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Final Report

Project Title:

Temporal Modeling of Highway Crash Severity by Involved Person Age

Project Number:	Project End Date:	Submission Date:
UCNR23-2	August 31, 2012	July 20, 2012

Introduction

This project consisted of three studies, each described in the following sections. Three published documents were generated; these are listed in the last section.

Study 1: Temporal Modeling of Highway Crash Counts for Senior and Non-Senior Drivers

This paper introduces dynamic time series modeling in a Bayesian framework to uncover temporal patterns in highway crashes in Connecticut. Existing state sources provide data describing the time for each crash and demographic attributes of persons involved over the time period from January 1995 to December 2009 as well as the traffic volumes and the characteristics of the roads on which these crashes occurred. Induced exposure techniques are used to estimate the exposure for senior and non-senior drivers by road access type (limited access and surface roads) and area type (urban or rural). We show that these dynamic models fit the data better than the usual GLM framework while also permitting discovery of temporal trends in the estimation parameters, and that computational difficulties arising from Markov Chain Monte Carlo (MCMC) techniques can be handled by the innovative Integrated Nested Laplace Approximations (INLA). Using these techniques we find that while overall safety is increasing over time, the level of safety for senior drivers has remained more stagnant than for non-senior drivers, particularly on rural limited access roads. The greatest opportunity for improvement of safety for senior drivers is on rural surface roads.

More information is available in Publication #1.

Study 2: Temporal Modeling of Highway Crash Severity for Seniors and Other Involved Persons

This paper describes analysis using ordinal logistic regression to uncover temporal patterns in the severity level (fatal, serious injury, minor injury, slight injury or no injury) for persons involved in highway crashes in Connecticut. Existing state sources provide data describing the time and weather conditions for each crash and the vehicles and persons involved over the time period from 1995 to 2008 as well as the traffic volumes and the characteristics of the roads on which these crashes occurred. Controlling for characteristics known to be related to severity, e.g., age, crash type, and road characteristics, statistical modeling enables us to predict the probability of an individual to have a specific severity outcome if he/she is involved in a crash. Specifically, this paper investigates overall, long-term, time dependent and seasonal trends in senior drivers and travelers (65 years and over). This study also accounts for special conditions in data distribution and modeling in order to point to significant impacts on public health and safety as seniors become a larger portion of the population. Findings indicate an overall increase in increased crash severity probability for seniors, as well as a distinct seasonal trend. Other time-dependent trends in the data were visible, but not significant.

More information is available in Publication #2.

Study 3: Analysis of Driver and Passenger Crash Severity Using Partial Proportional Odds

The question of whether crash injury severity should be modeled using an ordinal response model or a non-ordered (multinomial) response model is persistent in traffic safety engineering. This paper proposes the use of the partial proportional odds (PPO) model as a statistical

modeling technique that both bridges the gap between ordered and non-ordered response modeling, and avoids violating the key assumptions in the behavior of crash severity inherent in these two alternatives. The partial proportional odds model is a type of logistic regression that allows certain individual predictor variables to ignore the proportional odds assumption which normally forces predictor variables to affect each level of the response variable with the same magnitude, while other predictor variables retain this proportional odds assumption. This research looks at the effectiveness of this PPO technique in predicting vehicular crash severities on Connecticut state roads using data from 1995 to 2009. The PPO model is compared to ordinal and multinomial response models on the basis of adequacy of model fit, significance of covariates, and out-of-sample prediction accuracy. The results of this study show that the PPO model has adequate fit and performs best overall in terms of covariate significance and prediction accuracy. Combined with the ability to accurately represent the theoretical process of crash injury severity prediction, this makes the PPO technique a favorable approach for crash injury severity modeling.

More information is available in Publication #3.

Publications:

1. S. Hu, J. Ivan, N. Ravishanker and J. Mooradian, "Temporal Modeling of Highway Crash Counts for Senior and Non-Senior Drivers", submitted to *Accident Analysis and Prevention*, in review.
2. J. Mooradian, J. Ivan, N. Ravishanker and S. Hu, "Temporal Modeling of Highway Crash Severity for Seniors and Other Involved Persons", Transportation Research Board Annual Meeting, Paper No. 12-3582, Washington, DC, Jan. 2012.
3. J. Mooradian, J. Ivan, N. Ravishanker and S. Hu, "Analysis of Driver and Passenger Crash Severity Using Partial Proportional Odds", submitted to *Accident Analysis and Prevention*, in review.