AN ECONOMIC MODEL OF HIGHWAY FATALITIES

by

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# AN ECONOMIC MODEL OF HIGHWAY FATALITIES

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1. **Introduction**

Traffic accidents result in nearly 44,000 deaths each year in the United States.¹ Local, state and federal government officials, concerned over the number of traffic deaths occurring each year, are taking steps to make automobile travel safer. Several areas where efforts have been concentrated recently include:

- Enactment of mandatory seat belt usage laws
- Raising the drinking age to 21 years old
- Relaxation of the National Maximum 55 MPH speed limit.

The purpose of this thesis is twofold. The first part is an empirical study using multiple regression to determine the effect of several traffic related variables on the highway fatality rate. The second part will utilize the results of the empirical model to determine on which policy actions state, local, and federal government officials can concentrate their resources in order to reduce the highway fatality rate.

2. **An Economic Model of Highway Fatalities**

According to Forrester, McNown and Singell in their paper entitled "Cost Benefit Analysis of the 55 MPH Speed Limit", the probability that an individual will be involved in a fatal automobile accident is a function of the degree of safety practiced by the driver as well as traffic and highway conditions. In their analysis, a highway fatality model was built to determine the costs and benefits of the nationally mandated 55 MPH speed limit. A time series analysis using data from 1952 through 1979 was employed to test the impact on the highway fatality rate of the following variables:

- Income
- The number of vehicle miles traveled
- The age of drivers
- The number of motorcycle registrations relative to automobile registrations
- Average speed
- Concentration of speed
- Price of gas
- 55 MPH dummy variable
- The number of imported cars as a fraction of all car purchases.

All variables tested significant at the 5% level with the exception of the age and imported car variables.

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3. Frequently referred to as speed variance in other studies. Speed variance in the Forrester model is defined as the percentage of cars traveling between 45 and 60 MPH.
In a similar study entitled "Speeding, Coordination and the 55 MPH Limit," Charles Lave built a highway fatality model to determine whether average speed or speed variance had the largest impact on highway fatalities. Using a cross-section of data from states for 1981 and 1982, Lave calculated the impact of average speed and speed variance on highway fatality rates for six road types. Based on this analysis Lave concluded that the speed variance, not the average speed, has the largest impact on the highway fatality rate.

The Lave and Forrester, et al. highway fatality models were used as a basis in developing a model to determine where local, state, and federal government officials can concentrate their resources in order to reduce highway fatalities. Like the Lave model, this highway fatality model is based on a cross section of data from various states over a two year time period; in this case years 1984 and 1985. Lave, however, based his model primarily on two variables, average speed and speed variance. Like the work previously described by Forrester et al., the highway fatality model presented here will analyze the cause and effect relationship of ten variables. The remainder of this section will present a discussion of each of these variables included in the regression analysis.

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2.1 The Highway Fatality Variable

The dependent variable is the highway fatality rate per hundred million vehicle miles traveled per state. Exhibit 1 shows how the highway fatality rate, nationwide has declined over the past decade. Several factors may be responsible for this decline including:

- The imposition of the Maximum National Speed Limit of 55 MPH in 1974
- The increased use of seat belts among drivers as a result of mandatory usage laws in many states
- The raising of the minimum age for drinking beer to 21 years of age
- Safer and better built cars
- Better emergency and long term medical care
- Improvements in the design and construction of highways.

Some of these factors will be considered in the highway fatality model presented here.

Ten independent variables were considered for inclusion in the highway fatality model. They were selected because past studies have indicated that they may have an impact on the highway fatality rate. These ten variables, of course, do not account for all factors which impact the highway fatality rate. Several factors such as better emergency and long term medical care, safer and better built
Exhibit 1

NATIONWIDE TREND IN HIGHWAY FATALITY RATES

Source: Federal Highway Administration
cars as well as improvements in highway design and construction were excluded due to the difficulty in quantifying their impact. Other variables were excluded such as the number of motorcycle drivers and the number of small cars on the road due to the lack of data on a state by state basis. The variables included are:

- Average speed
- Percentage of drivers exceeding 55 MPH
- Speed variance
- Percentage of licensed drivers less than 25 years old
- Percentage of drivers wearing seat belts
- Per capita alcohol consumption rate
- Minimum drinking age for beer
- Percentage of licensed male drivers
- Percentage of population living in urban areas
- Percentage of roads in urban areas.

2.2 Speed Variables

Average speed was included in both the Lave and Forrester et al. models and is recognized throughout the literature as having a significant impact on highway fatalities. According to the Insurance Institute for Highway Safety, higher average speeds increase both the likelihood and severity of an automobile crash.\textsuperscript{5} Crash tests have shown that a driver crashing at the speed of 50 MPH is twice as likely to be killed as one crashing at 40 MPH.\textsuperscript{6}

\textsuperscript{6}Ibid.
The expected sign in the regression equation for the average speed variable is positive to reflect the fact that the higher the average highway speed, the higher the highway fatality rate. Exhibit 2 shows the average speed by year on U.S. interstates. Note that the graph takes a dip in 1974 which correlates with the year the National Maximum Speed Limit of 55 MPH went into affect.

Another variable also used to test the impact of speed on the highway fatality rate is the percentage of drivers exceeding 55 MPH in each state. The expected sign of this variable in the regression equation is also positive.

Speed variance or concentration of speed was also included in both the Lave and Forrester et al. models. In fact, Lave found in his analysis that speed variance, not average speed has the greatest impact on the highway fatality rate. He went on to conclude that to reduce highway fatalities it is important that everyone drive at close to the same speed. Therefore, drivers driving below the speed limit are just as dangerous as those driving above the speed limit.7

Speed variance is linked closely to the speed limit. According to the Insurance Institute for Highway Safety lower maximum speed results in traffic traveling at a more uniform speed.8 Therefore, one would expect that a decrease in the average highway speed would result in a decrease in speed variance and therefore a reduction in highway fatalities.

7Lave, op. cit., p. 1163.
8“55 Speed Limit,” IIHS Facts.
Exhibit 2

NATIONWIDE TREND IN AVERAGE SPEED ON U.S. INTERSTATES

Source: Federal Highway Administration
"Quarterly Speed Summary" 1973 - 1986
Speed variance can be calculated in a number of ways. This paper uses Lave's approach which is defined as the 85th percentile speed minus the average speed. In addition, since it is difficult to quantify the impact a change in average speed has on the speed variance, for regression purposes the speed variance is assumed independent of the average speed. The expected sign of this variable is positive to reflect that the greater the speed variance, the higher the highway fatality rate.

2.3 Age Variable

Young drivers have traditionally been considered high risk drivers by insurance companies in this country. Statistics show that young drivers, due to their inexperience and perhaps their levels of maturity, are more likely to be involved in a fatal automobile accident than older drivers. In fact, according to the Insurance Institute for Highway Safety nearly 10,000 teenagers die each year in automobile crashes, making motor vehicle crashes the number one killer of teenagers. However, according to Forrester et al., young drivers are also more resilient and thus able to withstand more serious injuries.

In this paper a young driver is defined as 24 years old or younger. To account for the impact young drivers have on the highway fatality rate, the percentage of licenses held by young

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10Forrester, et. al., op. cit., p.632.
drivers relative to the total licenses issued in the state is used. The expected sign of this variable is positive to reflect that an increase in young drivers will result in an increase in the highway fatality rate.

2.4 Seat Belt Variable

Seat belt use can also have an impact on the highway fatality rate. Wearing seat belts won't prevent accidents; however, it can reduce the consequences of an accident by possibly saving a life. Exhibit 3 shows that a higher percentage of Americans are wearing seat belts today than ever before. This is primarily due to the passage of Mandatory Usage Laws in many states.

The seat belt variable used in this model is the percentage of drivers wearing seat belts by state. Most of this data was collected through observation or surveys conducted by the Department of Transportation in various states. The expected sign for this variable is negative to reflect that the more people wearing seat belts the lower the highway fatality rate.

2.5 Drinking and Driving Variables

Nearly half of all automobile fatalities involve alcohol. Two variables are considered in this model to account for the impact of drinking and driving. The first is the per capita alcohol consumption

Exhibit 3

NATIONWIDE TREND IN SEAT BELT USAGE

Source: Federal Highway Administration
"Driver Safety Belt Usage by City and Quarter"
1984 and 1985
rate per state and the other is the minimum drinking age for beer in each state.

Drinking and driving, although on the decline, is considered a serious problem in this country.\textsuperscript{12} Since nearly half of all traffic accidents involve alcohol, it follows then that the more alcohol that is consumed, the more likely that drinking and driving will occur. To account for the impact of drinking and driving on the highway fatality rate the per capita alcohol consumption rate, per state is used. The expected sign of this variable is positive.

The drinking age is being raised in many states in an effort to reduce the number of accidents involving teenagers and drunk driving. Although teenagers are not the worst offenders, when they do drink and drive they are more likely to be involved in a fatal automobile accident according to the Insurance Institute for Highway Safety.\textsuperscript{13} Many studies have shown that raising the drinking age results in a decrease in highway fatalities among teenagers. In a study of 26 states where the drinking age has been raised, the Insurance Institute for Highway Safety, using regression analysis, estimated the proportional decreases in the highway fatality rates associated with the prohibition of alcohol from drivers for various ages and age group combinations. They concluded that raising the

\textsuperscript{13}Allan F. Williams, "Raising the Legal Purchase Age in the United States: Its Effects on Fatal Motor Vehicle Crashes," \textit{Alcohol Drugs and Driving}, April-June, 1986, p. 6.
drinking age resulted in a 13 percent decrease in night time fatal crashes among teenagers. 14

Another study by Mike Males, however, in response to the Insurance Institute for Highway Safety's findings claims that increasing the drinking age from 18 to 21 doesn't save lives in the long run.15 Instead of 18, 19 and 20 year olds dying from drinking and driving, the range is shifted to 21 and older drivers.16 Males study is based on 14 states which have raised their minimum purchase age for alcoholic beverages. For each state he develops a Fatal Crash Ratio (FCR) and compares that ratio against the FCRs calculated for 14 similar states which have not yet raised their drinking age.17 Based on this approach, Males concludes that raising the drinking age will result in the long run in a net increase of three percent in all fatal crashes.18

Despite the latter study, the postulated sign for the drinking age for beer is negative, reflecting the expectation that higher drinking ages result in lower highway fatality rates. Exhibit 4 shows the nationwide trend in the average drinking age for beer over the past decade.

14 Ibid.
15 Williams in a critique of Males study claimed that it is flawed conceptually and statistically and has been contradicted by other research using similar data. (Statement of Allan F. Williams, Vice President, Insurance Institute for Highway Safety before the U.S. House of Representatives Committee on Public Works and Transportation, September 18, 1986).
17 Fatal Crash Ratio is defined by Males as the ratio of fatal crashes involving drivers of each of five age groups to those involving drivers ages 21 to 24.
18 Males, op. loc.
Exhibit 4

NATIONWIDE TREND IN THE MINIMUM DRINKING AGE FOR BEER

Source: National Institute on Alcohol Abuse and Alcoholism "U.S. Apparent Consumption of Alcoholic Beverages" 1985 and 1986
2.6 Male Drivers Variable

Male drivers are considered by insurance companies a higher risk than female drivers. In fact, according to the Insurance Institute for Highway Safety male drivers account for nearly 80 percent of accidents involving a fatality.\textsuperscript{19} The percentage of males holding licenses in each state is selected as the representative variable, and its sign is expected to be positive.

2.7 Urban Variables

Urban areas tend to have fewer fatal traffic accidents, not necessarily because they are safer to drive in but because accidents on urban roads normally occur at lower speeds resulting in more "fender benders" than fatal accidents. To account for this phenomenon in the model, two variables were used; the percentage of urban population and the percentage of urban roads in each state. Both of these variables should have negative coefficients to reflect the more urban a state is, the lower the highway fatality rate.

\textsuperscript{19}Williams, op. cit. p. 9.
2.8 **The Highway Fatality Model**

Thus, based on the above independent variables the postulated highway fatality model is:

\[ \text{FVMT} = F(\text{SPD}, \text{EXCD}, \text{VRC}, \text{AGE}, \text{ALC}, \text{DRNK}, \text{STBT}, \text{URB}, \text{RD}, \text{ML}) \]

Where:

- \( \text{FVMT} \) = Highway fatalities per 100 million vehicle miles traveled
- \( \text{SPD} \) = Average speed
- \( \text{EXCD} \) = Percentage of drivers exceeding 55 MPH
- \( \text{VRC} \) = Average speed variance
- \( \text{AGE} \) = Percentage of licensed drivers less than 25 years old
- \( \text{ALC} \) = Per capita alcohol consumption rate
- \( \text{DRNK} \) = Minimum drinking age for beer
- \( \text{STBT} \) = Percentage of drivers wearing seat belts
- \( \text{URB} \) = Percentage of population living in urban areas
- \( \text{RD} \) = Percentage of roads in urban areas
- \( \text{ML} \) = Percentage of licensed male drivers

Data were collected for each of the above variables by state. Unfortunately, data were scarce for several variables. Consequently, for 1984, a complete data set was collected for only 20 states and for 1985, 28 states. The 1984 and 1985 data were combined to form one large data base of 48 observations. Exhibit 5 summarizes the data collected by state and variable for 1984 and 1985. For data based on the 1980 census, such as the percentage of urban population the data for each state are the same in 1984 and 1985. The data are also identical in 1984 and 1985 for the per capita
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Source Code

2. Federal Highway Administration - Quarterly Speed Summary 1984 and 1985
3. Federal Highway Administration - Drivers Licenses By Sex and Age 1984 and 1985
5. Federal Highway Administration - Survey Results of Usage Rates in States with MULS 1986
   Driver Safety Belt Usage by City and Quarter 1984 and 1985
7. Statistical Abstract of the United States - 1986
alcohol consumption rate and percentage of urban roads since the 1985 data were not available at the time of this analysis. The mean, variance and standard deviations were calculated for each variable and are presented in Exhibit 6.
## Variable Statistics

### 48 Observations

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3. **Regression Results**

The highway fatality rate equation was estimated using ordinary least squares. Exhibit 7 presents five iterations of the model. The independent variables are listed in the left hand column along with the estimated coefficient and T-statistic (in parentheses) for each iteration. All the equations presented are in linear form. At the bottom of the exhibit the correlation coefficient, \( R^2 \) and \( R^2 \) the sum of squares of the residuals (SSR) and the standard error of the estimate (SEE) are listed for each iteration.

The first iteration included all of the independent variables. However, only the age, drinking age, urban population and urban roads variables tested significant at the ninety percent level. In addition, the sign for the percentage of urban population was opposite of what was expected.

For the second iteration the independent variables with the lowest T-statistics were dropped from the equation. The average speed variable, however, was retained since it is recognized in the literature as having an impact on the highway fatality rate. The result of this run was a dramatic increase in the significance of all the remaining variables. The only variable testing insignificant at the five percent level was the speed variance. Contrary to expectations, the sign for the percentage of urban population was still positive.
### SUMMARY OF REGRESSION RESULTS

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* Indicates significance at the 5% level  
** Indicates significance at the 1% level  
*** Indicates significance at the 10% level
However, when looking at the correlation coefficient matrix for the variables in equation two, it was discovered that the percentage of urban roads and the percentage of urban population were highly correlated. Therefore, for the third iteration the urban population variable was dropped from the equation since it had a lower T-statistic than the urban roads variable. Consequently, the R-squared value dropped significantly in the third iteration. All of the variables tested significant at the ninety-five percent level except the speed variance.

The fourth iteration added the seatbelt variable. However, this variable remained insignificant and had a sign opposite of that expected.

The last iteration substituted the percentage of drivers exceeding 55 MPH for the average speed variable. The result is an increase in significance of all the variables except the percentage of urban roads. There was no significant change in the R-squared value.
4. **Analysis**

Where can state, local and federal government officials concentrate their resources in order to reduce the highway fatality rate?

Today government officials are spending time and money considering legislation to relax the 55 MPH speed limit on rural interstates, increasing the drinking age to 21 years of age for all alcoholic beverages, as well as instituting mandatory seat belt usage laws. Local and state police departments are spending resources to enforce the 55 MPH speed limit, keep drunk drivers off the road, enforce whatever the drinking age in that state may be, and provide, to the maximum extent possible, a safe environment in which to drive. The passage of legislation to increase the drinking age to 21 and/or to require mandatory seat belt usage will require additional time and money in order to properly enforce.

To estimate the costs involved to pass new traffic legislation or to enforce current or future traffic laws is beyond the scope of this study. However, by using the highway fatality model constructed in the previous section, it is possible to estimate which factors have the greatest positive or negative impact on the highway fatality rate. If reducing the highway fatality rate is a high priority regardless of cost, then that factor(s) which has the greatest impact on the
highway fatality rate is where government officials and police departments should concentrate their time and money.

Included in the analysis will be the variables listed below:

- Average speed
- Seat belt usage rates
- Percentage of drivers under 25 years of age
- Drinking age for beer.

Equation four will be the basis of the analysis since all of the above variables are included in that equation. The percentage of urban roads, even though it tested significant in equation four, will not be included in the analysis since it is an environmental factor over which government officials or police departments have little control.

The speed variance variable is also excluded from the analysis because the policy action to control speed variance on highways is the same as for average speed. In addition it is difficult to determine how and in what magnitude speed variance fluctuates. As discussed earlier there is evidence to suggest that as average speed increases so does speed variance. However, when looking at the correlation coefficient matrix for equation four, the average speed and speed variance variables showed no sign of correlation.

The analysis will present two examples for each variable examined; one using the state of New York as an observation and the second using national averages. The state of New York was specifically chosen due to the amount of data available on seat belt usage rates.
4.1 Average Speed

A common bumper sticker on cars is "55 Saves Lives". The highway fatality model presented here would support that assertion. According to the model, a one MPH increase in average speed would result with all other factors being equal, in a .139 increase in highway fatalities per hundred million vehicle miles traveled. In the state of New York in 1985, over 475.6 hundred million vehicle miles were traveled on roads posted at 55 MPH. Thus an increase in the average speed of one MPH would be expected to result in about 66 additional deaths in New York state.

Nationally, drivers traveled 8,929 hundred million vehicle miles on roads posted at 55 MPH. Thus an increase in the average speed of one MPH would be expected to result in 1,241 additional highway fatalities nationwide.

Presently the average speed on roads posted at 55 MPH is 56.2 MPH. If states were to increase police enforcement so as to bring the average speed down to 55 MPH, then 1,489 additional lives would be expected to be saved nationwide. In the state of New York, the average speed on roads posted at 55 MPH is 55.6 MPH. If the 55 MPH speed limit was more strictly enforced 38 additional lives would be predicted to be saved.

Congress recently passed legislation to permit states to raise the speed limit on rural interstates to 65 MPH. This represents approximately nine percent of the total vehicle miles traveled in this
country. What will be the impact of this legislation on the highway fatality rate?

Since the average speed on all roads posted at 55 MPH nationwide is 56.2 MPH, we can safely assume that roads posted at 65 MPH will have an average speed limit of at least 65 MPH. This represents an 8.8 MPH increase in the average speed on these roads. In 1985, Americans drove 1,541 hundred million vehicle miles on rural interstates. Based on the above statistics, an increase in the speed limit on rural interstates would be predicted to result in 1,885 additional highway deaths.

As mentioned previously, speed variance normally increases when average speed increases. However, the above calculations do not include the impact an increase in speed variance would have on the highway fatality rate. Therefore, the above estimates can be considered conservative.

4.2 Seat Belts

Most of the studies to date on seat belts conclude that they save lives. However, the seat belt variable in the highway fatality model presented here, not only tests insignificant, but also has a sign opposite of what was expected, thus suggesting that the more people wearing seat belts, the higher the highway fatality rate.

There are several plausible explanations as to why the seat belt variable not only tested insignificant, but also had a positive sign.
The first reason might be the data. Data on seat belt usage rates by state is scarce especially since the Federal Highway Administration does not require states to report this information. However, there are two relevant reports, both issued by the Department of Transportation. The first is a survey of seat belt usage rates in nineteen U.S. cities by quarter for 1984 and 1985. The second is a survey of seat belt usage rates in states having implemented or considering implementation of a mandatory seat belt usage law. Unfortunately, in the latter report, the data was not collected in all 50 states nor in consistent time periods. Some data was collected on a quarterly basis while other data was collected on a yearly basis.

When comparing the city seat belt data with their respective state data (when available) the values were similar. Therefore, the two sources were combined to yield one data base. Consequently, the inconsistent data could be the cause of the unexpected results.

Seat belt usage rates also tend to fluctuate widely within and among states. Seat belt usage rates tend to be very high when the law first goes into effect and then taper off several months later. For example, in New York seat belt usage rates were observed to be about 62 percent when the law first went into affect. Eight months later, however, usage rates had dropped to 46 percent.

23Ibid.
In addition, the level of enforcement also affects the seat belt usage rate in a state. Seat belt usage rates are considerably lower in those states which only ticket an offender for failure to buckle-up when pulled over for another offense. On the other hand, states which consider failure to wear a seat belt a primary offense have significantly higher usage rates. Consequently, seat belt data can differ significantly depending on when the observations are made in the life of the law as well as the level of enforcement in a state.

There are other possible reasons for the curious seat belt variable results. Several studies by the Insurance Institute for Highway Safety have concluded that those drivers most likely to be involved in a serious car accident are the least likely to wear a seat belt. Based on observations in New York state (which has a mandatory seat belt usage law), the following conclusions were reached:

- Shoulder belt usage rates for high school students are 5 to 17 percentage points lower than the average

- Seat belt usage rates among males are 6 to 8 percentage points lower than female drivers

- Seat belt usage rates among drivers traveling at speeds greater than 65 MPH are 11 percentage points lower than drivers traveling closer to the speed limit

25Ibid.
26Ibid.
27Ibid.
28Ibid.
• Seat belt usage rates among Bar patrons are 12 percentage points lower than other drivers observed at nearby locations\textsuperscript{29}

Therefore the imposition of a seat belt law may have a less than expected impact on the highway fatality rate.

For example, in New York, the Department of Transportation estimated that the implementation of a mandatory seat belt law would result in a 16 to 20 percent decrease in front seat occupant fatalities. However, during the nine month period following the institution of the law, only a nine percent reduction in highway fatalities was observed.\textsuperscript{30}

4.3 Percentage of Young Drivers

The percentage of young drivers tested significant at the ninety-eight percent level for all iterations of the highway fatality model. Based on the model, the more drivers under the age of 25 on the road, the higher the highway fatality rate. For example, in the state of New York about 15 percent of drivers licenses are held by drivers ages 24 or less. Every one percentage point increase in the number of young drivers is expected to result in approximately 25 additional highway fatalities. Nationally, approximately 18 percent


of all drivers are under 25. A one percentage point increase in drivers in this age group would result in 494 additional highway fatalities according to the model.

Unfortunately, there are few measures local and state officials can take to reduce the impact young drivers have on the highway fatality rate outside of raising the driving age or restricting when and where young people can drive. Some states have already instituted laws to restrict young drivers.

In New Jersey, the driving age is 17. If the driving age in all states was raised to 17 years of age, it is estimated that approximately 544 sixteen year old lives would be saved each year. However, an increase in the highway fatality rate for 17 year olds may result since that will now be the age at which drivers have the least experience and maturity.

In New York and several other states night time driving is not permitted for drivers under 18 years of age. This type of law makes sense, because 45 percent of all teenage traffic-related deaths occur between the hours of 8:00 p.m. and 4:00 a.m. If such a law was adopted nationwide, approximately 578 teenage lives would be saved each year according to the model presented.

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4.4 Drinking Age for Beer

The drinking age for beer variable tested significant in all but the first equation at the ninety-eight percent level. Based on the highway fatality model, the higher the drinking age for beer, the lower the highway fatality rate.

Most states have already raised the drinking age for beer to 21 as of 1986. If the remaining seven states (Hawaii, Idaho, Montana, Ohio, South Dakota, West Virginia, Wyoming), raised their drinking age for beer to 21, then approximately 20 lives in the affected age groups would be saved. This can be considered a conservative estimate since drunk drivers can also cause the death of a driver outside of the affected age group.
5. **Conclusion**

Where can state and local governments concentrate their resources to reduce the highway fatality rate? Exhibit 8 presents a summary of the results. The left hand column lists actions which police departments and/or local or state governments can take in the hopes of reducing the highway fatality rate. The second and third columns present the number of lives which could be saved if the actions were taken either nationwide or in the state of New York based on the regression equation calculated here. The results are presented as a point estimate and in ranges using one standard deviation.

Based on the highway fatality model, raising the speed limit to 65 MPH on rural interstates would have the greatest impact on highway fatalities. Therefore, if minimizing highway fatalities is a high priority, then states should not raise the speed limit to 65 MPH on rural interstates. In addition, if states were to increase enforcement of the 55 MPH speed limit (i.e.: bring the national speed limit from 56.2 MPH to 55 MPH), an additional 1,489 lives would be saved nationwide.

But decreasing speed limits increases travel cost, by increasing the time component in long distance travel. The trade-off between the costs of travel and the cost of fatalities can be calculated using
### Exhibit 8

#### SUMMARY OF RESULTS

<table>
<thead>
<tr>
<th>ACTION ITEM</th>
<th>Potential Lives Saved</th>
<th>Potential Lives Saved</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Point</td>
<td>Interval*</td>
</tr>
<tr>
<td>Enforce 55 MPH Speed Limit</td>
<td>1489</td>
<td>844 - 2132</td>
</tr>
<tr>
<td>Keep Speed Limit at 55 MPH on Rural Interstates</td>
<td>1885</td>
<td>1069 - 2699</td>
</tr>
<tr>
<td>Raise Drinking Age for Beer to 21 in 7 Remaining States</td>
<td>20</td>
<td>13 - 30</td>
</tr>
<tr>
<td>Raise Driving Age to 17 Years of Age</td>
<td>544</td>
<td>336 - 751</td>
</tr>
<tr>
<td>Restrict Teenage Night Time Driving</td>
<td>578</td>
<td>357 - 799</td>
</tr>
</tbody>
</table>

* Based on one standard deviation

** Drinking age for beer is 21 in New York as of 1986

*** Teenage night time driving already restricted in New York
the Forrester et.al approach. The first step involves determining the value of a human life.

One approach considered by Forrester et.al in assigning a value to a human life is based on the present discounted value of life-time income. The approach is as follows.

The average age of persons killed in highway accidents is 33.5 years.32 The life expectancy of a person aged 33.5 is 43.8 additional years of age.33 However, in the United States most people retire at age 65, so the additional years of income are only 31.5. The average annual non-farm income in 1985 was $20,049.34 Based on the assumption that gains in income will offset the discount rate, then the value of a human life lost due to a highway accident is $631,547.35

The next step is to calculate the cost of the additional travel time required due to a decrease in the speed limit. If police departments were to more stringently enforce the 55 MPH speed limit so as to bring average speed down from 56.2 MPH to 55 MPH, then 345 million additional hours would be required to travel the same distance. On the average, there are 1.8 people per car.36

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35 This approach for valuing the human life neglects the social value an individual may provide to society. This approach also ignores the other benefits of the 55 MPH speed limit such as reduced gas consumption and less serious traffic injuries.
Therefore, the total additional time spent on the road by all travelers is 621 million hours.

The average hourly rate of a non-farm worker in the United States is $9.52 an hour. However, there is some argument as to whether or not automobile travel time should be calculated at 100, 50 or 30 percent of the hourly rate, so all three will be considered in the analysis.

Exhibit 9 summarizes the results of the cost/benefit analysis of the two policy actions related to the 55 MPH speed limit. Each value represents the total value of lives which would be saved/lost divided by the total value of the increased/decreased travel time as a result of a change in the speed limit.

Note that the exhibit is divided into two sections. The first section bases the calculation of the additional travel hours required based on only one person per car, the second section bases the additional travel hours required on 1.8 people per car. This dual approach is presented due to the fact that the Forrester et.al model neglected to incorporate the 1.8 people per car factor in their calculations even though they outlined it in their approach. This error, although having a significant impact on the numerical calculations, has no impact on Forrester et.al's conclusion that the 55 MPH speed limit is not cost effective.

That is not the case in this analysis. If the additional travel time is calculated based on only one person per vehicle and valued at

37 The 1987 Almanac, p. 63.
### Exhibit 9

#### SUMMARY OF COST/BENEFIT ANALYSIS

<table>
<thead>
<tr>
<th>Value of Time</th>
<th>Enforce 55 MPH Speed Limit</th>
<th>Keep Speed Limit at 55 MPH on Rural Interstates</th>
</tr>
</thead>
<tbody>
<tr>
<td>One Person Per Car</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Hourly Wage Rate</td>
<td>0.29</td>
<td>0.34</td>
</tr>
<tr>
<td>One Half Average Hourly Wage Rate</td>
<td>0.58</td>
<td>0.64</td>
</tr>
<tr>
<td>30 Percent Average Hourly Wage Rate</td>
<td>0.95</td>
<td>1.13</td>
</tr>
<tr>
<td>1.8 People Per Car</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Hourly Wage Rate</td>
<td>0.16</td>
<td>0.19</td>
</tr>
<tr>
<td>One Half Average Hourly Wage Rate</td>
<td>0.32</td>
<td>0.38</td>
</tr>
<tr>
<td>30 Percent Average Hourly Wage Rate</td>
<td>0.53</td>
<td>0.63</td>
</tr>
</tbody>
</table>
30 percent of the hourly wage rate, and then compared to the value of lives saved by keeping the speed limit at 55 MPH on rural interstates, then one would conclude that the 55 MPH speed limit is cost effective.

However, the proper approach is to consider the additional time spent on the road for all travelers (ie: drivers and passengers). Therefore, according to Exhibit 9, neither policy action regarding the 55 MPH speed limit can be justified based on the cost/benefit analysis presented here.
BIBLIOGRAPHY


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AN ECONOMIC MODEL OF HIGHWAY FATALITIES

by

Kathy Cox Allen

(Abstract)

Where can state, local and federal government officials concentrate their resources in order to reduce the highway fatality rate?

A highway fatality model was developed to determine which factor has the greatest positive or negative impact on the highway fatality rate. A cross-section of data from states for 1984 and 1985 was collected for the following variables: average speed, speed variance, percentage of drivers wearing seat belts, percentage of licensed male drivers, percentage of drivers under 25 years of age, drinking age for beer, per capita alcohol consumption, percentage of urban population, and percentage of urban roads.

The highway fatality equation was estimated via an iterative approach using ordinary least squares. The variables testing significant include: average speed, speed variance, drinking age for beer, percentage of drivers under 25 years of age, and percentage of urban roads.
When translating the results into a policy action, it was determined that keeping the speed limit at 55 MPH on rural interstates would prevent the greatest number of traffic fatalities. Other policy actions considered in order of their impact on highway fatalities include: more stringent enforcement of the 55 MPH speed limit, restricting teenage night-time driving, raising the driving age to 17 years of age, and raising the drinking age for beer to 21 in the seven remaining states.