Relationship between road safety and economic indicators

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International Benchmarking on Road Safety
TRB Annual Meeting, Washington, 12-15 January 2014

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Background

- Annual or occasional changes in economic indicators, interrupting the smooth macroscopic trends, 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 the mobility.

Objectives

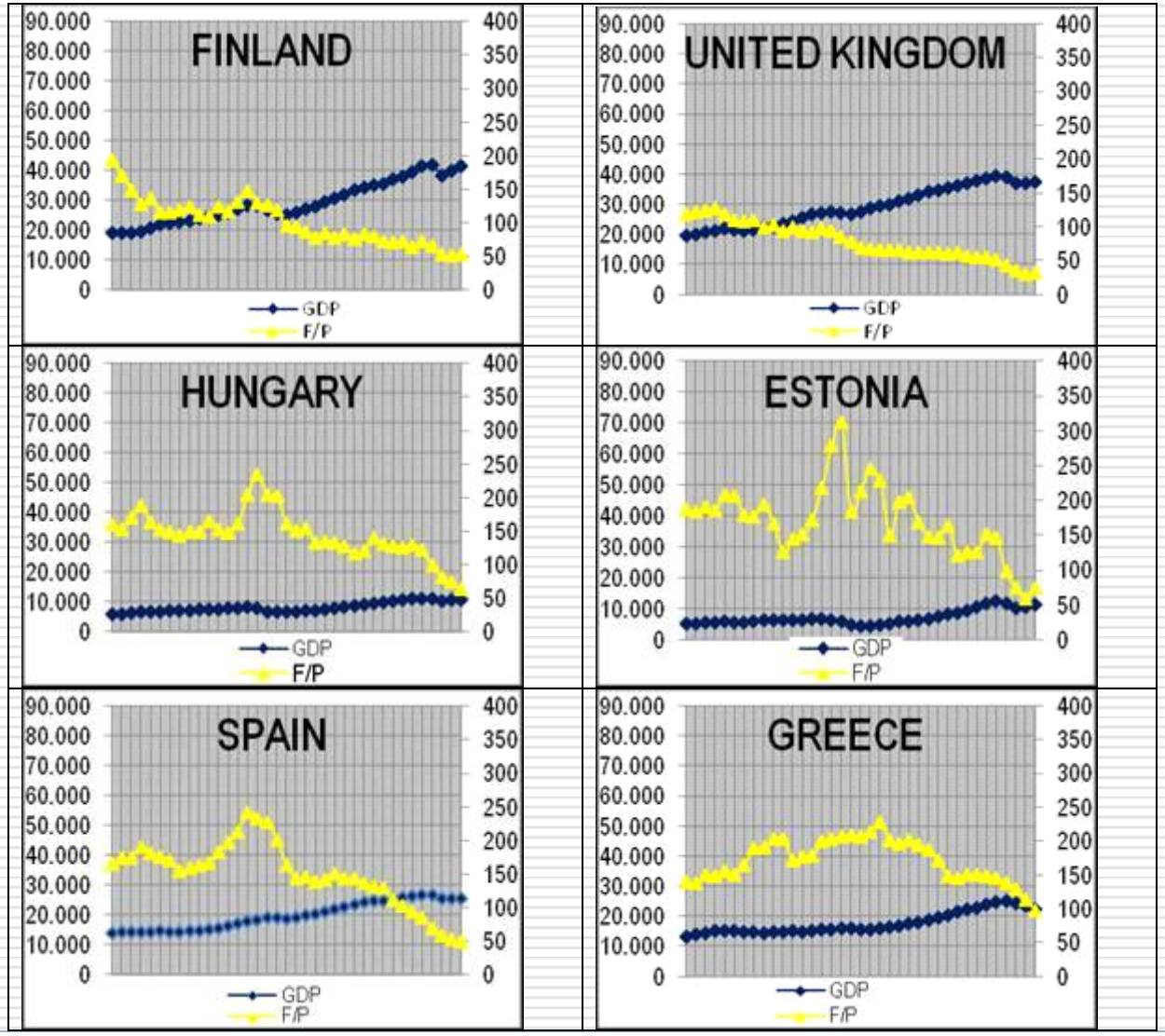
The present research aims to associate
short term annual changes in Gross Domestic Product (GDP)
with the related
short term annual changes in the number of road traffic fatalities.

- Economic and road safety data (1975-2010) from **27 European countries** are used for the development of mixed linear models.

- The models proposed may be able to characterise the **short-term dynamics** of the variables but not their long-run relationships.

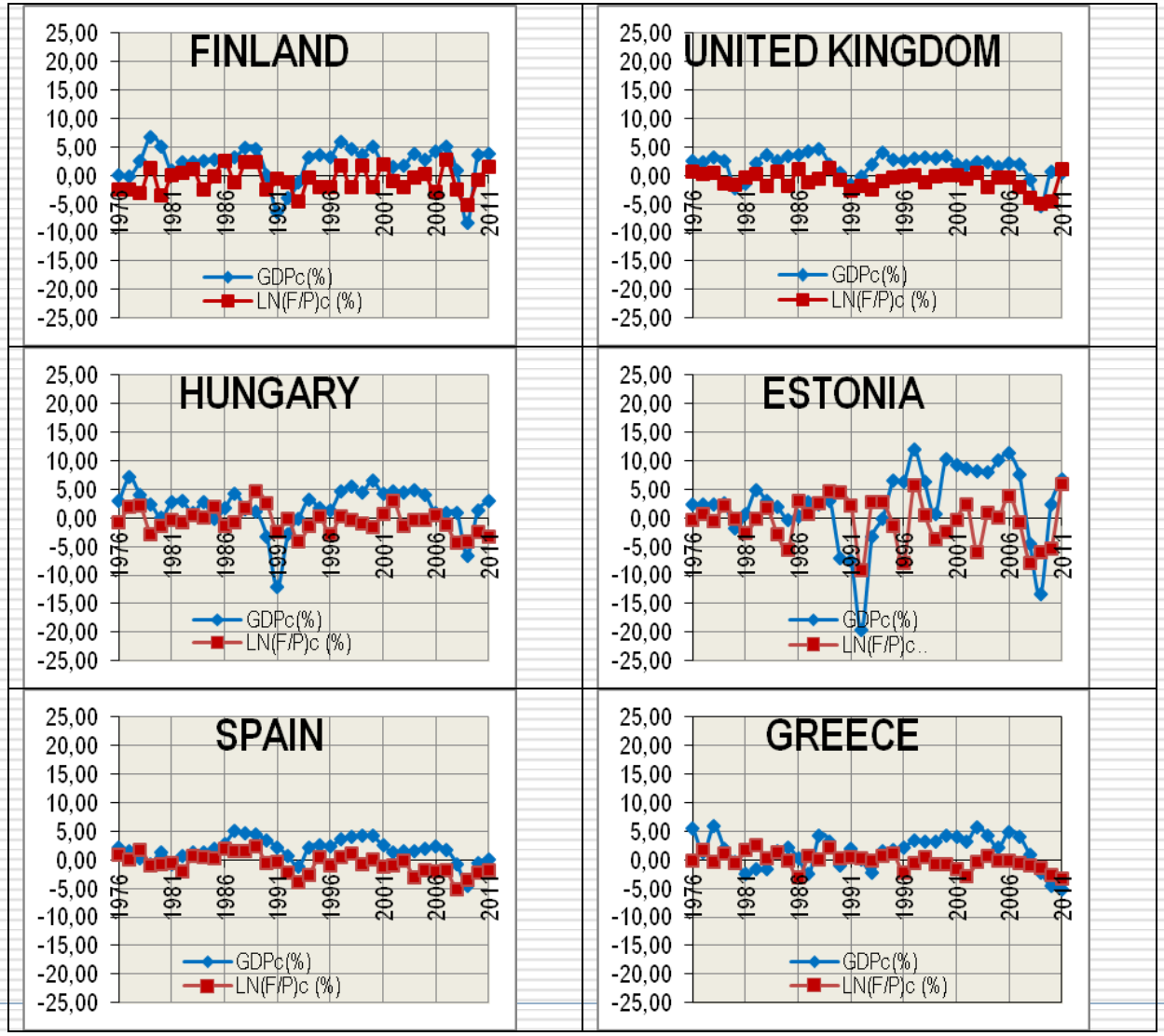
Data exploration – long term (macroscopic)

- The effects of the recession on GDP are visible in most countries

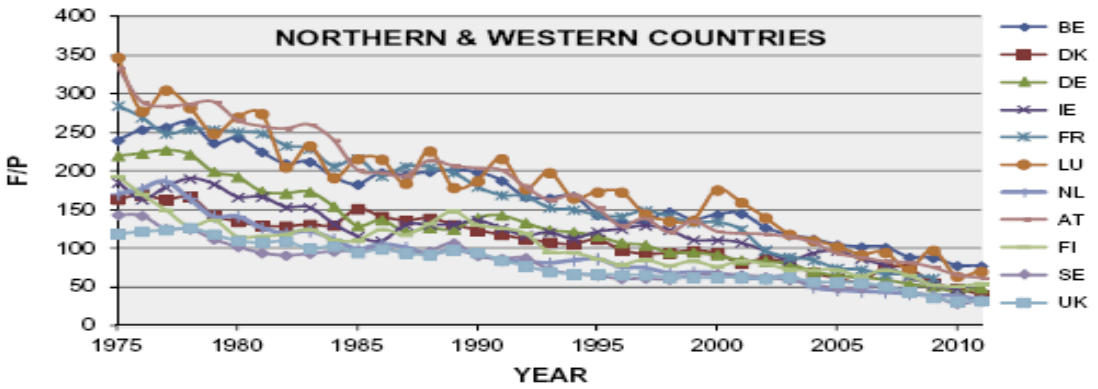


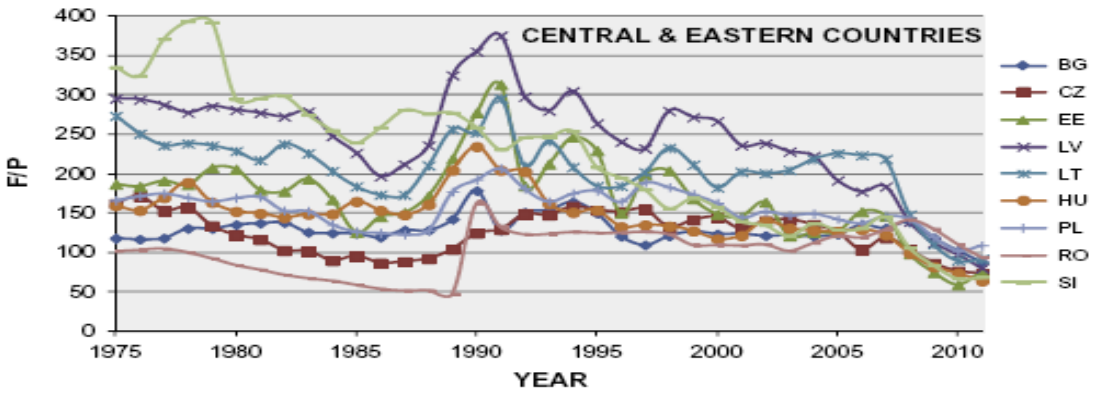
Data exploration – short term (annual change)

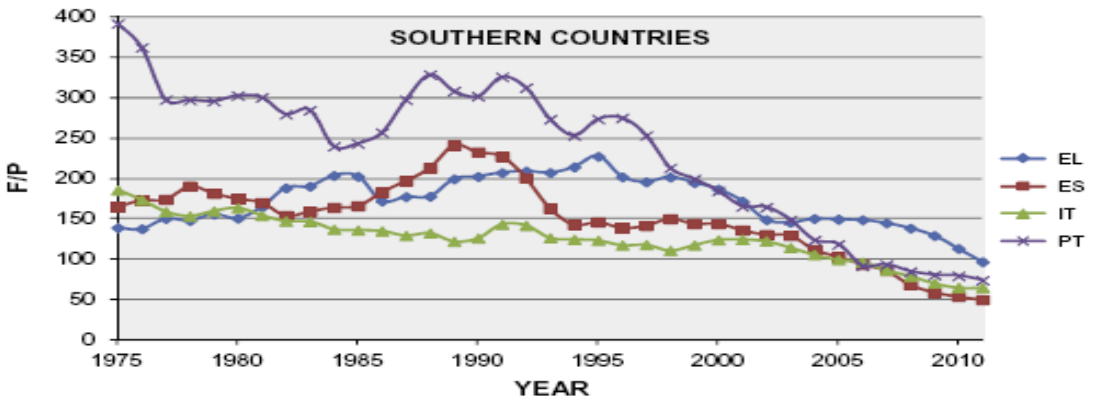
- Annual fatality rate changes appear to “follow” annual GDP changes



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

Analysis methods

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

- A mixed linear modelling technique (logarithmic form of the model)
- Fixed effects: groups of countries, GDP annual change
- Random effects: random variation of 1st order autoregressive nature (AR-1) in the random error e, to express the continuous repeated measurements (time series) over the examined countries.

$$\log FAT_{it} - \log FAT_{i(t-1)} = \alpha + \beta_1[\log GDP_{it} - \log GDP_{i(t-1)}] + \beta_2 CountryGroup_{it} + \varepsilon_{it}$$

With $E(\varepsilon_{it}) = 0$ and $Var(\varepsilon_{it}) = R = \sigma_t^2 \begin{bmatrix} 1 & \rho & \rho^2 & \rho^3 \\ \rho & 1 & \rho & \rho^2 \\ \rho^2 & \rho & 1 & \rho \\ \rho^3 & \rho^2 & \rho & 1 \end{bmatrix}$

Results – Model for all countries

Fixed effects	Estimate	t	p-value
Intercept	-1.322	-6.746	0.000
[Country group=Eastern]	0.667	2.360	0.019
[Country group=Southern]	0.426	1.127	0.260
[Country group=Northern]	0[a]	.	.
Log[GDPincrease]	0.763	3.516	0.000
Log[GDPdecrease]	-0.857	-2.141	0.033
[Country group=Eastern] *Log[GDPdecrease]	0.752	1.862	0.063
[Country group=Southern] *Log[GDPdecrease]	0.073	0.099	0.921
[Country group=Northern] * Log[GDPdecrease]	0[a]	.	.
[Country group=Eastern] * Log[GDPincrease]	-0.612	-2.679	0.008
[Country group=Southern] * Log[GDPincrease]	-0.239	-0.641	0.522
[Country group=Northern] * Log[GDPincrease]	0[a]	.	.
Covariance parameters			
AR1 diagonal (σ^2)	5.085	20.670	
AR1 rho (ρ)	-0.032	-0.900	
Likelihood Ratio Test	3862.375		
Degrees of freedom	10		

- an increase of annual GDP per capita leads to an increase of fatality rates,
- a decrease of annual GDP per capita leads to a decrease in fatality rates

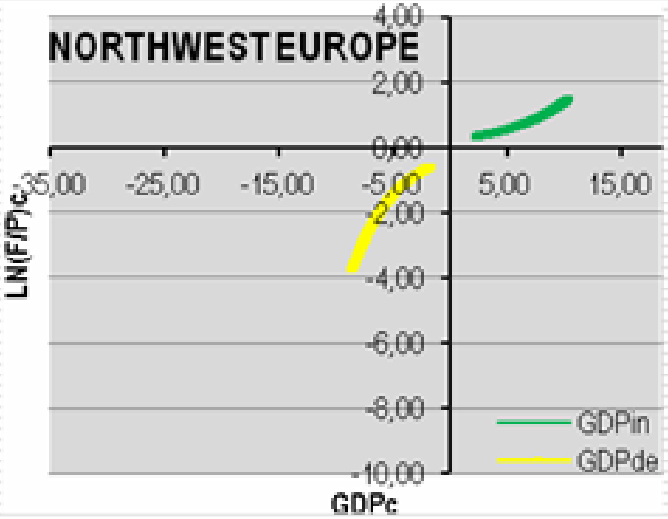
Results – Models for groups of countries

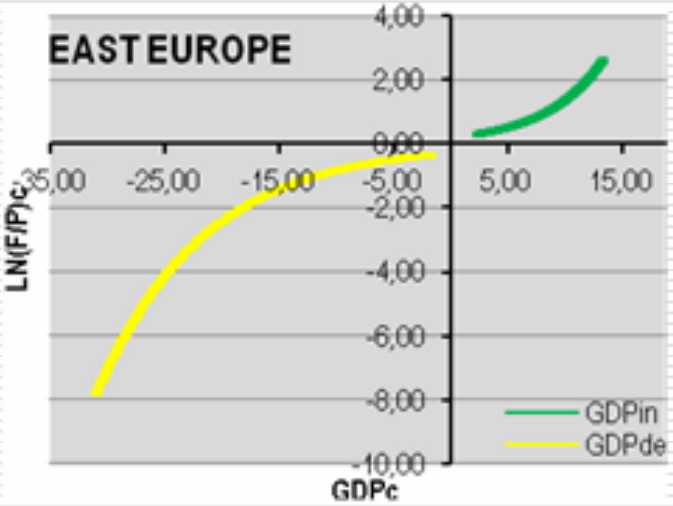
- Including one-year lagged effects

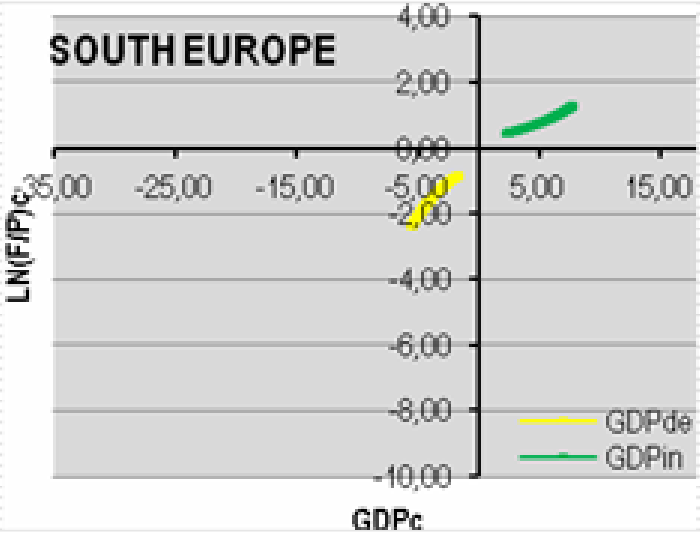
	Northern countries			Southern countries			Eastern countries		
Fixed effects	Estimate	t	p-value	Estimate	t	p-value	Estimate	t	p-value
Intercept	-1.250	-8.832	0.000	-0.964	-3.215	0.002	-1.752	-5.273	0.000
Log[GDPincrease]	0.657	3.663	0.000	0.417	1.914	0.058	0.445	3.760	0.000
Log[GDPdecrease]	-0.751	-2.422	0.016	-0.599	-1.522	0.130	-0.147	-2.245	0.026
Log[GDPincrease]-lag1	0.114	0.639	0.524	0.196	0.919	0.360	-0.050	-0.448	0.655
Log[GDPdecrease]-lag1	-1.125	-3.637	0.000	-0.281	-0.698	0.486	0.096	1.469	0.144
Covariance parameters									
AR1 diagonal (σ^2)	3.210	12.841		2.075	7.437		5.516	9.59253	
AR1 rho (ρ)	-0.291	-5.813		0.337	4.158		-0.035	-0.43868	
Likelihood Ratio Test	1555.316			496.398			868.652		
Degrees of freedom	6			6			6		

- GDP effects are confirmed in all groups of countries
- The lagged effect was only found to be significant in Northern / Western countries, and only as regards GDP decrease

GDP annual change - Road fatalities annual change







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.

From correlation to causation

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

- On the other hand, one might consider other impacts that might contribute to an increase in fatalities rather than a decrease:
  - Poorer vehicle fleet and roads: more older cars on the roads and fewer applications of passive and active safety-related devices, slowing down of infrastructure improvements;
  - More vulnerable road users on the roads: pedestrians, bicyclists and motorcyclists;
  - More risky driving: driver stress, depression, or higher alcohol consumption, etc.

Within this complicated system of possible impacts of economic recessions on road safety, the mobility reduction may be the critical determinant of the final road safety outcomes.

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 test 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 changes on road fatalities

- The long-term relationship between these two measures also warrants further investigation. In this case, appropriate statistical techniques should be implemented to account for possible cointegration between the two series (i.e. the Error Correction Model), allowing for **a combined analysis of long- and short-term dynamics**.

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