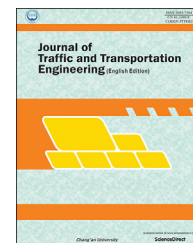


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## Original Research Paper

# Effectiveness of enforcement levels of speed limit and drink driving laws and associated factors – Exploratory empirical analysis using a bivariate ordered probit model



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## HIGHLIGHTS

- Simultaneous association between drink driving and speeding among fatally injured drivers has been quantified.
- Bivariate ordered probit model is statistically superior compared to univariate counterpart.
- Socioeconomic factors, fatalities and highway agency road safety policies are simultaneously associated with enforcement levels of speed limit and drink driving laws.

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## ABSTRACT

The contemporary traffic safety research comprises little information on quantifying the simultaneous association between drink driving and speeding among fatally injured drivers. Potential correlation between driver's drink driving and speeding behavior poses a substantial methodological concern which needs investigation. This study therefore focused on investigating the simultaneous impact of socioeconomic factors, fatalities, vehicle ownership, health services and highway agency road safety policies on enforcement levels of speed limit and drink driving laws. The effectiveness of enforcement levels of speed limit and drink driving laws has been investigated through development of bivariate ordered probit model using data extricated from WHO's global status report on road safety in 2013. The consistent and intuitive parameter estimates along with statistically significant correlation between response outcomes validates the statistical supremacy of bivariate ordered probit model. The results revealed that fatalities per thousand registered vehicles, hospital beds per hundred thousand population and road safety policies are associated with a likely medium or high effectiveness of enforcement levels of speed limit and drink driving laws, respectively. Also, the model encapsulates the effect of several other agency related variables and socio-economic status on the response

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outcomes. Marginal effects are reported for analyzing the impact of such factors on intermediate categories of response outcomes. The results of this study are expected to provide necessary insights to elemental enforcement programs. Also, marginal effects of explanatory variables may provide useful directions for formulating effective policy countermeasures for overcoming driver's speeding and drink driving behavior.

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## 1. Introduction

Speeding and drink driving are the key risk factors that significantly contribute to road traffic crashes (RTCs) (WHO, 2013). Specifically, drink driving contributes to as much as 30%–40% of road deaths globally which validates the influence of alcohol on risk taking driving behaviors (WHO, 2013). Quantitatively, in 2012, approximately 10,322 deaths in United States occurred due to crashes involving drunk drivers that equate to single fatal accident every 51 min (Blincoe et al., 2002). The situation is equally frightening on global level with almost 20% of all road traffic crashes related to drink driving (Room et al., 2005). Likewise, in year 2011, 30.72% of the total (32,367) road traffic fatalities (RTFs) occurred due to speeding (FHWA, 2011). Speeding was found as a contributory factor in 44% of the total fatal road crashes in UK (Clarke et al., 2010). One conclusion from Clarke et al. (2010) study of particular relevance is that approximately 65% of the reported crashes involved speeding, drunk driving, and/or non-usage of seat belts. Another study concluded effectiveness of publicity and enforcement campaigns against drunk driving and speeding in reducing RTCs (Tay, 2005). Therefore, effective enforcement of speeding and drink driving laws is crucial in reducing the global burden of excessive RTCs. Also, it seems imperative to understand the impact of several factors that may be associated or correlated with effectiveness of enforcement levels of speed limit and drink driving laws. A rigorous analysis of country-level data files regarding the road safety will eventually reveal covariates that may be associated with high or low effectiveness of speed limit and drink driving enforcement. Thus, the objective of present study is to investigate the simultaneous association between socioeconomic factors, vehicle ownerships, fatalities, agency road safety polices, health services, and effectiveness of speed and drink driving enforcement, respectively. Utilizing country level data from World Health Organization (WHO) and International Road Federation (IRF), the bivariate ordered probit modeling framework encapsulates the effect of several explanatory variables on two response outcomes.

## 2. Literature review

Several independent studies concluded drivers' non-compliance to drink driving law as a major reason for occurrence of road traffic crashes. Specifically, these studies concluded that blood-alcohol concentration (BAC) of drivers is much above

the recommended statutory limit (i.e., BAC of  $\leq 0.05$  g/dL) for up to half of total road traffic crashes (Baker et al., 2002; Evans, 1990; González-Wilhelm, 2007; Hingson et al., 2002; Voas et al., 2006). Moreover, a more pronounced effect of drink driving has been observed for young aged drivers, night time driving, and weekend driving, respectively. For example, an application of conditional logistic regression technique on case control data revealed positive BACs for majority of young drivers (aged 21 or less) involved in road crashes, where alcohol intake was suspected to affect crash avoidance skills of novice and young drivers (Peck et al., 2008). Likewise, for drivers of age 40 or less driving on lower volume roads, as much as 50% of night time risk (on weekend) was encapsulated by the odd consequences of alcohol (Keall et al., 2005). Also, several achievements have been made in terms of analyzing the vulnerability of young and novice drivers to consuming alcohol and the resulting risk of crash. The occurrence of road crash as a result of driver's first drink driving offense and more preferably at young age was concluded as an important factor in perception of drivers to repeat drink driving offense (Ferrante et al., 2001). Similarly, it was found that the proportion of New Zealand young drivers who consume large amount of alcohols are 2.6 times more likely to get engage in road traffic crash than those who do not undertake drunk driving (Horwood and Fergusson, 2000). As a result, the alleviated pattern of driver's risks and crash severities that results due to consumption of alcohol are more profound for young divers than the adult ones (Walker et al., 2005; Williams, 2003). In fact, the strong association between intensive outcome of a crash (injury severity) and drink driving is validated by a broad spectrum of methodological studies including (but not limited to) discrete choice models (Jiang et al., 2015), generalized ordered logit (Abegaz et al., 2014), ordered probit (Haleem and Gan, 2011), longitudinal empirical analysis (Morrison et al., 2002), mixed logit (Li et al., 2014), ordered logistic regression (MacKenzie et al., 2015), and random coefficient heteroskedastic ordered response model (Paleti et al., 2010). Due to the strong influence of drink driving on crash risk and severity, several researchers have studied the impact of various enforcement programs in an attempt to reduce alcohol-related RTCs. Past research has also been focused on quantifying the efficacy of publicity and enforcement schemes, social marketing, effectiveness of enforcement intensity, and drink driving enforcement strategies in reducing alcohol-involved RTCs (Li et al., 2012; Nguyen et al., 2012; Tay, 2005). A detailed synthesis of literature thus revealed drink driving as an important determinant of probability of crash involvement. Having this said, stringent enforcement of drink driving law

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