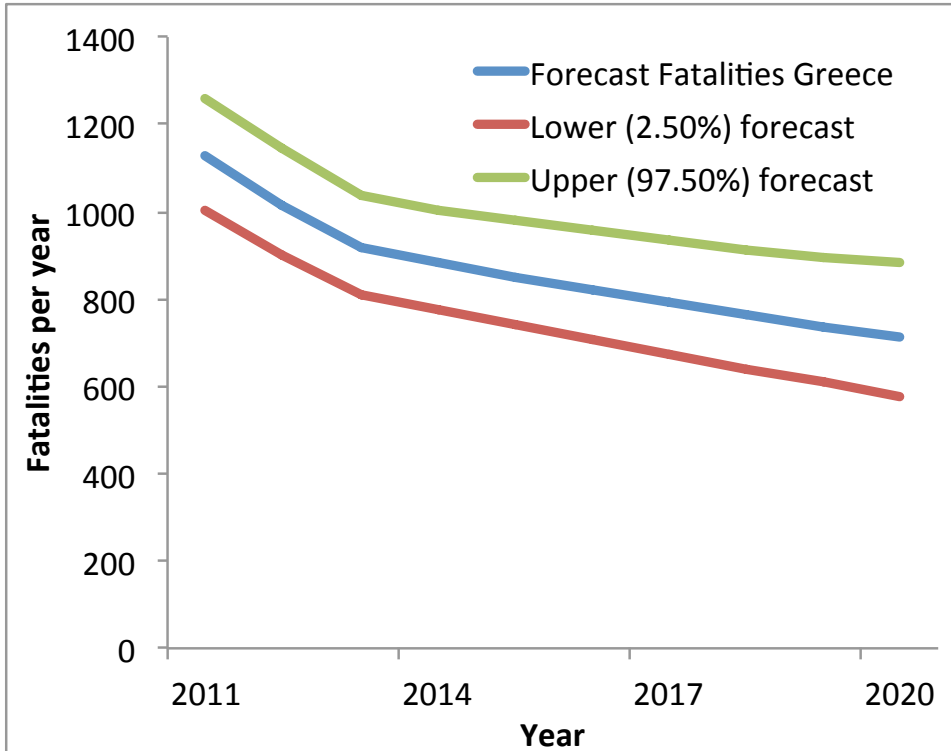
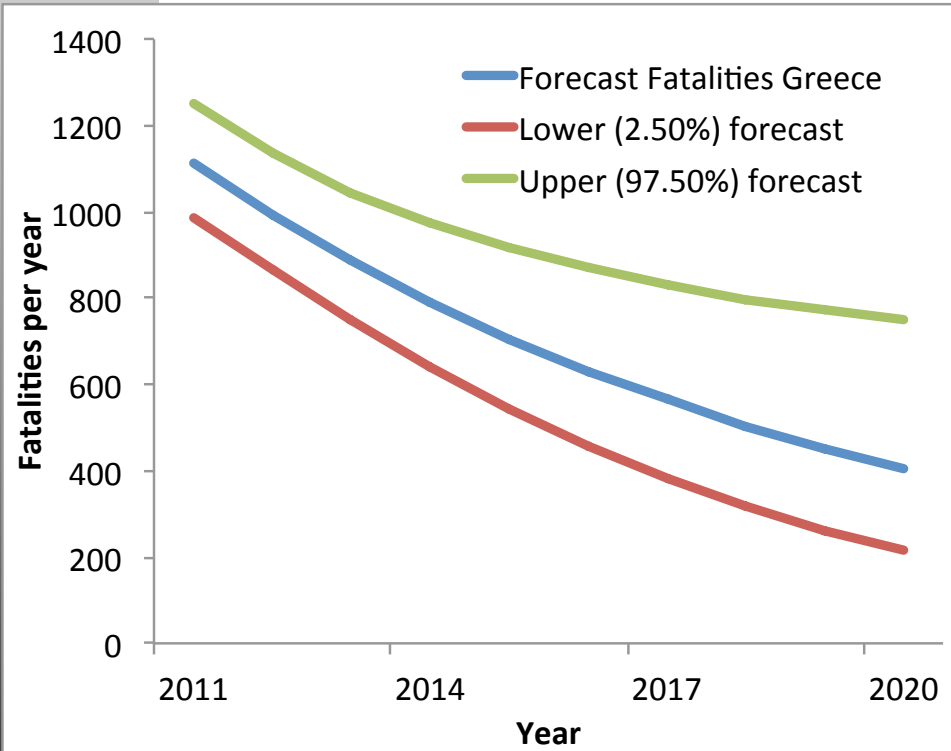
Forecast plots  
Latent Risk Model Greece



# Modeling recession (Greece)



# The two scenarios side-by-side





# DaCoTA

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



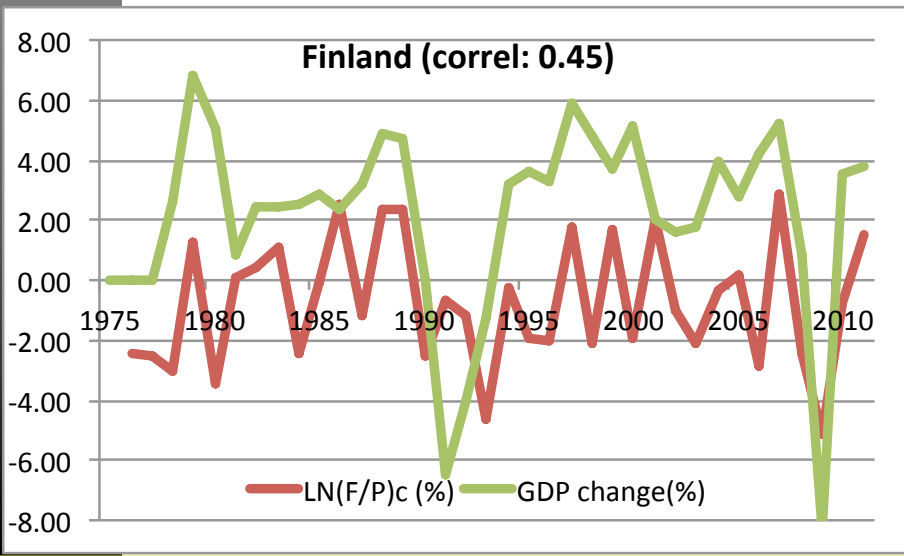
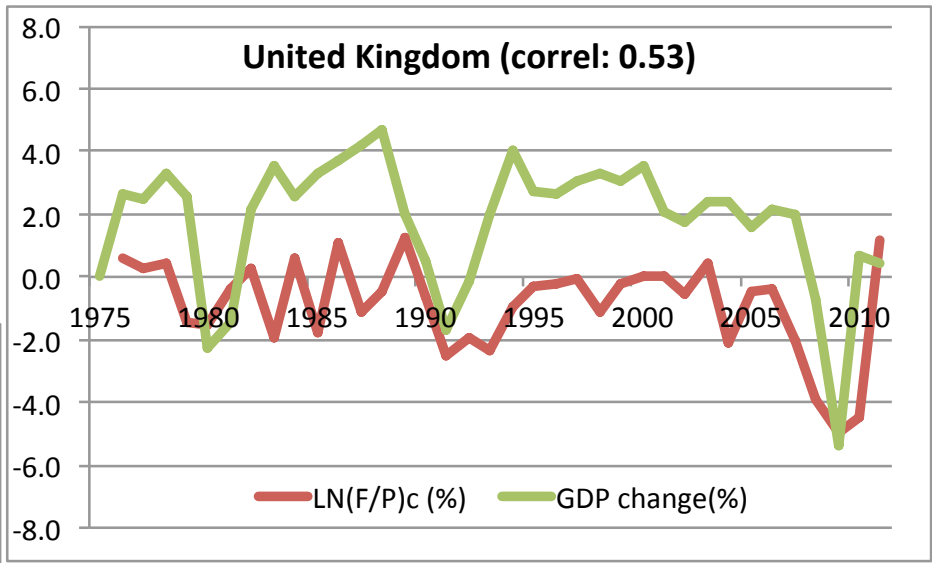
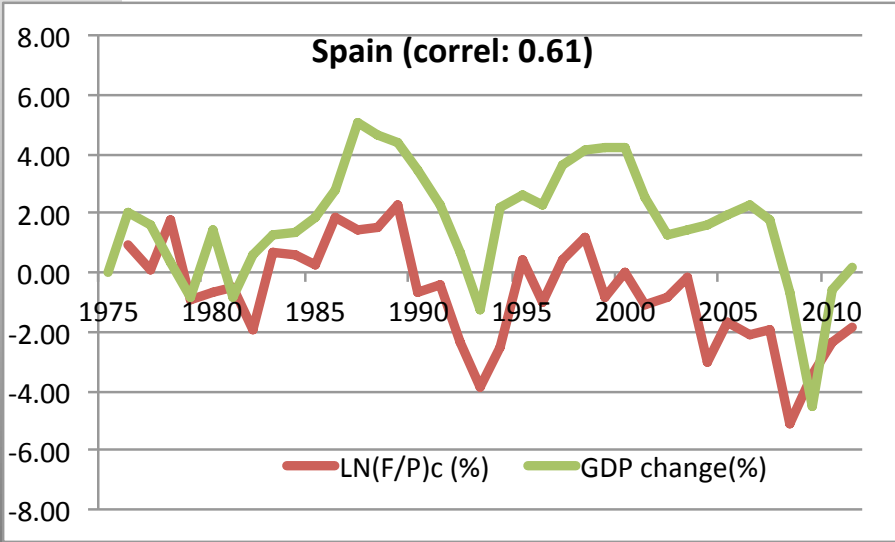
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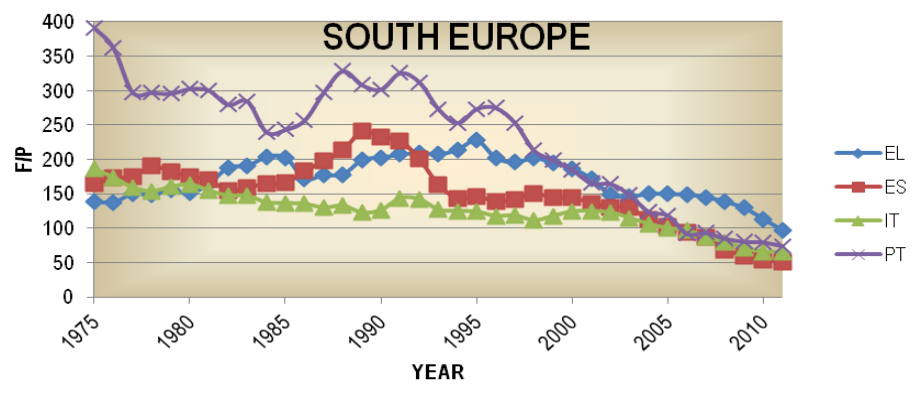
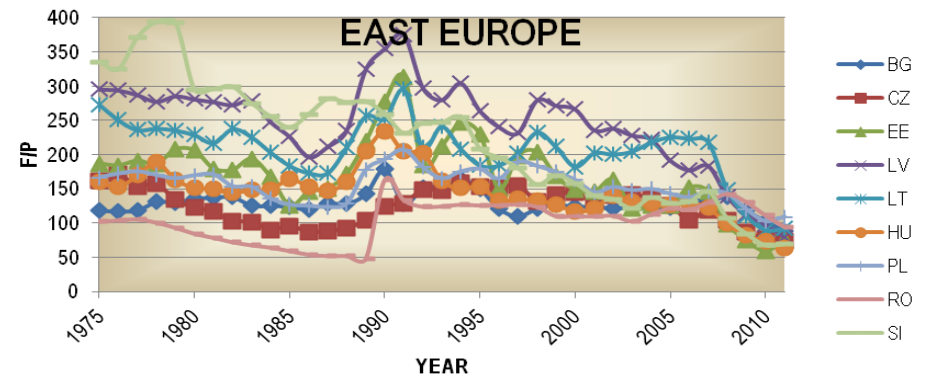
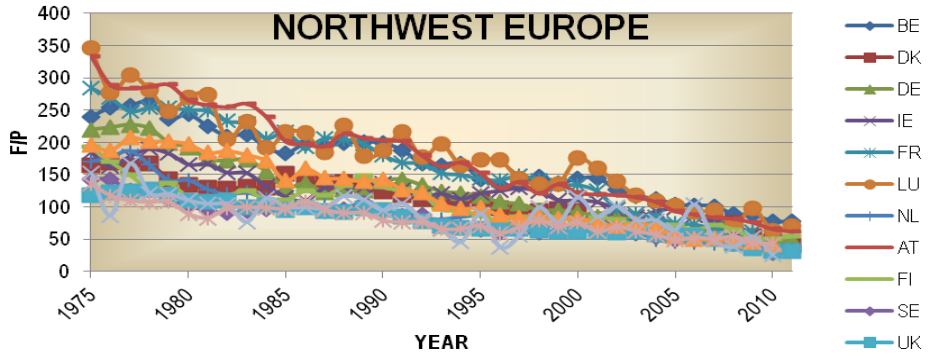
# Data and analysis methods

- 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

# Fatality rates “follow” GDP



# Data exploration - groups of countries



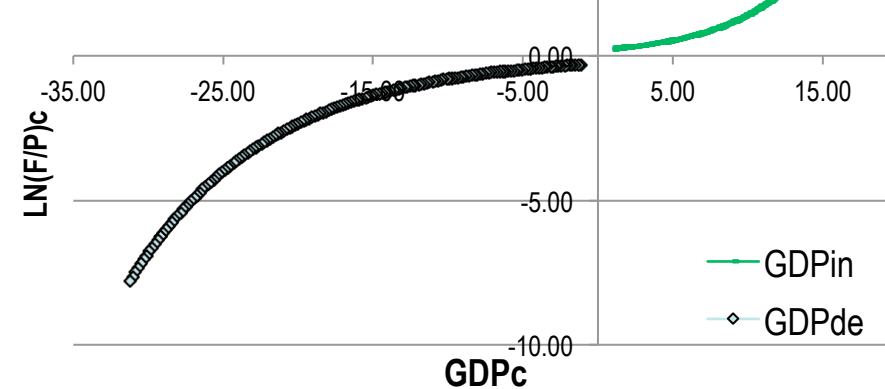
- Northern / Western:  
A decreasing trend in the fatality rate spans the entire period
  
- Central / Eastern:  
the fatality rate shows more fluctuation, and the effect of the changes in political regimes of the early nineties is striking
  
- Southern:  
The decrease started somewhat later, following an initial increasing trend

# GDP annual change – Road fatalities annual change

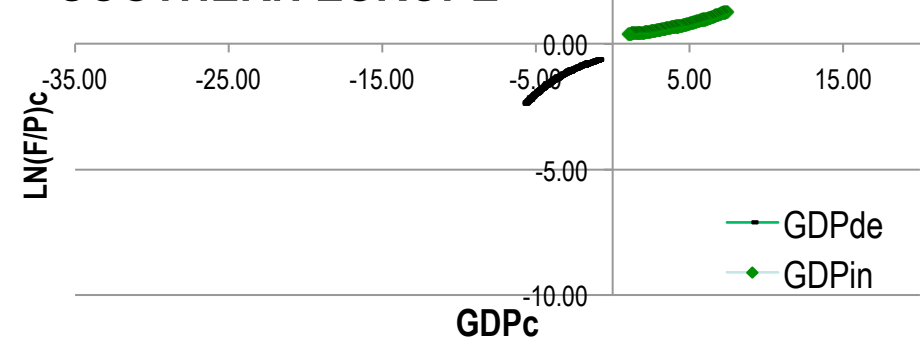
## NORTHWESTERN EUROPE



## EASTERN EUROPE



## SOUTHERN EUROPE





# The current recession

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



# DaCoTA

**Short + long  
term**

## 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)]

## 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)

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

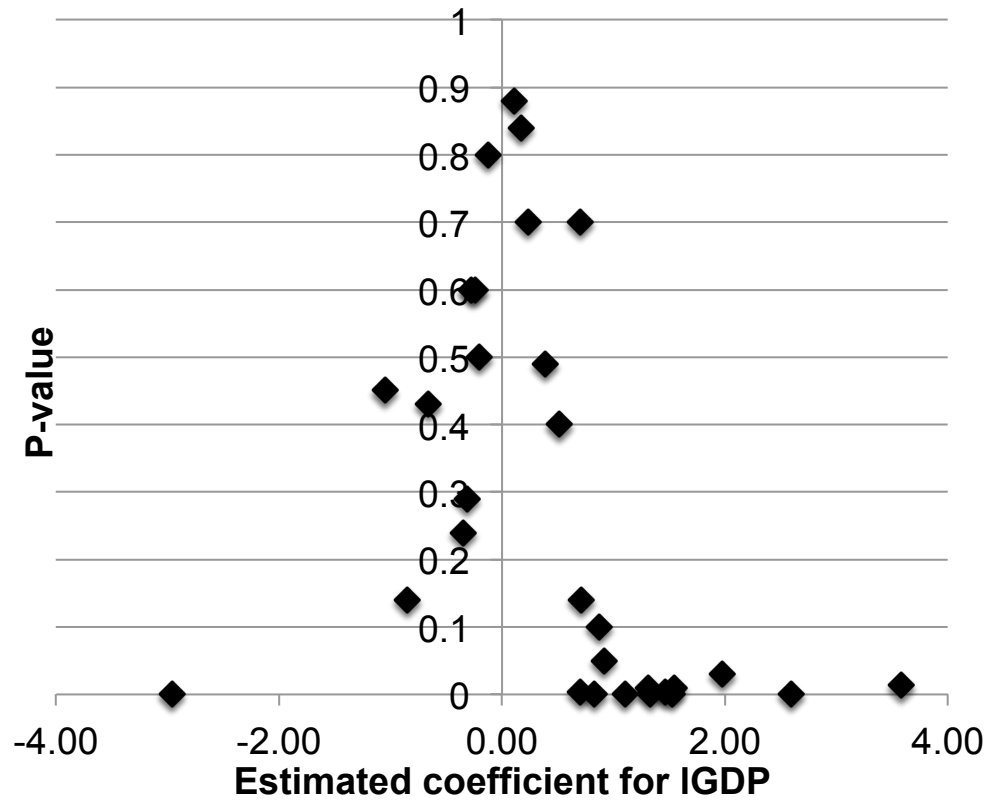
# Summary of preliminary results

**MG**

(IFAT)	coef	z-test
IGDP	0.74	23.07

**CCEMG Pesaran**

(IFAT)	coef	z-test
intercept	1.266	1.4
IGDP	0.458	2.23
t	0.018	0.015
IFAT2	0.928	5.57
IGDP2	-0.971	-2.51



# 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



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# From correlation to causation

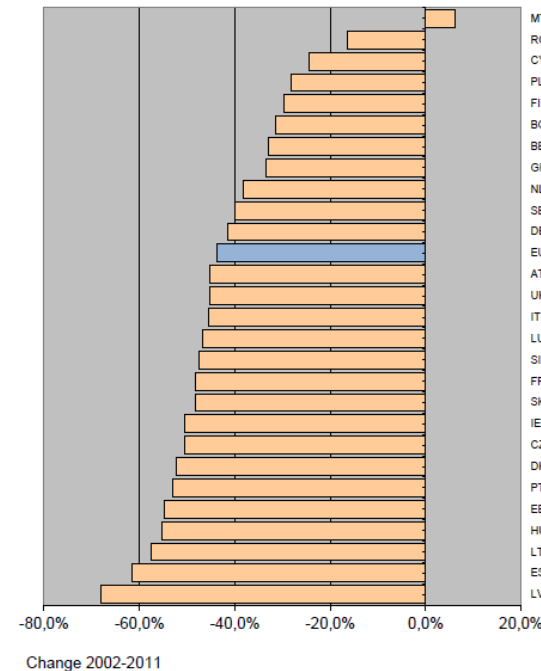
- A number of possible impacts of economic recession are suspected to contribute to the impressive reductions in fatalities:
- Fewer vehicle-kilometers: increased fuel prices, decrease of recreation mobility, less heavy goods vehicle traffic
- Less speeding: increased fuel prices, more economical and 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



## 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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