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A multivariate tobit analysis of highway accident-injury-severity rates

Panagiotis Ch. Anastasopoulos[a,*], Venky N. Shankar[b,1], John E. Haddock[c,2], Fred L. Mannering[d,3]

[a] School of Civil Engineering, Purdue University, Indiana Local Technical Assistance Program, 550 Stadium Mall Drive, West Lafayette, IN 47907-2051, United States
[b] Department of Civil and Environmental Engineering, Pennsylvania State University, University Park, PA 16802, United States
[c] Department of Civil Engineering, Purdue University, and Indiana Local Technical Assistance Program, 550 Stadium Mall Drive, West Lafayette, IN 47907-2051, United States
[d] Department of Civil Engineering, Purdue University, 550 Stadium Mall Drive, West Lafayette, IN 47907-2051, United States

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ABSTRACT

Relatively recent research has illustrated the potential that tobit regression has in studying factors that affect vehicle accident rates (accidents per distance traveled) on specific roadway segments. Tobit regression has been used because accident rates on specific roadway segments are continuous data that are left-censored at zero (they are censored because accidents may not be observed on all roadway segments during the period over which data are collected). This censoring may arise from a number of sources, one of which being the possibility that less severe crashes may be under-reported and thus may be less likely to appear in crash databases. Traditional tobit-regression analyses have dealt with the overall accident rate (all crashes regardless of injury severity), so the issue of censoring by the severity of crashes has not been addressed. However, a tobit-regression approach that considers accident rates by injury-severity level, such as the rate of no-injury, possible injury and injury accidents per distance traveled (as opposed to all accidents regardless of injury-severity), can potentially provide new insights, and address the possibility that censoring may vary by crash-injury severity. Using five-year data from highways in Washington State, this paper estimates a multivariate tobit model of accident-injury-severity rates that addresses the possibility of differential censoring across injury-severity levels, while also accounting for the possible contemporaneous error correlation resulting from commonly shared unobserved characteristics across roadway segments. The empirical results show that the multivariate tobit model outperforms its univariate counterpart, is practically equivalent to the multivariate negative binomial model, and has the potential to provide a fuller understanding of the factors determining accident-injury-severity rates on specific roadway segments.

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1. Introduction

The preponderance of past research has studied the occurrence of accidents by considering their frequency and applying count-data modeling techniques to study factors that affect the frequency of accidents over some time period on specific roadway segments. This body of literature has applied a wide variety of modeling approaches such as Poisson and negative binomial models, Poisson-lognormal models, zero-inflated count models, Conway–Maxwell–Poisson models, negative multinomial models, Gamma models, generalized estimating equation models, generalized additive models, random effects and random parameters count models, and finite mixture and Markov switching models (for a complete review of this literature see Lord and Mannering, 2010).

While traditional accident-frequency approaches have undeniably improved our understanding of factors affecting accident occurrence, some recent research has suggested the tobit regression as an alternative (Anastasopoulos et al., 2008, 2012). The tobit-regression approach considers accident rates (such as the number of accidents per vehicle-miles traveled) on roadway segments as opposed to accident frequencies. This results in data that are continuous (instead of the discrete count data in the traditional frequency approaches) and in data that are left-censored at zero because accidents may not be reported on some roadway segments during the time period over which data are collected. This censoring may occur for a number of reasons ranging from the simple possibility that no accidents occurred on the roadway segment over the study period, to the possibility that accidents not involving injury may not be reported if their property damage does not exceed a specified threshold (this threshold is open to the interpretation of the officer at the accident scene and thresholds may vary from one jurisdiction to the next).

* Corresponding author. Tel.: +1 765 494 7760.
E-mail addresses: panast@purdue.edu (P.Ch. Anastasopoulos), shankarv@engr.psu.edu (V.N. Shankar), jhaddock@purdue.edu (J.E. Haddock), flm@purdue.edu (F.L. Mannering).
[1] Tel.: +1 814 865 9434.
[2] Tel.: +1 765 496 3996.
[3] Tel.: +1 765 496 7913.

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