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Let's talk about the weather – interpretation of short term changes in road accident outcomes

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Abstract

The monthly road traffic accident victim numbers in Belgium (2003-2014) were analyzed in latent trend time series models separately for pedestrians, cyclists, moped riders, car occupants and road user types jointly. For each road-user type the effect of a range of meteorological variables was tested. The resulting models allow a detailed view on the weather effects for different modes of transport. The strongest effects are observed for two-wheelers (motorcyclists and cyclists), with snow leading to a reduction in victim numbers while warm and sunny weather leads to an increase. The effect of rain differs according to the road user type involved.

The principles of state-space time series modelling are described along with the treatment of multicollinearity in models with several predicting variables. An outlook is given of the potential uses of the resulting models.

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1. Introduction

To provide feedback for road-safety policy, it is important to monitor road traffic accident and victim numbers for different types of road users. It is, however, difficult to differentiate short term variations due to external factors from real developments in road safety. An important external factor is the weather. Numerous studies have demonstrated that the number of road accident victims is strongly affected by the weather conditions.

Meteorological variables, like rain and snow but also warm temperatures and sunshine can influence the number of accidents in two ways. They can influence (1) the accident risk but also (2) the exposure to the accident risk.

(1) For the accident risk, factors like vision and visibility and a possibly reduced friction can lead to an increased accident risk, but road users' compensation for these problems can also lead to a reduction of risk. The result of these contradicting tendencies is not easy to predict and depends on the type or road user. As a general trend, snow and frost tend to lead to a lower accident risk while rain often increases the risk (for an overview see Bergel-Hayat et al., 2013; Focant & Martensen, 2014).

(2) The weather also has a strong influence on the exposition to risk, because it influences the number of trips undertaken (in bad weather, e.g., excursions might be postponed) as well as the choice of traffic mode (e.g., walking or cycling in fine weather, using the car with rain or cold weather). In particular the traffic volume of vulnerable road users is strongly affected by the weather condition.

The objective of the present study is to identify the relation between variations in the meteorological conditions and variations in the number of traffic victims, taking into account the type of road user. Without having detailed data on the traffic volume for all road-user types it is not possible to differentiate between risk-effects and exposure effects. Consequently, the aim is not so much to explain the causes of the weather effects. Rather, the models presented quantify the effects of different weather conditions and can therefore facilitate the interpretation (and communication) of variation in victim numbers. For the correct interpretation of new developments in road safety outcomes, it is important to quantify the changes that would have been expected on the basis of the meteorological conditions in a particular period. Only with statistical model of the relation between meteorological factors and victim numbers in the past, it is possible to determine whether recent developments were due to the weather or constitute genuine changes in road safety.

The meteorological variables included are the mean temperature (mean of daily maxima); number of days with snow, the number of days with frost, the precipitation height, and the mean duration of direct sunlight. Their effect was calculated on the monthly number of victims among pedestrians, cyclists, moped riders, motor cyclists, car occupants and all road users jointly.

2. Method

2.1. Data

All models were based on the log of the monthly number of victims injured in road traffic accidents in Belgium between January 2003 and December 2014 (i.e. 132 observations).

The traffic victims were categorized in 6 exclusive categories: pedestrians, cyclists, moped riders, motorcyclists, car occupants. For the other categories (e.g., occupants of vans, trucks, and busses) the victim numbers were too small to run statistical models. The monthly victim numbers are based on police records and may be subject to underreporting. The meteorological variables were based on monthly averages or sums published by the Royal Belgian Meteorological Institute.

Initially, four more meteorological variables -- the mean wind speed and the number of days with temperatures higher than 20, 25, and 30 °C -- as well as a number of calendar variables like number of days, the number of free days (i.e. either weekend or holidays), and the number of working or school days, were included into the analysis. These variables were however not significant and were later dropped from the analyses described here.

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