Effect of Text Messaging Bans on Fatal Accidents

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Abstract
Do text messaging bans make roads safer? To determine the answer to this question, a multivariate regression model was developed to determine how fatal accidents by state were affected by the following variables: texting bans, cell phone bans, primary versus secondary enforcement, time since bans were passed, vehicle miles traveled per state, gas and beer tax per state, percentage of population under 25 years of age, population density, and unemployment rate. The results indicate that text messaging bans do decrease fatal accidents and also decrease the danger of driving as the vehicle miles driven increases.

Introduction
In 2010, 2.1 trillion text messages were sent in the United States alone (CTIA 2011); that is more than 66,000 every second! Texting has become a staple of everyday life, and for many people not even driving in a car can stop their text messages from hitting the airways. Scientific studies have shown how dangerous texting is while driving, and many states have responded with bans on texting while driving. Washington was the first state to do so in 2007. Today 30 states and Washington, D.C., have texting bans on all drivers, and eight states have partial bans.
With all these bans going into place it is logical to question if these bans are doing what they were intended to do—are text messaging bans making roads safer? This is an important question because what is the purpose of a piece of legislation if it has no effect on the people it was made to protect?

This study is a cross-sectional comparison of states that have bans to states that do not. Variables considered include roadway fatalities by state, texting ban, other cell phone usage bans, primary versus secondary offence, population density, miles traveled on state roadways, blood alcohol content of drivers, beer and gas taxes, unemployment rate, and length of time ban has been in effect. This data was collected from the U.S. Census Bureau (2011), the Fatal Analysis Reporting System (FARS) (2011), and the Insurance Institute of Highway Safety (2011).

**Literature Review**

Since the cultural adoption of cell phones, there have been multiple studies on the effect of cell phone use on automobile accidents and distracted driving.

Wilson and Stimpson (2010) examined trends in distracted driving fatalities and their relationship to cell phone use, specifically texting volume, between 1999 and 2008. In this study, data were obtained from the Fatality Analysis Reporting System (FARS), which records data on U.S. public road fatalities. Wilson and Stimpson (2010) looked specifically at distracted driving fatalities, which are accidents in which drivers were inattentive, careless, or using cell phones, computers, fax machines, onboard navigation, or heads-up display systems. This data was compared to cell phone subscriber data from the U.S. Federal Communications Commission’s Wireline Competition Bureau as well as text messaging volume data from Commercial Mobile Radio Services Competition Reports. Wilson and Stimpson (2010) conducted a linear multivariate regression analysis to examine the relationship between state-level text messaging
volumes and the number of distracted driving fatalities. They controlled for variables such as precipitation, temperature, percentage of vehicle miles traveled on urban roadways, total state vehicle miles, state unemployment rate, region, and year. Using this regression analysis they predicted the number of distracted driving fatalities if texting volume was zero. The results showed that the increase in cell phone subscriptions during this time did not correlate to the changes in distracted driving fatalities, but there was a strong relationship between the fatalities caused by distracted driving and the average monthly number of text messages sent in a state. Using their regression model, they predicted that the rapid increase in texting volumes resulted in more than 16,000 additional distracted driving fatalities from 2002 to 2007. Wilson and Stimpson (2010) also claimed that for the average state, an additional one million text messages sent per month would increase the distracted driving fatalities in that state by more than 75%.

Jacobson, Nikolaev, and Robbins (2010) studied the effect of cell phone bans on driver safety. They wanted to know if laws banning cell phone use while driving made roads safer, decreasing accident risk. They examined the accident rates in New York (the first state to have a statewide hand-held cell phone ban) by counties. Jacobson, Nikolaev, and Robbins (2010) compared counties’ fatal automobile accidents and personal injury accidents before and after the cell phone ban took effect. Another important variable they looked at was driver density by county. They used a one-tailed t-test to analyze the data. The results showed that 46 out of 62 New York counties experienced a decrease in fatal automobile accidents, 10 of which were at a statistically significant level. All 62 counties experienced a decrease in personal injury automobile accidents, with 46 being at a statistically significant level. Overall, New York experienced a decrease in both accident categories at a significant level with the ban.
Clarke and Loeb (2009), on the other hand, studied the effects of cell phones on pedestrian fatalities. This was the first study to specifically look at the effect on pedestrian fatalities. Their data came from various U.S. sources and included census data, a National Highway Traffic Safety Administration (NHTSA) study, and Cellular Telecommunications and Internet Association (CTIA) data, all from 1975 to 2002. Clarke and Loeb (2009) used a mathematical model and regression analysis to conduct their study. The variables they included were unemployment rate, per capita ethanol consumption, vehicle miles driven, total interstate, urban and rule highway mileage, population, blood alcohol content, real GDP, year, and number of cell phone subscribers. The results of the study suggested an interesting nonlinear effect. Clarke and Loeb (2009) found that when cell phones first became adopted they had a negative effect on pedestrian fatalities; however, at a certain number of cell phone subscribers the life-saving effect of cell phones overtook the life-taking effect. Then as cell phones subscriptions continued to increase, the life-taking effect again took over. Today, they believe that this life-taking effect is still dominant. As the number of cell phone subscriptions increase, the number of pedestrian fatalities also increases.

All three articles agreed that despite numerous past studies and conflicting results, there is little statistical evidence that increasing cell phone use is directly related to increases in automobile accidents or fatalities. All three, however, suggested that cell phones in some way have a negative effect on automobile accidents and fatalities.

I believe that cell phones have a negative effect on driver safety. We need to look deeper into how people are using their cell phones rather than overall use, similar to Wilson and Stimpson’s (2010) texting volume study. With the popularity of smartphones and the ability to access the Internet and use applications, will we see a greater increase in auto accidents as more
and more people adopt this technology? Or will future cell phone technology advance so that the life-saving effect found by Clarke and Loeb (2009) increases and extends to drivers as well as pedestrians?

**Economic Model and Data Description**

Accid = α + β₁text + β₂cell + β₃primary + β₄timepass + β₅vmt + β₆popdens + β₇under25 + β₈ur + β₉beertax + β₁₀gastax

The above equation is the basic economic model for my research. I investigated the effect of text messaging bans on road fatalities by doing a cross-sectional study among U.S. states. The variables used in the study are defined in table 1.

**Table 1.** Variable definition
The dependent variable is *fatalities*. This measures the total road fatalities in a state for a quarter (three months). I measured this variable in two different ways. First, I collected data on all fatal accidents for each state (accid). Then I collected data on all fatal accidents involving drivers with any blood alcohol content for each state (anybac). Creating these two dependent variables helped me examine the effect of alcohol consumption on my research. The data for these variables came from the National Highway Traffic Safety Administration Fatality Analysis Reporting System (FARS). The mean number of total fatal accidents is 154.47, while the mean

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Expected Effect</th>
<th>Statistics</th>
</tr>
</thead>
</table>
| **Accid** | Total number of road fatalities in a state in a certain year | n/a | Mean: 154.47  
Standard Deviation: 152.66 |
| **Anybac** | Total number of road fatalities in a state in a certain year with the driver being under the influence | n/a | Mean: 56.50  
Standard Deviation: 58.01 |
| **Text** | Whether or not there is a texting ban in effect. | - | % With Ban: 25.49%  
% Without Ban: 74.51% |
| **Cell** | Whether or not there is a total cell phone ban | - | % With Ban: 11.76%  
% Without Ban: 88.24% |
| **Primary** | Whether the ban is a primary or secondary law | - | % Primary: 77.45%  
% Secondary: 22.55% |
| **Timepass** | The time in months that have passed since texting ban has been in effect | - | Mean: 3.67  
Standard Deviation: 10.65 |
| **Vmt** | The number of vehicle miles traveled in one year (in millions of miles) | + | Mean: 4864.15  
Standard Deviation: 5041.24 |
| **Popdens** | State population density (population per square mile) | + | Mean: 380.60  
Standard Deviation: 1357.88 |
| **Under25** | The percent of the population that is from 5 to 24 years old | + | Mean: 0.2721  
Standard Deviation: 0.0159 |
| **Ur** | State unemployment rate | - | Mean: 8.85  
Standard Deviation: 2.15 |
| **Gastax** | The state gas tax in dollars per gallon | - | Mean: 0.2493  
Standard Deviation: 0.0728 |
| **Beertax** | The state tax on beer in dollars per gallon | - | Mean: 0.2701  
Standard Deviation: 0.2421 |
The number of fatal accidents involving alcohol is 56.5. The standard deviations are large for both total fatal accidents and fatal accidents containing alcohol, 58.0 and 152.66, respectively. The highest number of total accidents in a quarter was 743 and the lowest was five.

The first independent variable, and the variable of interest in this study, is text messaging bans while driving (text), specifically which states have them and which states do not. This is a dummy variable, so states with bans were coded as “1” and states without a ban were coded as “0.” As of today, 30 states plus Washington, D.C., have bans on texting while driving that equates to about 74.5% of the country with bans. These bans are on all drivers, regardless of age. This data is from the Insurance Institute of Highway Safety (2011), which keeps an updated list of laws restricting cell phone use for every state.

The second, third, and fourth independent variables deal with details of the text messaging bans. Cell is another dummy variable stating whether or not there is an all handheld cell phone ban in a state. This means that using a handheld cell phone in any way while driving is illegal. This is important because drivers in states with stricter laws for all cell phone use while driving will probably be less likely to use their cell phone while driving. The more laws there are, the less likely texting while driving will occur. Today eight states plus Washington, D.C., enforce an all handheld cell phone ban (IIHS 2011). Primary is defined as the degree to which the ban can be enforced; that is, whether the law is primary or secondary. Primary means that a driver can be pulled over and cited just for texting while driving whereas under a secondary law the driver would have to be breaking another law in order to be cited for texting while driving. This variable helped determine the degree to which the ban is enforced, which has a direct link to the ban’s effectiveness. States with primary enforcement should have a lower number of fatalities; therefore, there should be a negative relationship between fatalities and the third
independent variable. *Timepass* measures the number of months that have passed since the text messaging ban was established. The length of time a ban is in place will affect how well the ban is enforced and followed. I would expect that states with longer amounts of time with the ban in place will have lower fatalities, so this would be a negative relationship between the variables. Texting bans are new to a majority of the states so the mean of this variable is relatively small.

*Vmt* is the number of vehicle miles driven in a state in a given year. This is one of the most important control variables to include when conducting studies on traffic accidents and fatalities. After all, the number one cause for traffic accidents is simply driving. The average number of vehicle miles driven in the data set was 4,864.2 million miles. Due to the variety of state sizes, we see a wide range with this variable. The District of Columbia recorded the least number of miles at approximately 294 million miles while California had the greatest number of miles with 27,975 million miles. This data was collected from the U.S. Department of Transportation Federal Highway Administration (2011).

The remaining variables include, *state population density, population under the age of twenty five, state unemployment rate, state gas tax, and beer tax*. These are all common variable used in state-level studies dealing with traffic accidents and alcohol consumption. These variables were collected from U.S. census data (2011) and data from the Tax Foundation (2011).

**Regression Analysis and Results**

I ran several regressions to determine the best model. When running regressions to determine what combination of variables created the best fit regression I used total fatal accidents (*accid*) as my dependent variable. Once the best model was determined I ran the same regression on fatal accidents where alcohol was involved (*anybac*). My original regression with the 10 original variables produced the following results found in table 2:
This regression had an adjusted $R^2$ value of 0.9512, which shows that the variables included do a good job in explaining the variance in fatalities. However, not all the variables are statistically significant. This led me to run a variety of tests to create the best model possible. After running many regressions and econometric tests, I came up with my best model, displayed below:

$$\text{Accid} = \alpha + \beta_1\text{text} + \beta_2\text{cell} + \beta_3\text{vmt} + \beta_4\text{gastax} + \beta_5\text{beertax} + \beta_6\text{beertaxsq} + \beta_7\text{textavgvmt}$$

In the final model some variables from the original regression were eliminated. There were also a few variables added. The most important variable added was $\text{textavgvmt}$, which is an interaction term between text and the deviation from the average vehicle miles traveled in a state. For example, this variable for Illinois in 2009 with a texting ban would be 3,328 ($8192 - 4864$), the difference in vehicle miles traveled from the mean multiplied by one. States with lower than average vehicle miles traveled, like Delaware, will have a negative number: -4,145 ($719 - 4864$). For states without a texting ban this variable will be zero. This variable made the final regression
more significant and made the interpretation of the text ban variable easier to understand and apply. The final regression was run twice, first with accid as the dependent variable and second with anybac as the dependent variable. The statistical results for both regressions are shown below in tables 3 and 4.

Table 3: Total fatal accidents final regression

<table>
<thead>
<tr>
<th>Variable name</th>
<th>Estimated coefficient</th>
<th>Standard error</th>
<th>T-ratio 94 DF</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text</td>
<td>-14.95</td>
<td>8.745</td>
<td>-1.709</td>
<td>0.091</td>
</tr>
<tr>
<td>Cell</td>
<td>-27.986</td>
<td>10.11</td>
<td>-2.769</td>
<td>0.007</td>
</tr>
<tr>
<td>Vmt</td>
<td>3.24E-02</td>
<td>1.00E-03</td>
<td>32.39</td>
<td>0.000</td>
</tr>
<tr>
<td>Gastax</td>
<td>-100.02</td>
<td>47.26</td>
<td>-2.116</td>
<td>0.037</td>
</tr>
<tr>
<td>Beertax</td>
<td>111.65</td>
<td>44.2</td>
<td>2.526</td>
<td>0.013</td>
</tr>
<tr>
<td>Beertaxs</td>
<td>-87.545</td>
<td>37.09</td>
<td>-2.36</td>
<td>0.020</td>
</tr>
<tr>
<td>Textavgv</td>
<td>-4.60E-03</td>
<td>1.17E-03</td>
<td>-3.925</td>
<td>0.000</td>
</tr>
<tr>
<td>Constant</td>
<td>11.38</td>
<td>15.54</td>
<td>0.7325</td>
<td>0.466</td>
</tr>
</tbody>
</table>

*Note: $R^2 = 0.9600$, $R^2$ adjusted = 0.9570.*

Table 4: Fatal accidents including alcohol

<table>
<thead>
<tr>
<th>Variable name</th>
<th>Estimated coefficient</th>
<th>Standard error</th>
<th>T-ratio 94 DF</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text</td>
<td>-10.038</td>
<td>4.702</td>
<td>-2.135</td>
<td>0.035</td>
</tr>
<tr>
<td>Cell</td>
<td>-8.9523</td>
<td>6.136</td>
<td>-1.459</td>
<td>0.148</td>
</tr>
<tr>
<td>Vmt</td>
<td>1.28E-02</td>
<td>8.63E-04</td>
<td>14.77</td>
<td>0.000</td>
</tr>
<tr>
<td>Gastax</td>
<td>-47.955</td>
<td>30.71</td>
<td>-1.562</td>
<td>0.122</td>
</tr>
<tr>
<td>Beertax</td>
<td>48.326</td>
<td>23.13</td>
<td>2.09</td>
<td>0.039</td>
</tr>
<tr>
<td>Beertaxs</td>
<td>-36.745</td>
<td>20.32</td>
<td>-1.808</td>
<td>0.074</td>
</tr>
<tr>
<td>Textavgv</td>
<td>-3.42E-03</td>
<td>8.53E-04</td>
<td>-4.003</td>
<td>0.000</td>
</tr>
<tr>
<td>Constant</td>
<td>2.7444</td>
<td>6.345</td>
<td>0.4325</td>
<td>0.666</td>
</tr>
</tbody>
</table>

*Note: $R^2 = 0.9217$, $R^2$ adjusted = 0.9158.*
The final regression output with \textit{accid} as the dependent variable showed six out of the seven variables to be statistically significant. The variables \textit{cell}, \textit{vmt}, \textit{gastax}, \textit{beertax}, \textit{beertaxsq}, and \textit{textavgvmt} were all significant at the 95\% level. The text variable had a p-value of 0.09 so it is significant at the 91\% level. This regression provided the highest adjusted $R^2$ value, 0.9570. This means that the variables included in my best regression account for 95.70\% of the variation in total fatal accidents. This high number shows that the data is of high quality and the model is good.

The same regression run with \textit{anybac} as the dependent variable showed four out of seven variables to be statistically significant. \textit{Text}, \textit{vmt}, \textit{beertax}, and \textit{textavgvmt} were all significant at the 95\% level. \textit{Cell} recorded a p-value of 0.148, \textit{gastax} was 0.122, and \textit{beertaxsq} was 0.074. This regression showed less explanatory power with an adjusted $R^2$ of .9158.

Cell phone bans were shown to decrease total fatal accidents in a state by approximately 28 accidents per quarter (three months). Approximately nine of those fatal accidents per quarter involved alcohol according to the \textit{anybac} regression. However, this was not statistically significant.

The regressions showed a significant increase in fatal accidents as the vehicle miles traveled in that state increases. For every 100 million miles driven in a state per year, you can expect approximately 3.24 fatal accidents per quarter. From that same 100 million miles, approximately 1.28 out of the 3.24 fatal accidents per quarter would involve alcohol.

Gas tax only showed significance in the total accidents regression. If a state increases its gas tax by $.01$, you would expect to see a decrease in fatal accidents by approximately one per quarter. The effect on alcohol-related accidents was approximately half of the total, showing that
a $.01 increase on the gas tax would decrease fatal accidents involving alcohol by approximately 0.48 per quarter.

The regressions showed that beer taxes increase fatal accidents until the beer tax is nearly $0.65 per gallon. This was not expected and may be the result of an omitted variable that beer tax rate is correlated with, such as drinking habits. However, when beer taxes become greater than $0.65 per gallon there is a negative effect on fatal accidents. Therefore, a state that wanted to curb fatal accidents by increasing a beer tax would have to charge more than $0.65.

In terms of the variable of interest, these results indicate that texting bans do in fact decrease fatal accidents. This is significant at the 90% level for total fatal accidents and at the 95% level for fatal accidents involving alcohol. When interpreting this variable in the regressions, we must interpret both text and the interaction term between texting bans and the deviation from the mean vehicle miles travel as the same time. The regression shows that in terms of total fatal accidents, in states that drive the average vehicle miles traveled in a year (≈4,864 million miles) a texting ban will decrease fatal accidents by 14.95 per quarter. Fatal accidents involving alcohol account for approximately 10.038 of those accidents per quarter. So we can conclude that texting bans only decrease non alcohol-related accidents by approximately 4.95 per quarter.

The beta on the interaction term tells us that as vehicle miles traveled in a state increases, states with texting bans will see less of an increase in fatal accidents. For example, a state with no texting ban that is one standard deviation above the mean vehicle miles traveled in a year will see an increase of approximately 163 total fatal accidents per quarter compared to the average state. If that same state had a texting ban, it would see a decrease of 14.95 fatal accidents per quarter plus an additional 23.19 less fatal accidents per quarter. So a state one standard deviation
above the mean in terms of vehicle miles traveled and a texting ban in place will only see a 124.86 increase in fatal accidents per quarter instead of the full 163 it would see without a texting ban. This shows that texting bans curb the effect of vehicle miles traveled on fatal accidents.

**Conclusion**

Are text messaging bans making roads safer? Yes, based on the research above texting bans do in fact decrease the number of total fatal accidents and accidents involving alcohol. This study shows a significant relationship: as vehicle miles traveled increases, states with texting bans see a smaller increase in fatal accidents. This lessened effect of vehicle miles traveled on fatal accidents can be simply put—texting bans make driving less dangerous on a mile-per-mile basis.

In conclusion, this research shows through multivariate regression analysis the effect of texting bans on fatal driving accidents. This research, although limited, did produce significant results. Given the opportunity to continue this research, I would change a few aspects. First, I would collect more data over longer periods of time. This data only reflects two quarters of 2009; a wider range of data would provide more significant results. I would also include additional variables, such as percent of driving population under 25 and rural versus urban driving miles. A deeper look into this research would be required before making text messaging and driving policies based on this analysis.

**Bibliography**


