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Determinants of Traffic Fatalities in the U.S.

Hanna Stapleton
Minnesota State University, Mankato

DETERMINANTS OF TRAFFIC FATALITIES IN THE U.S.

Kwang Woo (Ken) Park, Minnesota State University at Mankato, Mankato, USA
Myeong Hwan Kim, State University of New York at New Paltz, New Paltz, USA
Hanna Beth Stapleton, Minnesota State University at Mankato, Mankato, USA

ABSTRACT

This paper investigates the determinants of motor vehicle fatalities in each of the 50 states in the U.S., along with the District of Columbia. Using a panel data set from 1994 to 2005, we analyze how the factors, such as safety belt laws, speed control, alcohol usage, fine, driving conditions and annual vehicle-miles of travel (VMT), affect the incidence of traffic fatalities. Econometric models are developed and the estimates are obtained from a general-to-specific specification search based upon all the diagnostic tests in order to increase the probability of selecting models which are statistically reliable. The empirical results show that number of drivers and vehicles, VMT, speed, and fine are statistically significant, whereas safety belt usage and state alcohol policies do not show any significant support for reducing traffic fatalities.

Keywords*: Fatality; Traffic Accident; Safety Belt; BAC; VMT.*

I. INTRODUCTION

According to the United States (US) Transportation Secretary Norman Mineta, highway traffic deaths are a “national epidemic.” Traffic crashes come at an enormous cost to society. The National Highway Traffic Safety Administration (NHTSA) estimates that highway crashes cost society $230.6 billion a year, or an average of about $820 per capita. From the point of view of social welfare, such losses are not only financially significant, but also economically significant losses on human capital. Traffic accidents continue to be the leading cause of fatalities and serious injuries. In particular, a leading cause of death in American children and young adults is the traffic fatalities, accounting for 12,669 deaths and 1,000,000 injuries of 0-20-year-olds in 2005 alone (NHTSA, 2005). Almost a quarter of the at-fault drivers are younger than 25. In the Unitied States, nearly 40,000 people die every year in traffic accidents (Levitt and Porter, 2001). It is important for everyone, not only young people, to understand the different factors that may affect traffic crashes.

Regarding the major factors of traffic fatalities, most prior studies focus on the effectiveness of a single variable such as safety belt laws, alcohol polices, driver licensing policies, income distribution and so on. Even if some of the variables have been suggested as determinants of traffic fatalities, there is little concern in the literature which of those variables matter concurrently. Most authors examine the sensitivity of their model based upon one policy variable. In this study, however, we put together all the pre-examined variables in an econometric model and specify the most relevant econometric model to explain traffic fatalities in the U.S.

Among the several factors of traffic fatalities, we may consider the variables related with driving conditions such as roads, vehicles, drivers’ condition, etc. Some researchers have addressed the effect of alcohol in traffic accidents. Levit and Porter (2001) shows that drinking drivers are at least seven times more likely to cause fatal crash than sober drivers are. Saffer (1995) points out that alcohol advertising is a contribution factor in the high level of motor vehicle fatalities in the U.S.

Saffer (1995) analyzes the effect that alcohol advertising has on alcohol-related traffic fatalities. This study suggests that with a ban on broadcast alcohol advertisement, traffic fatality rates could be reduced by 1,300 deaths per year, in spite of the claims of alcohol companies that their advertising intent was aimed at brand loyalty versus an increase in consumption. Since this study examines only the effect on the banning of broadcast advertisements, not other forms of alcohol advertisements, it presents a limited rationale that these broadcast ads have an impact on traffic fatalities.

Wibowo (1999) examines the effects that young drivers have on traffic fatalities, primarily focusing on how alcohol related fatalities are more prevalent in younger drivers versus older drivers. The study describes the efficacy of alcohol leglisalation, specifically those directed at young adults in attempts to reduce drunken driving, was overestimated by Congress. Wibowo concludes that policymakers should try to reduce alcohol usage amongst all categories, not just young adults, and furthermore, that speed was a more significant factor in traffic fatalities.

Another study examining the effects of alcohol was by Chaloupka et al. (1993) which looks closely at deterrence laws and alcohol-control policies on drivers. The findings indicate that certain deterrence laws were unremarkable. These were mandatory jail sentences, community-service laws, and open-container laws. However, imposing high mandatory fines and the laws of minimum drinking age preliminary breath-test, and dram-shop had a remarkable impact.

In shifting the attention from alcohol influence analysis to other research, Siland and Kilsztajn (2003) focus on the relationship between mortality due traffic accidents, the number of registered motor vehicles, and economic activity in Brazil form 1980 to 1999. The results indicate that the number of deaths in traffic accidents follows economic waves and shows a general tendency to decrease as the number of motor vehicles per capita increase. Kilsztajn et al. (2001) and Michelin et al. (2001) analyze the relationship between mortality due traffic accidents and the number of motor vehicles.

Other researchers have tried to justify which factors influence the accidents caused by driver distraction. Cohen and Einav (2003) analyze driving behavior effects in response to mandatory safety belt law, primarily focusing on the compensating-behavior theory, stating that careless driving is encouraged with the use of a safety belt. Evidence from the study concludes that no significant effects on driver behavior are cause by higher safety belt usage. The study finds, however, that safety belt laws strongly correlate to a reduction in the number of traffic fatalities. Furthermore, it supports that having a primary safety belt law versus a secondary law has a high impact on the effectiveness of reducing fatalities.

The purpose of this paper is to empirically investigate the wide range determinants of motor vehicle fatalities in each of the 50 states in the U.S., along with the District of Columbia. In order to carefully examine the sensitivity of the empirical findings, we attempt to see whether the variables reported to be significant in a particular regression are robustly related to motor traffic fatalities. We analyze to what extent variables that have been suggested in literature as influencing traffic fatality are indeed robust determinants. Following the theoretical and empirical findings of prior studies pertaining to motor vehicle accidents, econometric models are developed and the estimates are obtained from a general-to-specific specification search based upon all the diagnostic tests in order to increase the probability of selecting models which are statistically reliable. The balance of the paper is organized into the following sections: The Empirical Framework, The Data, Empirical Results and Conclusion.

II. THE EMPIRICAL FRAMEWORK AND DATA

The basic approach is to estimate a simple linear equation, with traffic fatalities as the dependent variable and with policy-related variables and driver-specific variables as the explanatory variable. Following the theoretical and empirical findings of prior studies pertaining to motor vehicle accidents, the generic fixed-effects estimation equation for dependent variable, motor vehicle fatalities, is depicted as follows:

$$
\begin{aligned}
\ln Fatility_t = {} & \beta_0 + \beta_1 \ln SafetyBelt_t + \beta_2 \ln Driver_t + \beta_3 \ln \left(Male / Female \right)_t \\
& + \beta_4 \ln \left(Vehicle / Road \right)_t + \beta_5 \ln VMT_t + \beta_6 BAC_t + \beta_7 Speed_t \\
& + \beta_8 Fine_t + \sum \Phi T_t + \varepsilon_t
\end{aligned}
\qquad (1)
$$

where *Fatalities* is number of traffic related fatalities at year *t*, *Safety Belt* represents safety belt use rate, *Driver* is licensed driver per population, *Male* and *Female* are the licensed male and female drivers, *Vehicle* is number of registered vehicle, *Road* is number of miles of public roadway, *VMT* is annual vehicle-miles of travel, and *BAC* is a binary variable that is illegal per se level (e.g., 1 if 0.08 and 0 if 0.1). As the policy related variables, we use two control variables. *Speed* is a binary variable that is unity if maximum interstate speed limit exceeds 65 mph at time *t*; *Fine* is a binary variable that is unity if fine is less than $26.60 (Average fine: $26.60 of 50 states and District of Columbia). T_t is a comprehensive set of time fixed effects, and ε_t represents the other omitted influences on fatalities and assumed to be well behaved.

We use year fixed effects to control for any time-specific macro effects that shift the level of traffic fatalities for all states. In our context, such macro effects are the significant technological changes that introduced safety innovations or national campaigns that affected the behavior of drivers across the states. The time effects also capture the increased penetration of air bags and shoulder harness over time.

In addition, we consider the simultaneity problem between the traffic fatality and the safety belt usage rate. As Cohen and Einav (2003) points out, the probable positive correlation between safety belt usage and the error terms is likely to exist even if year fixed effects are controlled. For the possible endogeneity, Cohen and Einav (2003) argues that the states experienced an increase in traffic fatalities might invest in promoting safety belt usage, and such investment might lead to an increase in usage, which again might generate a positive correlation between usage and the error term and thereby positive bias of the estimated coefficient. Hence, we also take into account the plausible endogeneity issue through two stage least square (2SLS) estimation with the instrumental variables. The instrumental variables we use are the two dummy variables that stand for mandatory safety belt laws with the primary and second enforcement.

The final form of model specifications based upon the general functional form, equation (1), was obtained from “general-to-specific” specification search, which was popularized particularly by Hendry (see Hendry, 1993 and 1995, and Hendry and Mizon, 1990; Mizon, 1995). Hendry and Krolzig (2001) recommend the use of multiple search paths in the process of moving from a Generalized Unrestricted Model (GUM) to a parsimonious specification. The reason for this recommendation is to avoid the risk of deleting an important variable that should ideally be retained in the final specification along any single search path and to minimize the risk of retaining as proxies for the missing variable with the result that the final model is overparameterised. In addition, this approach is ideally suited to the analysis in the search process of unspecified functions because the underlying theory is sufficiently loose to admit a wide range of candidate regressors. Therefore, our final form of each team in the generic equation (1) is determined by parsimony, satisfactory performance against diagnostic tests incorporated with Schwarz criterion.

In this study, we use a panel of annual state-level variables for all U.S. jurisdictions. The data covers all 50 U.S. states and the District of Columbia for the years 1994-2005. The dependent variable is number of traffic related fatalities from the Fatality Analysis Reporting System (FARS). We use safety belt use rate, licensed driver per population, licensed male/female driver, number of registered vehicle, number of miles of public roadway and annual vehicle-miles of travel as explanatory variables. As provisions of safety laws, we use illegal per se level (BAC), fine for not wearing a safety belt and maximum interstate speed limit. We obtained these data from the National Highway Traffic Safety Administration (NHTSA).

IV. EMPIRICAL RESULTS

Table 1 presets the general and specific form of linear regressions of traffic fatalities on the control variables. The first and second columns show the general form of regression result estimated by considering year-fixed effects in order to see the technological innovations on safety laws. Most of estimators are significant at 99 percent except for safety belt and BAC.

The most obvious effects on traffic fatalities are the variables related with driving conditions such as driver, vehicle per road and VMT. Regulations on speed are also one of the important factors to determine traffic fatalities. The estimation represents that states with the maximum interstate speed limit of exceeding 65 mph have about 32 percent higher traffic fatality than the states of having maximum speed below 65 mph.

Table 1

Variables	General Form		Specific Forms	
	OLS	2SLS	OLS	OLS
Safety Belt	0.130	0.638	0.128	
	(0.215)	(0.525)	(0.215)	
Driver	0.760**	0.766**	0.761**	0.748**
	(0.069)	(0.070)	(0.068)	(0.069)
Male per Female	-1.065**	-1.473**	-1.065**	-0.956**
	(0.379)	(0.057)	(0.381)	(0.384)
Vehicle per Road	0.102	0.136**	0.103*	0.096*
	(0.054)	(0.059)	(0.054)	(0.055)
VMT	0.221**	0.201**	0.221**	0.236**
	(0.065)	(0.069)	(0.065)	(0.065)
BAC	-0.008	-0.018		
	(0.055)	(0.062)		
Speed	0.313**	0.299**	0.323**	0.317**
	(0.065)	(0.079)	(0.064)	(0.064)
Fine	0.160*	0.172**	0.161**	0.147**
	(0.066)	(0.072)	(0.065)	(0.067)
Constant	-10.695**	-12.332**	-10.689**	-10.35**
	(1.058)	(1.892)	(1.058)	(0.765)
Observation†	601	601	601	601
R^2	0.955	0.950	0.955	0.955

Note: ** and * denote significant at 99 and 95 percent, respectively. † State of Maine (2000-2003), New Hampshire (2000-2002, 2004, 2005) and Wyoming (2003, 2005) did not report safety belt use rate.

Fine is also a significant factor to reduce the traffic fatalities. The states introducing the heavier fine than the average level have about 16 percent less traffic fatalities than the other states. These results show that the states regulations on speed control through placing fine are very significant and lead to reduce the fatality rate. In particular, considering young drivers who have relatively low-income level and high-income elasticities, the states policies on fines on traffic violations will be more effective to those age groups than the matured drivers who are relatively in higher tax-bracket.

One interesting finding in this study is that as the ratio of the male per female drivers increase, the traffic fatalities may decrease significantly. According to the NHTSA, male drivers were involved in 27,000 more fatal accidents, 432,000 more injury crashes and 1,369,000 more property-damaged incidents than female drivers - which inevitably equated to 1,828,000 more insurance claims in a single a year. However, the results show that as the ratio of male drivers becomes relatively larger compared to female drivers, the traffic fatalities decrease.

However, the final specific form of regression shows that the law enforcements on alcohol drink are not effective to reduce the traffic fatalities. Even if a driver with alcohol in their blood are much more likely to cause a fatal crash, the small differences in the drinking level itself per se level do not show major differences amongst the states in their traffic fatalities. Following Henry (1995), the important factor to avoid the fatal traffic accident is the regulation itself through heavy fine on alcohol driving, but the matter of “illegally” or “legally” per se levels is not as effective when the BAC level is relatively close to the per se level.

For the issues on safety belt usage, Cohen and Einav (2003) argue that it would decrease overall traffic fatalities by about 0.13 percent for every 1 percent increase in safety belt usage. Yet, the empirical founding on safety belt use is statistically ambiguous on reducing traffic fatalities in our study. The first and the second column of Table 1 show that the estimated coefficient not only is statically insignificant, but also the direction is incorrect. This might be from the data limitation in which we consider a primary and secondary restraint law.

V. CONCLUSION

This paper investigates the wide range determinants of motor vehicle fatalities in each of the 50 states in the U.S., along with the District of Columbia. Unlike previous empirical studies, which examine the sensitivity of their model based upon one policy variable, we put together all the pre-examined variables in an econometric model and attempted to specify the most relevant econometric model on the traffic fatalities in the U.S. to date. By using panel data analysis from 1994 to 2005, we analyze separately the year fixed effects on fatalities and we allow for the endogeneity of control variables by considering instrumental binary variables such as mandatory safety belt law, fine, and speed.

The most obvious effects on traffic fatalities are the variables related with driving conditions such as driver, vehicle per road and VMT. Regulations on speed are also one important factor in determining the number of traffic fatalities. The estimation represents that states with the maximum interstate speed limit of exceeding 65 mph have about 32 percent higher traffic fatality than the states of having maximum speed below 65 mph. Fine is also a significant factor to reduce the traffic fatalities. The states introducing the heavier fine than the average level have about 16 percent less traffic fatalities than the other states. These results show that the states regulations on speed control through placing fines are very significant and lead to a reduction in the fatality rate. However, the final specific form of regression shows that the law enforcements on safety belt and alcohol drink are ineffective to reduce the traffic fatalities. Based upon these conclusions, policymakers should reconsider the efficacy of current alcohol and safety belt legislation. Since introducing heavier fines is significant, it may be effective to enable a smaller fine on having a BAC of 0.01 and an increasing fine amount for every alcohol level up to, and possibly beyond, the legally per se level in order to decrease the number of traffic fatalities.

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AUTHOR PROFILES

Student author:
Hanna Beth Stapleton is a research assistant of economics at Minnesota State University at Mankato.

Faculty Mentors:
Dr. Kwang-Woo (Ken) Park earned his Ph.D. at Claremont Graduate University in 2003. Currently he is an assistant professor of economics at Minnesota State University at Mankato.

Dr. Myeong Hwan Kim earned his Ph.D. at Claremont Graduate University in 2006. Currently he is an assistant professor of economics at State University of New York at New Paltz.