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Effect of GDP changes on road traffic fatalities

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ABSTRACT

Road safety developments are correlated with mobility developments, which are in turn affected by socioeconomic factors (level of motorisation, economic growth etc.). During the last few years, road traffic fatalities exhibit important annual reductions in several developed countries; these reductions cannot be justified by policy efforts alone, and are partly attributed to the global economic recession affecting most countries' economy and mobility. The present research aims to associate annual Gross Domestic Product (GDP) changes with the related annual changes in road traffic mortality rates. Mortality rates and GDP per capita data for the period 1975–2011 are used from 27 European countries, for the development of mixed linear models. The results suggest that an annual increase of GDP per capita leads to an annual increase of mortality rates, whereas an annual decrease of GDP per capita leads to an annual decrease of mortality rates. These effects are statistically significant overall, and in different groups of countries (Northern/Western, Central/Eastern and Southern). A one-year lagged effect of annual GDP decrease was found to be significant in Northern/Western countries. These effects may capture annual GDP increases from the improvement in the prosperity level of most European countries, as well as occasional annual GDP decreases as a result of socioeconomic events (e.g. economic recessions, political changes in Central/Eastern European countries in the early nineties etc.). The models proposed in this paper are able to characterise the short-term dynamics of the examined variables, but not their long-run relationships.

1. Background and objectives

Road traffic fatalities and related injuries present a constantly decreasing trend during the last decades in most developed countries, as a result of systematic efforts at national and international level. Nevertheless, the total number of road fatalities in several countries and as a whole is still considered to be unacceptable, and more efforts are required for achieving the ambitious road safety targets adopted by most countries (ETSC, 2012). Within this context, the analysis and understanding of past developments is critical for the identification and quantification not only of efficient road safety interventions and good practice examples, but also of the effects of underlying or external factors that may affect these developments (IRTAD, 2012).

Road crash risk developments over time are typically correlated with mobility developments, as expressed in the amount of vehicle-kilometres of travel. These mobility estimates are in turn affected by socioeconomic factors, reflecting the level of motorisation in a country, the economic growth and the level of prosperity overall. The hypothesis that economic growth leads to increased vehicle ownership and increased amount of travel, affecting the road safety level, has been tested and confirmed by several macroscopic studies, dating since Smeed (1968).

More recently, Page (2001) presented a statistical model to compare road mortality in OECD (Organisation for Economic Co-operation and Development) countries, and showed that, the higher the GDP per capita, the higher the vehicle ownership in each country, whereas road fatalities per registered vehicles tend to decrease over time as GDP increases. Another study (Lassarre, 2001) applied the local linear trend model to ten European countries and used the estimated trend and elasticities to make inference about the relationship between traffic flow and number of fatalities. Another study (van Beeck et al., 2000) examined the association between prosperity and traffic accident mortality in industrialised countries in a long-term perspective (1962–1990) and found that the long-term relation between prosperity and traffic accident mortality appears to be non-linear. More recently, (Kopits and Cropper, 2005) researchers used linear and log-linear forms to model region specific trends of traffic fatality risk per income growth, using panel data from 1963 to 1999 for 88 countries. In another study (Yannis et al. 2011) piece-wise linear regression models were fitted to identify critical changes in macroscopic road accident trends in European countries, and the results suggested that the maximum fatality rates experienced in various countries over time lied within a relatively short range of vehicle ownership, namely around 200–300 vehicles per 1000 inhabitants, a point at

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which the fatality rates switched from an increasing trend to a decreasing one.

On the other hand, microscopic or occasional changes in economic and social factors, interrupting the smooth macroscopic trends, were also proved to be associated with road safety changes. The global petrol crisis in the early seventies has been studied (Tihansky, 1974), concluding that the reduced speed limits introduced by the authorities and the more cautious driving by an energy-conscious public have contributed to striking declines in the highway death toll.

The economic recession of the early eighties has been studied by several researchers with respect to its effects on road traffic fatalities. A significant concurrent inverse relationship between the rate of unemployment and the frequency of crash involvement was revealed (Wagenaar, 1984), as well as a significant positive one-year lagged effect between these two variables. In the same context (Hedlund et al., 1984), several factors were found to have contributed to the 1982 changes in road traffic fatalities in the USA, including demographic shifts, economic conditions, and travel patterns. Another study examined the effects of that recession within a broader scope, by associating unemployment rates with road fatalities, suicides and homicides (Reinfurt et al., 1991); the results revealed that unemployment rates do not appear to improve short-term forecasts of road fatalities.

During the last few years, road traffic fatalities exhibit important reductions in several countries; these reductions cannot be justified by the considerable policy efforts alone, and are already partly attributed to the global economic recession affecting most countries' economy and thus mobility. More specifically, a number of possible effects of economic recession are suspected to contribute to this impressive reduction, however they have not been substantiated so far (IRTAD, 2012). A recent study (Kweon, 2011) examined the 2008 reduction in traffic fatalities in the US using historical annual data and found that annual changes in unemployment rate and CPI (Consumer Price Index) were strongly associated with annual changes in road safety outcomes.

The objective of the present research is the analysis of the effect of changes in Gross Domestic Product (GDP) on mortality rates. More specifically, the present research aims to associate annual GDP changes with the related annual changes in mortality rates in Europe, unlike most existing studies which focus on the long-term relation between these two. This type of short term analysis is expected to shed some light on how the ongoing economic growth has resulted in constant decrease in fatalities overall, and – most importantly – how temporary economic recessions, especially the current one, may affect road safety beyond the expected effects. For that purpose, economic and road safety data from 27 European countries are used for the development of mixed linear models. It is therefore underlined that the models proposed may be able to characterise the short-term dynamics of the variables but not their long-run relationships.

2. Methodology and data

2.1. Time series data of road fatalities and GDP

In the present research, countries have been grouped according to their geographical location, while taking into account both the level of prosperity and the road safety development. Therefore, three groups of European countries were created, as follows:

- Northwest countries: Belgium (BE), Denmark (DK), Germany (DE), Ireland (IE), France (FR), Luxembourg (LU), Netherlands (NL), Austria (AT), Finland (FI), Sweden (SE) and United Kingdom (UK)
- Southern countries: Greece (EL), Spain (ES), Italy (IT) and Portugal (PT)
- Central/Eastern countries: Bulgaria (BG), Czech Republic (CZ), Estonia (EE), Latvia (LV), Lithuania (LT), Hungary (HU), Poland (PL), Romania (RO) and Slovenia (SI)

Indeed, Northwest countries are more prosperous with an average GDP per capita over 25.000$, followed by Southern countries whose average GDP per capita ranges between 12.000$ and 25.000$ and Central/Eastern countries with an average GDP per capita less than 12.000$. As regards the road safety development over time, countries of each group exhibit similar patterns, as it is described in detail below.

Fig. 1 shows the developments of road traffic mortality rates (F/P i.e. fatalities per population) and GDP per capita in a representative sample of eight European countries, including four Northwestern countries (the Netherlands, Germany, Finland and the United Kingdom), two Central-Eastern countries (Hungary and Estonia) and two Southern countries (Spain and Greece), for the period 1975–2011. The mortality rate is a popular indicator for risk performance assessment at international level, especially since vehicle-kilometres or other traffic data are not available or comparable at international level. However, this indicator does not take into account the level of motorisation, and its value can be low not only in case of high level road safety but in also case of low motorisation level (Papadimitriou et al., 2013).

In Northern–Western countries, the mortality rate presents a constantly decreasing trend during the last decades, however in Southern and Central-Eastern countries an increasing trend was initially observed within the examined period, with more fluctuations overall. It has been argued that Southern and Central-Eastern countries have reached the level of motorisation at which fatalities start to decrease later than Northern and Western countries (Yannis et al., 2011). In all countries, the GDP per capita shows a seemingly constantly increasing trend, with the effect of the current economic recession, as well as of the economic recession of the early eighties, being visible in almost all countries at the end and in the middle of the time series respectively.

Moreover, a clear regional pattern is identifiable (see Fig. 2): in Northwestern countries, the decreasing trend in the mortality rate spans the entire period, while in Southern countries the decrease started somewhat later, following an increasing trend that was initially observed within that period. In Central and Eastern countries, the mortality rate shows more fluctuation, and the effect of the changes in political regimes that took place in the early nineties is striking.

The overall picture of Fig. 1 appears to confirm the negative relationship between economic growth and road safety found in several macroscopic studies. However, when examining the annual percentage changes in mortality rates and GDP per capita in the same sample of countries for the same period (see Fig. 3), another pattern is observed. More specifically, it appears that annual changes in mortality rates are positively correlated with annual changes in GDP per capita, i.e. annual GDP increases coincide with annual mortality rate increases and vice versa, i.e. annual GDP decreases coincide with annual mortality rate decreases. This pattern is more identifiable in Central-Eastern and in Southern countries. Furthermore, a lagged effect is also detectable, suggesting that annual GDP changes, especially larger ones, may be positively correlated with next year's mortality rate changes i.e. an important annual drop in GDP per capita may result in an important annual drop of mortality rate one year later. The data from year 2008 onwards seem to suggest such a pattern in particular.

On the basis of the above, the present research aims to explore these patterns, by associating annual GDP changes with annual