Effects of GDP changes on road traffic fatalities

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International Traffic Safety Data and Analysis Group

Background and objectives

- 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.

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

Literature review

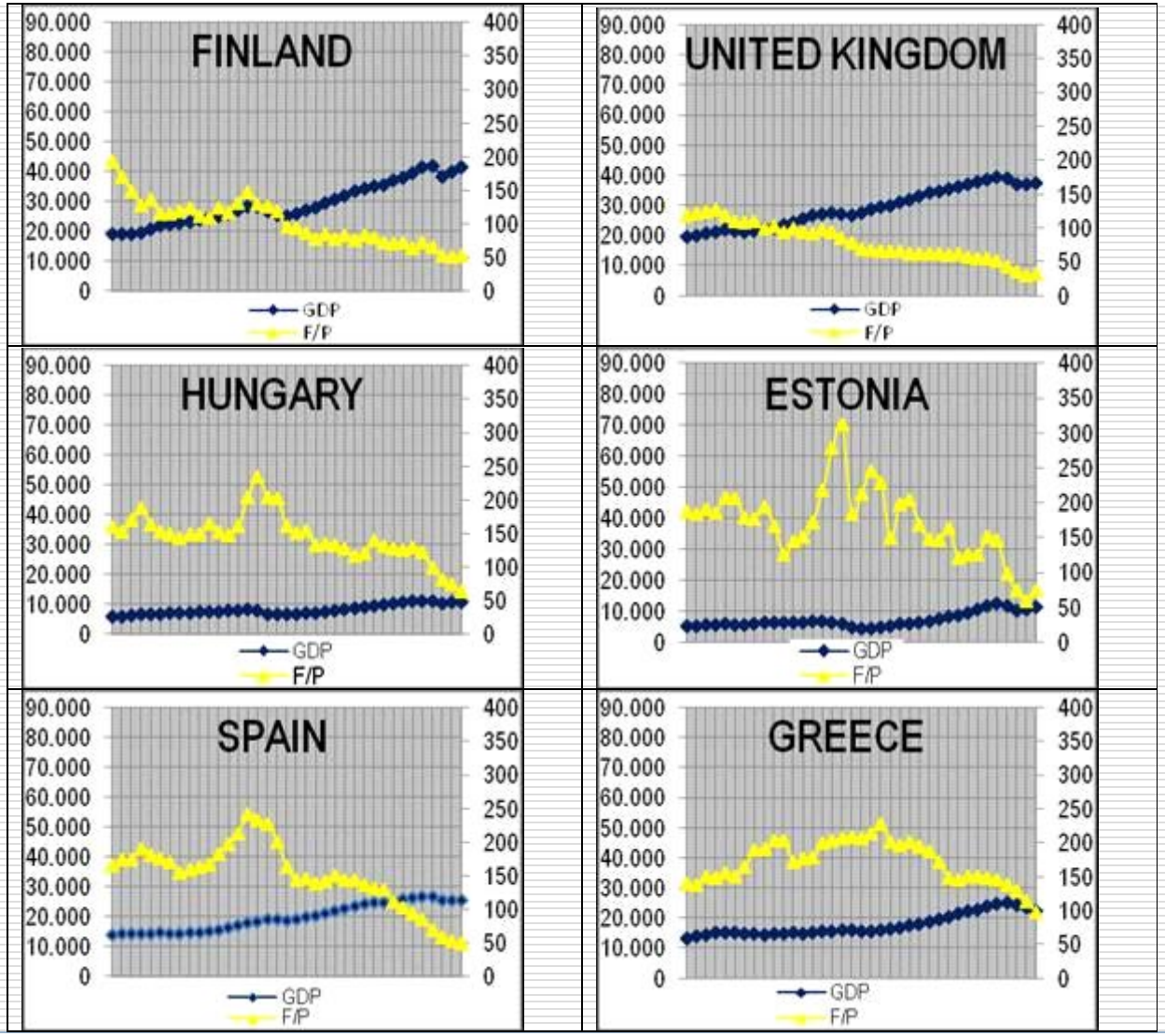
- The global petrol crisis in the early seventies has been studied, concluding that the reduced speed limits introduced by the authorities and more cautious driving by an energy-conscious public have contributed to striking declines in fatalities *(Tihansky, 1974)*

- The economic recession of the early-eighties has been studied by several researchers with respect to its effects on road traffic fatalities *(Wagenaar, 1984; Hedlund et al. 1984; Reinfurt et al. 1991)*

- A recent study examined the 2008 reduction in traffic fatalities in the US and found that annual changes in unemployment rate and CPI (Consumer Price Index) were strongly associated with annual changes in accidents and fatalities *(Kweon, 2011)*

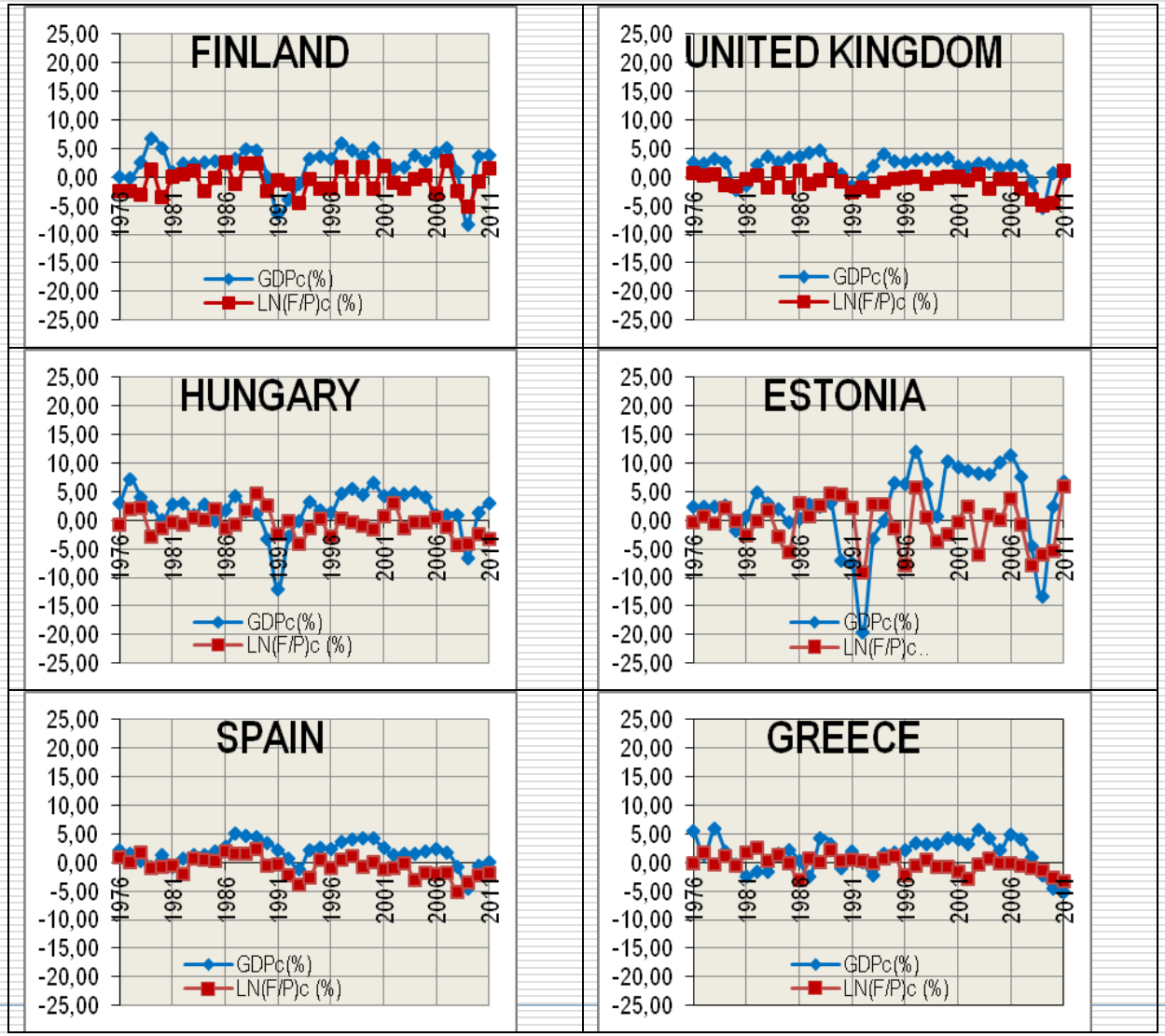
Data exploration - macroscopic

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

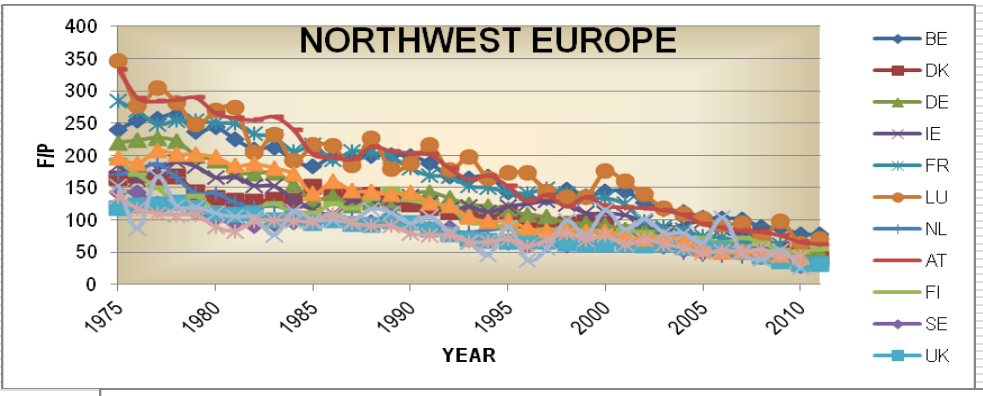


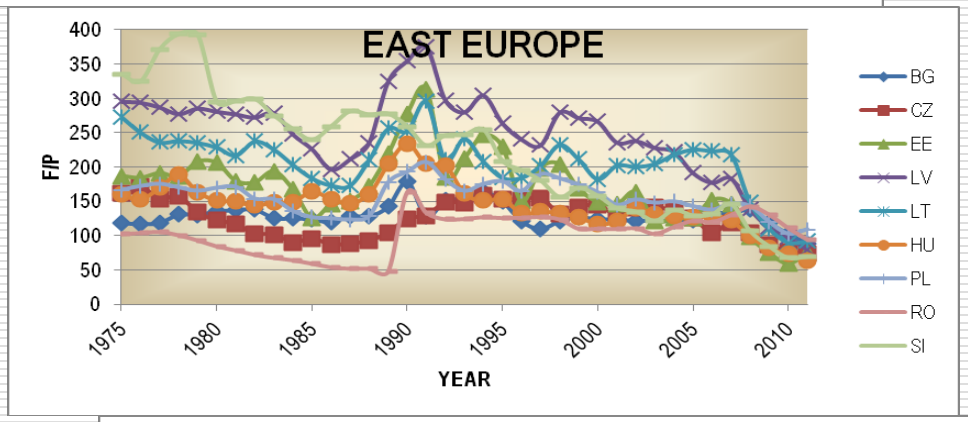
Data exploration – annual changes

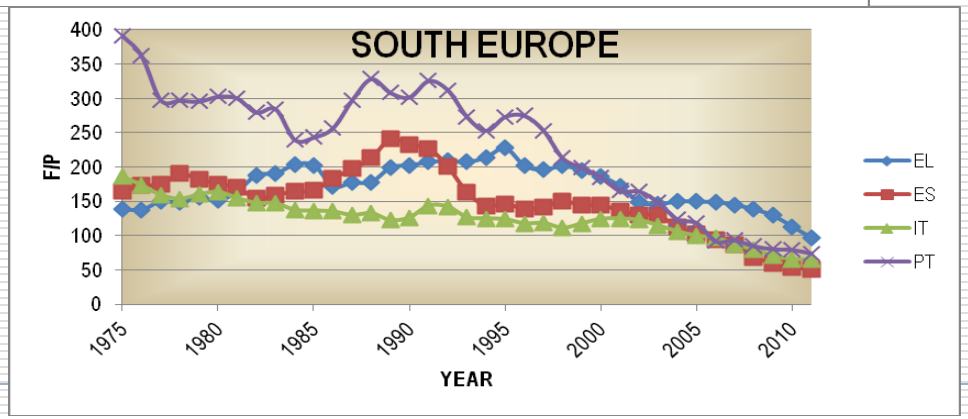
- Annual fatality rate changes appear to “follow” annual GDP changes



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 percentage change in the fatality rate**
- Main explanatory variable: the annual percentage change of GDP per capita.
- Panel data (time series for several countries)

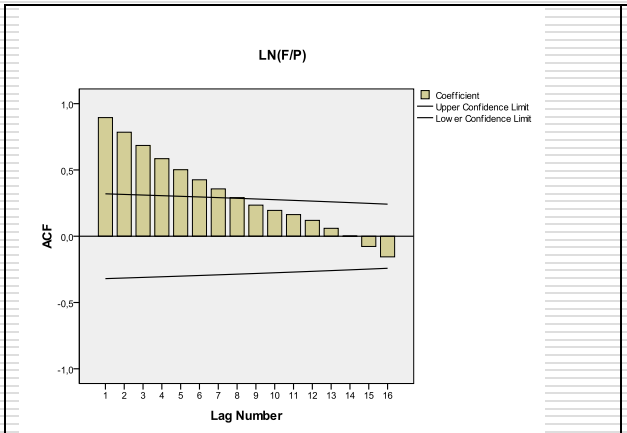
- A mixed effects modelling technique is applied
- Logarithmic form of the model
- Fixed effects: groups of countries
- Random effects: Autoregressive covariance structure to capture the time series effect

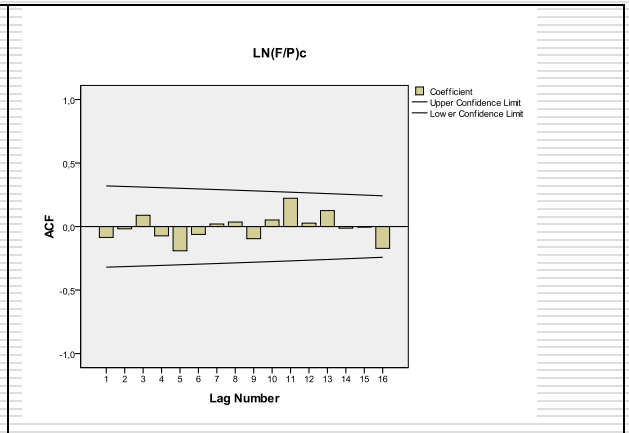
Results - Autocorrelations per country

Fatalities per population

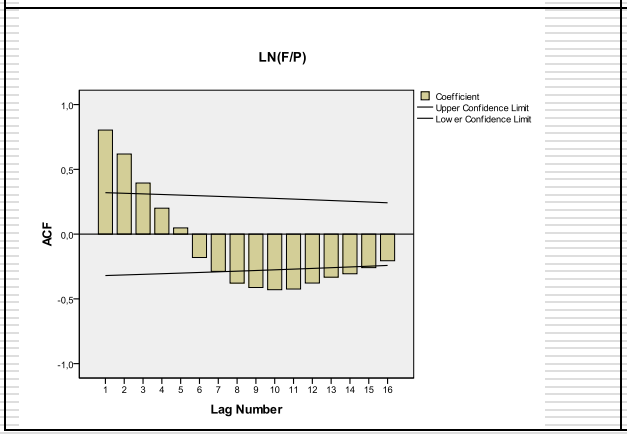
% change in F/P

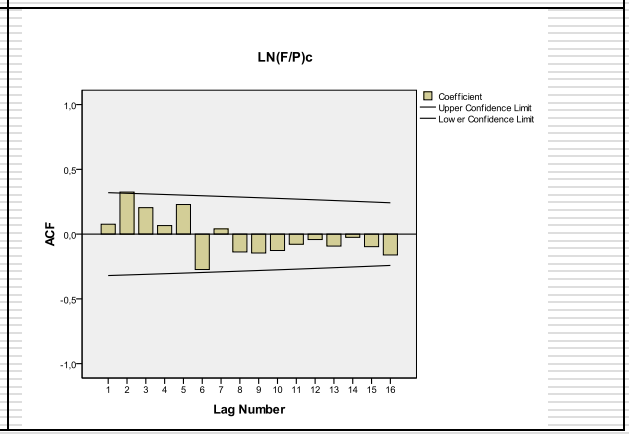
Belgium





Czech Rep.





The annual percentage changes in the fatality rate are not autocorrelated (- the absolute fatality rates are)

Results – Model for all countries

Fixed effects	Estimate	T	p-value
Intercept	-1,244	-5,983	0,000
[COUNTRYg=Central/Eastern]	0,782	2,530	0,012
[COUNTRYg=Southern]	0,333	0,850	0,396
[COUNTRYg=Northern/Western]	0[a]	.	.
GDPincrease	0,207	2,979	0,003
GDPdecrease	-0,336	-2,970	0,003
[COUNTRYg=Central/Eastern] * GDPincrease	-0,144	-1,704	0,089
[COUNTRYg=Southern] * GDPincrease	-0,015	-0,110	0,912
[COUNTRYg=Northern/Western] * GDPincrease	0[a]	.	.
[COUNTRYg=Central/Eastern] * GDPdecrease	0,230	1,931	0,054
[COUNTRYg=Southern] * GDPdecrease	0,062	0,268	0,789
[COUNTRYg= Northern/Western] * GDPdecrease	0[a]	.	.
Random effects	Estimate	Wald Z	Sig.
Residual	4,826	19,786	0,000

- 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

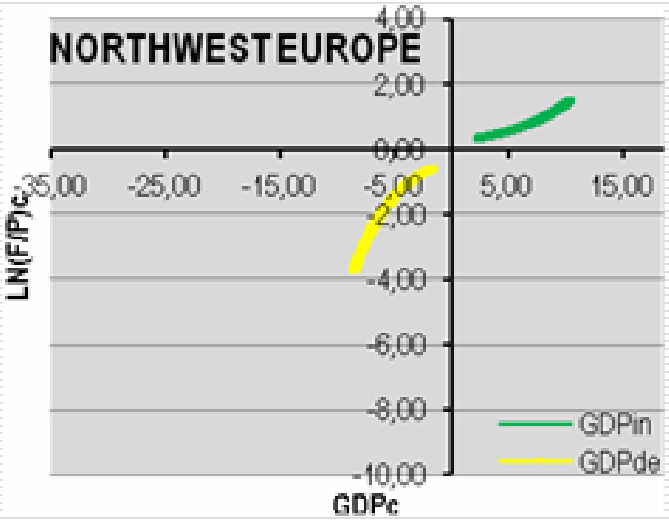
Results – Models for groups of countries

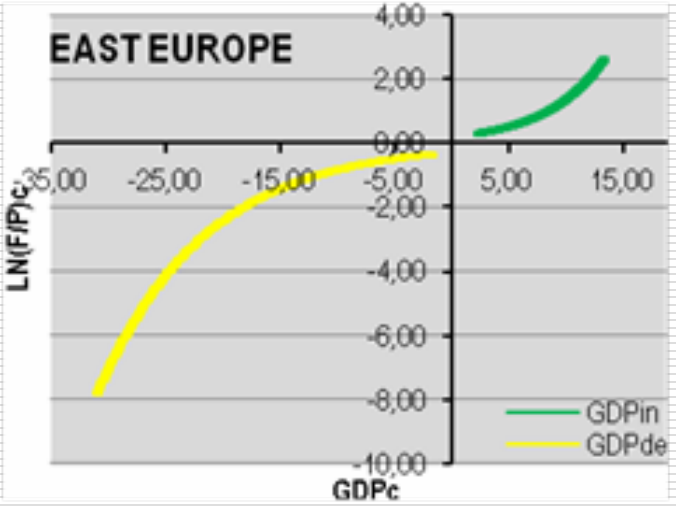
- Including one-year time-halo effects

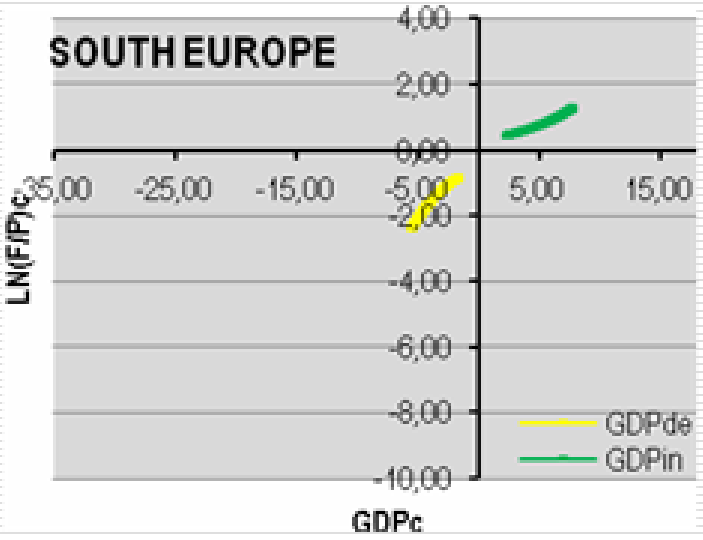
	Northwest countries			Central/Eastern countries			Southern countries		
Fixed effects	Estimate	t	Sig.	Estimate	t	Sig.	Estimate	T	Sig.
Intercept	-1,217	-7,193	0,000	-1,477	-4,218	0,000	-0,912	-4,250	0,000
GDPincrease	0,186	3,399	0,001	0,196	3,151	0,002	0,192	2,654	0,009
GDPdecrease	-0,266	-3,192	0,002	-0,107	-2,373	0,019	-0,274	-2,080	0,039
GDPincrease-1	0,036	0,655	0,513						
GDPdecrease-1	-0,281	-3,394	0,001						
Random effects	Estimate	Wald Z	Sig.	Estimate	Wald Z	Sig.	Estimate	Wald Z	Sig.
Residual	2,490	13,323	0,000	5,591	9,083	0,000	2,019	8,396	0,000

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

GDP annual change - Road fatalities annual change







Summary

- Statistically significant relationship between annual GDP increase and fatality rate increase was established, as well as a statistically significant relationship between annual GDP decrease and fatality rate decrease.

- Particularly in Northern / Western European countries, annual GDP decrease is associated with fatality rate decrease on the same year, as well as on one year later.

- A long period of related data was examined, likely to capture all sorts of annual effects, from systematic annual GDP increases as result of the overall improvement in the prosperity level of most European countries, to occasional annual GDP decreases observed due to socioeconomic events (e.g. economic recessions, political changes etc.)

Discussion – 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

- For several countries, the economy recovers after 2009, and fatalities have increased (the same year or one year later) - BE, DE, EE, IT, FI, SE and UK
- In some countries (GR, IE, ES, PT), both GDP and fatalities are still dropping
- A few exceptions (AT, NL, HU, CZ) where GDP recovers but fatalities continue decreasing - monitoring of future developments in these countries (growth and safety measures) will provide further insight

Discussion (cont.)

- 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

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 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

Taking into account the impact of GPD annual change (results of this study) may be proved very useful for time series analysis and forecasting of GDP trends impact to road safety.

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