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Analysis of driver injury severity in rural single-vehicle crashes

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ABSTRACT

Rural roads carry less than fifty percent of the traffic in the United States. However, more than half of the traffic accident fatalities occurred on rural roads. This research focuses on analyzing injury severities involving single-vehicle crashes on rural roads, utilizing a latent class logit (LCL) model. Similar to multinomial logit (MNL) models, the LCL model has the advantage of not restricting the coefficients of each explanatory variable in different severity functions to be the same, making it possible to identify the impacts of the same explanatory variable on different injury outcomes. In addition, its unique model structure allows the LCL model to better address issues pertinent to the independence from irrelevant alternatives (IIA) property. A MNL model is also included as the benchmark simply because of its popularity in injury severity modeling. The model fitting results of the MNL and LCL models are presented and discussed. Key injury severity impact factors are identified for rural single-vehicle crashes. Also, a comparison of the model fitting, analysis marginal effects, and prediction performance of the MNL and LCL models are conducted, suggesting that the LCL model may be another viable modeling alternative for crash-severity analysis.

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1. Introduction

According to the US Department of Transportation Rural Safety Initiative released in February of 2008 (USDOT, 2008), "*Rural roads carry less than half of America's traffic yet they account for over half of the nation's vehicular deaths.*" From 1997 to 2006, traffic fatality rates on rural roads have consistently been more than twice of those on urban roads in the United States. Among all the states, the 5-year average data from 2002 to 2006 show that Florida has the nation's highest rural traffic fatality rate, which is 3.54 fatalities per 100 million vehicle miles traveled (VMT), while the national average rate during this period is 2.32 fatalities per 100 million VMT.

Table 1 shows a comparison of urban and rural fatal crash rates in Florida in 2005. It can be seen that more than 60% of the fatal crashes occurred on rural roads. Moreover, for every 100 crashes on rural roads, about two of them are fatal crashes; while for every 100 crashes on urban roads, only one of them is a fatal crash. The significant difference between rural and urban roads' crash-fatality ratio necessitates the need to better understand the underlying reasons for the higher fatality rates on rural roads and to investigate their injury severity characteristics.

Many statistical methods have been applied to traffic crash injury severity modeling, including ordered probit model (Abdel-Aty, 2003; Xie et al., 2009), ordered logit model (O'Donnell and Connor, 1996), multinomial logit model (MNL) (Savolainen and Mannering, 2007; Khorashadi et al., 2005), nested logit model (NL) (Shankar et al., 1996), ordered mixed logit model (Srinivasan, 2002), heteroscedastic ordered logit model (Wang and Kockelman, 2005), and logistics regression (Al-Ghamdi, 2002). A more comprehensive review of crash injury severity models can found in (Savolainen et al., 2011). Among these models, the ordered logit/probit models and the MNL are the most widely used ones. In the ordered logit/probit models, each explanatory variable has one coefficient, which means that the effects of this particular variable on all injury outcomes are restricted to be the same. In the MNL model, each injury outcome has a separate severity function (i.e., utility function in discrete choice modeling literature) and two severity functions can include different sets of explanatory variables. This modeling structure is quite flexible and can readily handle the distinct effects of the same variable on different injury outcomes. Although the MNL model has some advantages in terms of flexible model structure, it has certain limitations due to its independence from irrelevant alternatives (IIA) property, which originates from the independence and identical distribution (IID) assumption of the error terms in each severity function. This limitation of the MNL model is demonstrated in a previous study by Abdel-Aty (2003). In his research, Abdel-Aty compared ordered probit, MNL, and nested logit models for injury severity analysis. His research finding

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