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What Factors Influence Seat Belt Usage Rates in the United States?: A Meta-analysis

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Executive Summary

Problem:

The traffic safety community is interested in reducing the number of lives lost and injuries due to automobile accidents. This can be done in two ways, through advancing automobile safety technology and by changing automobile driver behavior (Desai and You 1992). Seat belt laws are thought to be the behavioral solution because they have been proven to increase seat belt usage among automobile occupants. However, studies on the topic have varying answers when it comes to the degree to which these laws increase seat belt usage and factors which influence on seat belt uses.

Research Questions:

This study uses meta-analytic techniques to explore whether certain variables influence seat belt usage rates. The main research questions posed in this study are:

1. What common independent variables are included in the studies of the impact of seat belt laws?
2. Does the inclusion of certain variables affect the findings of the studies?
3. In what direction do these variables influence the results of the study?

The research hypothesis is that the inclusion of independent variables will have an effect on the influence of seat belt laws on seat belt use.

Research Design:

This study used a meta-analytic technique to pool data from five studies. A multiple regression was used to observe relationships between the dependent variable (percentage point increase in seat belt use) and independent variables such as race, gender, unit of interest, number of years included to the study, number of observations, year of publication and data source. A bivariate regression was used to further explore the relationships between the dependent and independent variables. Additionally, a qualitative review was conducted which included the seat belt law studies selected for inclusion in the meta-analysis.

Findings:

The multiple regression procedure using was not successful run due to the limited number of observations in this study. However, a bivariate regression analysis found correlations between percentage point increases in seat belt use and the primary seat belt law, secondary seat belt law, number of observation, unit of interest, and year published variables in a bivariate regression.

Conclusion:

This study did provide some insight into variables that influence seat belt rates however not many conclusions can be drawn from this study. Further research must be done to gain a better grasp of the factors that influence seat belt usage rates. Future meta-analytic studies on the seat belt laws and seat belt usage rates should include more studies and have broader set of criteria for the inclusion of studies and compare and contrast studies which examine studies that examine only primary or secondary laws.

Problem Statement

The traffic safety community is interested in reducing the number of lives lost and injuries due to automobile accidents. This can be done in two ways, through advancing automobile safety technology and by changing automobile driver behavior (Desai and You 1992). According to the National Highway Safety Administration, the use of seat belts is the best way to reduce accident related deaths and injuries (Lui et all 2006). "In order to encourage the use of safety belts, most states have enacted safety belt laws (Liu et al 2006 pp 1)." The National Highway Traffic Safety Administration reported that as of August 2005, 22 states had primary seat belt laws, 27 had secondary seat belt laws and one state (New Hampshire) had no seat belt law (States with Primary Seat belt Laws 2005). The premise is that when seat belt laws are in place, people are more likely to use a safety belt than when no law is in place. (Desai and You 1992).

Traffic safety research supports the idea that seat belt use does increase when seat belt laws are implemented. However, studies on the topic have varying answers when it comes to the degree to which these laws increase seat belt usage and the factors that influence seat belt use.

Research Questions:

This study uses meta-analytic techniques to explore whether certain variables influence seat belt usage rates. The specific research questions this study seeks to answer are:

1. What common independent variables are included in the studies of the impact of seat belt laws?
2. Does the inclusion of certain variables affect the findings of the studies?
3. In what direction do these variables influence the results of the study?

Literature Review

The effect of both primary and secondary seat belt laws are issues of interest in the traffic safety research community because "since 1949 motor vehicle accidents have been the single largest source of accidental deaths in the United States (Desai and You 1992 pp 247)". The traffic research community has found that seat belts use is an effective way to reduce the injury and death rates due to traffic accidents. A study by Peter Cummings found that "seat belt use by front-seat occupants reduced the risk of death in a crash by about 61% …which is greater than the effectiveness of air bags (Cummings, Wells et al. 2003 pp 148)".

The United States Federal Government started an initiative to encourage states to increase their seat belt usage rate above the national average for two consecutive years (TEA 21 Grant Information, www.nhtsa.gov/nhtsa/whatsup/tea 21programs/factsheet. 157 html.). States that do increase their seat belt use rate above the national average are eligible for a Federal Highway Transportation Incentive Grant (TEA 21 Grant Information, www.nhtsa.gov/nhtsa/whatsup/tea 21programs/factsheet. 157 html.). Furthermore, the Honorable Jeffrey Runge, administrator for the National Highway Traffic Safety Administration, testified before the United States Senate Subcommittee on Surface Transportation and Merchant

Marine and the Committee on Commerce, Science and Transportation that "the annual cost to our economy of all motor vehicle crashes is 230.6 million or 2.3% of the United States Gross Domestic Product (Testimony 2005 pp 1)."

Background on Seat Belts and Seat Belt Laws:

The first seat belt law went into effect in New York in 1984 (Eby and Vivoda et al 2002) and (Maguire and Faulkner 1996). However, New Jersey was the first state to differentiate between primary and secondary laws by providing that citations for non-seat belt use could only be given if the motorist was in violation of another traffic law (Eby and Vivoda et al. 2002 citing Moffat 1998). When a state is subject to a secondary seat belt law, in order to be cited for not wearing a seat belt, a driver must first be in violation of some other traffic law such as driving over the legal speed limit and may be cited for not wearing a seat belt as a secondary offense (Eby and Vivoda et al 2002). Conversely, with a primary seat belt law, a driver may receive a citation for not wearing a seat belt without being in violation of any other traffic law (Glassbrenner 2005).

Seat Belt Use Rates and Changes in Seat Belt Laws:

As of November 2005, “safety belt use in the United States ranged from 60.8% in Mississippi to 95.3% in Hawaii (Glassbrenner 2005).” Eight states (Maryland, California, Michigan, Oregon, Arizona, Nevada, Washington, and Hawaii) have seat belt use rates of 90% or higher (Glassbrenner 2005). One would assume that all of these states have primary seat belt laws, however, Nevada and Arizona have secondary seat belt laws (Glassbrenner 2005).

Many states have converted from secondary to primary law because primary seat belt laws have been found to be more effective at increasing seat belt use and reducing automobile related injuries than secondary seat belt laws (Farmer and Williams 2005). California was the leader in this trend having changed its law from secondary to primary in 1993 (Farmer and Williams 2005).

Research has presented many explanations for why seat belt laws work. One reason is that people fear fines. Neil K. Chaudhary, found in his research that "there is a relationship between belt use and perceived risk of getting a ticket (Chaudhary, Solomon et al. 2004 pp 388)."

Who uses seat belts?

Research has shown that factors such as age, gender and race have a relationship with seat belt usage. A study interested in learning patterns of seat belt use of individuals injured in automobile accidents found that women reported wearing seatbelts 12 percentage points more often than men (Lerner, Jehle et al. 2001). This finding is consistent with other research on the topic of gender and seat belt use.

African Americans were found least likely to wear seat belts in a study conducted by Jonathan Vidoda et al (2004) . An additional finding in this study revealed that when age and race were both taken into account, African Americans between the ages of 16 and 22 wore seat belts nearly three time less than their white counter parts (Vivoda, Eby et al. 2004).

Research Design

The purpose of this study is to identify the common independent variable in studies which explore the effect of seat belt laws to find out whether the inclusion of these variables influences the outcomes of studies. In efforts to research this topic, a meta-analytic technique was used. “Meta-analysis is "the statistical synthesis of the data from separate but similar (that is comparable studies), leading to a quantitative summary of the pooled results (Wholey 2004 pp 176)”. However, because only seven articles were selected for inclusion in this analysis based on set criteria, a qualitative review of the literature is also included in this analysis.

Typically, a meta-analysis uses the studies effect size as the outcome variable. “R-squared is commonly used as an index of the effect size, measuring the strength of the relationship between the predictor and the dependent variable (Wholey, Hatry et al. 2004 pp 486)”. However, in a meta-analysis, any integer which is present in all studies included in the analysis can be used (Wilson 1999). A meta-analysis is characterized by the process that one must employ. For an analysis to be complete one must finish the following steps:

1. *Specify the topic area.*
2. *Specify the search strategy.*
3. *Develop inclusion and exclusion criterion for the studies in the review and then screen them.*
4. *Develop a management strategy and procedures.*
5. *Develop an Analysis Strategy.*
6. *Interpret the report results (Wholey, Hatry et al. 2004 pp. 182 -189 citing Moher and others 1999; Sutton 2000; Lipsey and Wilson 2001; Wholey, Hatry et al. 2004)*

Search Strategy:

The initial search engine for articles included in this study was Academic Search Premier found on the University of Kentucky Library website (http://www.uky.edu/Libraries). This database allows the user to enter search terms in order to find journal articles and other written works that contain titles matching the search terms. Additional search engines used in this analysis were Google (www.google.com) and the Social Science Citation Index (SSCI). The (SSCI) database allows the user to find out if particular author has been cited in other written works. Search terms used to locate articles include the following words:

- increase in safety belt use
- seat belt
- primary seat belt law
- lives saved by seat belt use
- mandatory seat belt law
- secondary seat belt law

A total of 12 articles were selected for possible inclusion in the study solely based on title and abstract using the Academic Search Premier database. Four articles were collected using Google. An additional 10 articles were located by using the references listed in selected studies and the Social Science Citation Index.

Criterion for Inclusion:

This meta-analysis required that articles posses three criterion to be included in the analysis. The first criterion for inclusion was that the study must investigate whether a seat belt law had an impact. The second criterion is that the outcome of interest in each study must be the influence of seat belt laws on seat belt use. The third criterion was that the jurisdiction of interest in each study must be located within the United States. This included either one or more states, one or more cities or one or more counties located within the United States. Studies which discussed the economic impact of seat belt legislation were commonly found in the collection process; however, these articles were excluded from this analysis because they did not provide a measure of the outcome of interest for this study.

Based on the criterion for article inclusion, the initial 26 articles were narrowed down to seven studies (Dee 1998; Calkins and Zlatoper 2001; Eby, Vivoda et al. 2002; Houston and Richardson 2002; Cohen and Einav 2003; Majumdar, Noland et al. 2004; Houston and Richardson 2005). A second elimination process took place to exclude studies which explored the relationship between seat belt laws and lives saved because the two variables were not similar enough to be included as dependent variables within the same model. This process further reduced the number of included articles from seven to five.

Management Strategy and Procedure:

A very simple information management procedure was employed. First articles were reviewed for content and checked to insure that they met set criteria. Second, the data section in each article was analyzed critically in search of a common measure to use as a dependent variable. Based on the articles, the dependent variable used in this study was percentage point increase in seat belt use as a result of a seat belt law. Third, the common independent variables used in the seat belt law studies and variables of interest were identified. Detailed notes were taken on each article in efforts to make it more obvious when common themes occur.

Analysis Strategy:

This study included both a qualitative and quantitative analysis of the five articles selected for inclusion in this paper. The quantitative portion of this analysis was conducted using a multiple regression. The model selected for this analysis was very simple and only included a few independent variables because of the limited amount of data points in the model. Information regarding coefficients and p-values can be found in Appendix C. The notation for regression model 1 was:

(Percentage point increase in seat belt usage rate) = B_0 + B_1pl + B_2sl + B_3sspl + B_5ob +B_4r+ B_5g + B_6y+ B_7yp +B_8ui + B_{9NHTSA} + B_{10}fe. Appendix C lists coefficients and p-values for regression model 1. Because this regression model could not be successfully run, a series of simple or bivariate regressions were also used to explore the relationship between the change in seat belt use rates and each independent variable. Using the variables found to be statistically significant in the bivariate regression models a second multiple regression model was used explore whether these variables remained significant when other variables were held constant. Please refer to Appendices D and E to view statistical output from the simple regressions and regression model 2.

Dependent Variable:

In this study the dependent (outcome) variable was the percentage point increase in seat belt use found in studies which explored the effect of seat belt laws. The value for the dependent variable was the coefficient on primary, secondary or change from primary to secondary seat belt laws found in each studies regression output table. This coefficient gave a value for the influence of a seat belt law on seat belt use. If the value was not listed in a table of coefficients, it was assumed that the increase in seat belt use given in the study was the coefficient. It must be noted that several studies used more than one model to estimate change in seat belt use in relation to seat belt laws. These models explored the influence of different sets of independent variables on change in seat belt use. For these studies the coefficients were selected from the models which included fixed effects.

Originally, the coefficient on the lives saved from the included studies was used a dependent variable in this model. However, that variable had to be excluded from the analysis because it was too different from the change in seat belt use variable. By eliminating that variable, one of the major criticisms of meta-analysis, including studies which are too different to be compared quantitatively, was avoided (Wolf 1986). This caused an additional 2 studies, Houston and Richardson 2002 and Calkins and Zlapter 2001, had to be eliminated from the analysis bringing the total number of included studies down from seven to five.

Some of the studies measured the impact of more than one type of seat belt law. In example, the study by Cohen and Einav estimated the effects of primary seat belt laws, secondary seat belt laws and the effects of switching from primary to secondary seat belt laws (2003). For the purposes of this analysis, each coefficient on seat belt law was counted as a separate entry in the regression model. All of the studies with the exception of Eby 2002, were counted as more than one observation in this analysis. Ten entries were gathered from five studies. Details of the included studies can be found in Appendix A.

Independent Variables:

This study used variables which research has shown to have an effect on seat belt use, variables which were commonly used in the included studies as independent variables and study characteristic that might account for some of the variation in the degree to which seat belt laws influence seat belt usage. It was hypothesized that inclusion of these variables would have an impact on seat belt use rates. Race, gender, the number of observations in the study, the number of years observed in the study, whether or not a study used National Highway Transportation Safety data, whether or not a study used fixed effects models, whether the study examined primary laws, secondary laws or a change from a secondary to primary law, year of publication and unit of interest were all used as independent variables in this analysis. All of the studies included age in their models, therefore, age was not selected as independent variable. Eleven variables were selected as independent or explanatory variables. Many of the studies acknowledged whether their research interest was primary seat belt laws, secondary seat belt laws or the switch from primary to secondary seat belt law. As a result of this theme, each was used as an independent variable and coded with dummy variables. Please refer Appendix B for information on coding and variables used in this study.

Race and gender were selected as independent variables and coded as dummy variables. A code of 1 was given for studies that included the variable, and a code of 0 was given for studies that did not. In research, the number of observations or "sample size may have a dramatic effect on an analysis" because a "small sample may fail to demonstrate an effect of a program (Wholey 2004 pp 457)." For this reason the number of observations from the studies was selected as a dependent variable. Additional independent variables were number of years covered by the study, the year of publication and unit of interest (city, state, county).

Qualitative Review of the Included Studies:

A simple qualitative review was conducted to provide a qualitative aspect to this analysis. According to Frederic Wolf, a meta-analysis should include a qualitative review which discusses the research design and other attributes of the included studies that are not quantitative (1986). For this reason, the same studies selected for inclusion in the meta-analysis were also used for the literature in efforts to maintain consistency throughout this analysis. This procedure was used to identify trends in the literature. Details of the studies can be found in Appendix C.

Limitations

The technique used in this analysis contains limitations in and of themselves. A meta-analysis is subject to publication bias because they typically include articles which have been published in journals and the argument has been made that published research usually contains significant findings where as unpublished research may contain more instances of non-significant findings (Wolf 1986). However, it must be noted that a Google search (a search that locates both published and unpublished studies) was used to find articles. Although articles not published in journals were located, none met the criteria for inclusion. This suggests that there may not be a large body of unpublished research on the influence of seat belt law on lives saved or seat belt use.

Additionally opponents of the meta-analytic procedure believe that " results of meta-analysis are interpretable because results from poorly designed studies are included along with results from good studies" and "multiple results from the same study are often used which may bias or invalidate the meta-analysis and make results appear more reliable than they really are (Wolf 1986 pp 14)". This analysis did select more than one outcome variable from some of the studies which means that this analysis may be subject to bias.

Another limitation of this study is that only five articles were included in this analysis. Because of the small number of observations the degrees of freedom were limited. As a result the number of independent variables which could be used in this analysis was limited. Furthermore, variables such as speed limit and income which may have had an effect on the dependent variable were not included in the regression model. This means that this study may be subject to omitted variable bias.

One of the reasons for the low number of observations in this analysis was the criterion for selection of articles. It appears as though limiting the criterion for inclusion to studies which explore the effects of seat belt laws on seat belt use excludes other studies which could provide information about the relationship between the implementation of a seat belt law and seat belt use. Broadening the criteria for inclusion could have lead to the inclusion of more studies in this analysis.

All of the studies used in this analysis collected data on seat belt use from either observational, written or telephone surveys. It has been "suggested that the belt use data from telephone surveys are not predictive of actual belt use" (Dee 1998 pp 6, citing Robertson 1992). Because this analysis relied on studies which used such data, it is possible that this analysis is subject to the same instance of reporting bias as each of the studies included in this analysis.

Findings

Qualitative and Descriptive Analysis:

The qualitative portion of this analysis was conducted by critically reviewing selected article and looking at descriptive output data to find trends and issues of interest in the included studies. The most obvious finding consistent in all five studies was that primary seat belt laws are more effective than secondary laws, although the degree to which this occurs varied among studies. Another trend was that studies which included more independent variables found a lower level of seat belt use increase than studies which included fewer independent variables. The common independent variables found in the studies were primary law, secondary law, race, and gender. The independent variables found in these studies are listed in Appendix A.

Most studies which included fixed year, fixed state and fixed effects models in their regression analysis found a lower effect of seat belt laws than studies which did not. This suggests that studies which do not use this information may be overestimating the effects of seat belt laws (Dee 1998). However, in the article by Cohen and Einev, the inclusion of fixed effects resulted in a lower coefficient on primary secondary and change from secondary to primary laws and an increase in the coefficient of the change from secondary to primary seat belt laws when the dependent variable was seat belt usage rates (2003).

Quantitative:

A multiple regression revealed that there was no statistically significant relationship between most of the independent variables and change in seat belt use in studies which looked at the effect of seat belt laws. When the regression was run, many of the variables were dropped from the analysis. This most likely occurred because the small number of observations prevented the regression from running properly because the degrees of freedom were limited to nine. However, there was a statistically significant relationship between seat belt use and the secondary seat belt law variable, switch from primary to secondary seat belt law, number of observation year published and year variables. This means that holding all else constant studies which looked the effect of a secondary seat belt law found an 8.73 percentage point lower seat belt use rate on average than studies which did not. This finding was significant at the 95% confidence level leaving only 5% of this finding due to chance. Moreover, this coefficient of determination for this model was .912 which means that 91.2% "of the variation in the dependent variable can be predicted by the independent variables in the model (Wholey 2004 pp 504)". Additionally, the overall model did provided a good explanation of the variance in seat belt usage rates with an f-statistic of .0104. The coefficients and P-value from this model can be viewed in Appendix C.

At the 90% confidence level, the number of observations included in the study proved to have a statistically significant relationship with the dependent variable. This means that on average, holding all else constant, studies which explore the switch from secondary seat belt laws to primary seat belt laws found a 7.41 percentage point lower seat belt usage rate than studies that did not. Additionally, this regression model revealed that as the number of observations used in a study increased by the seat belt usage rate increased by .000029 percentage points and for each year the study spanned, the seat belt usage rate increased by .8039 percentage points on average holding all else constant.

To further explore the relationships between the independent variables and the dependent variable, a series of bi-variant regressions were used. This process revealed that no variables were significant at the 95% confidence level. However, because of the small number of observations used in this analysis, relationships at the 90% confidence level were observed. The influence of including a primary seat belt law variable was a seat belt usage increase of 6.62 percentage point. The influence of the secondary seat belt law variable was a decrease of 6.041 percentage points. As the number of observations increased by one, the seat belt usage rates increased by .000013. Moreover, studies which were interested in the impact of seat belt laws on a state as opposed to a city resulted in a 7.81 percentage point higher seat belt usage rate. The R^2 for all of the bi-variate regressions was less than .38, which means that the variation in the dependent variable was not predicted very well by the independent variables in the model. The statistical outputs for these simple regressions are displayed in Appendix D. Surprisingly, demographic variables such as age, race and gender were not statistically significant.

A multiple regression was run using the independent variables that were proven to have a statistically significant relationship with the dependent variable in the bivariate regressions. The model was (Percentage increase in seat belt usage) = $B_0 + B_1pl + B_2sl + B_3ob + B_4yp + B_5ui$. In this model only the primary seat belt law, number observations and unit of interest variables remained statistically significant and their influence on seat belt usage rates remained roughly the same with the exception of the unit of interest variable. The coefficient on the unit of interest variable suggests that when a study examines the impact of seat belt laws on seat belt usage rates, holding all the variables in the equation constant, that seat belt use increases by 68.13 percentage points. In this model 96% of the variation in the dependent variable can be predicted by the independent variables in the model.

Conclusion and Recommendations

While this study gives some insight into the variables that matter when estimating the effect of seat belt laws on seat belt use, it is in no way definitive in its findings. Because of the small number of observations included in this study, it is recommended that further research be done on this topic to better explain the ideas explored in this study. This study did not provide generalizable results.

It was expected that whether or not a study included fixed effects models would prove to be statistically significant because research has shown that the inclusion of fixed effects variables which take into account state, city or year attributes, may increase the validity of results (Dee 1998). Additionally it was expected that demographic variable such as race and gender would have an affect because research has shown that seat belt use varies depending on those variables. The lack of a statistically significant findings in those variables does not necessarily mean that these variables are no relationship with the change in seat belt usage rates. It may be a result of the low number of observation.

Recommendations for Further Research:

As mentioned earlier, many states have enacted primary seatbelt laws to decrease the number of automobile fatalities and to make highways safer. While research has been done to find the link between seatbelt usage and laws, there is a wide variation when it comes to data collection, dependent variables and independent variables. The main purpose of the study was to attempt to find the independent variables that influence usage and link to a common dependent variable such as percentage point increase in seat belt usage.

Correlations were found between percent change in seat belt use and the primary seat belt law, secondary seat belt law, number of observation, unit of interest, and year published variables. However, because of the small number of observations, the results cannot be generalized. The small number of observations also made the findings of the study non-definitive.

It was expected that demographic variable such as race and gender would have an effect because research has shown that seat belt use varies depending on those variables. The lack of a statistically significant relationships between seat belt percentage point increase in usage rates and on those previously mentioned variables does not necessarily mean that the variables have no relationship with the change in seat belt usage rates. It may be a result of the low number of observation. Recommendations for further research:

To better understand the influence of variables on seatbelt usage, it is recommended that future meta-analytic studies concerning seat belt use and seat belt laws include the following:

1. A more relaxed criterion for the inclusion of studies in the analysis. One of the main reasons for the small number of observations in the study was that very few studies met the set criteria. The criteria should be broadened to include studies which assess safety behaviors for instance. Other types of studies may include a seat belt law coefficient in their analysis which accounts for the impact of the seat belt law on seat belt use.
2. A more in-depth comparison of studies that only examine the impact of secondary seatbelt laws and studies that only examine the impact of primary seat belt laws would provide more insight into degree to which these laws influence seat belt usage rates and the variables in that influence seat belt use under each form of the seat belt law.

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Appendix A

Characteristics of Included Studies

Authors	Unit of Interest	Time Period	Dependent Variables	Independent Variable	Design	Results
Cohen and Eiinav	All 50 states	1983- 1997	Seat belt use	primary law, secondary law, control variables, and year and state Effects	Regression	mandatory laws are related to increased seat belt use but primary laws increase more
Dee	19 Cities with in the United States, Chicago, Dallas, Houston, Los Angeles, Miami, Minneapolis/St Paul, New Orleans, New York, Phoenix, Pittsburgh, Providence, San Diego and Seattle	1985-1991	rate of observed belt use	age, gender, race, and ethnicity	OLS Regression	Mandatory seat belt laws are related to an increase in seat belt use. Pre-post law comparisons overestimate the effect of seat belt laws
Eby, Vivoda and Fordyce	State (Michigan)	1998 - 2002	rate of observed belt use	type of enforcement, seating position, vehicle type, age, road type, sex	simple estimations using a set formula taken from Streff et al.	Belt use is higher for females, passengers and increases as age increases, Standard (primary) enforcement is related to increased belt use in Michigan
Houston and Richardson 1	47 states, excluded Maine New Hampshire, and Wyoming and DC because Of missing data	1991-2001	Observed annual state seat belt use rate	primary or secondary seat belt laws, whether a law covers occupants in all seats, minimum fine, education, per capita income, age, race	Time series cross-sectional regression analysis	level of enforcement of seat belt law is related to an increase in seat belt use
Majumdar, Noland, and Ochieng	All states with the exception of Alaska and Hawaii	1990 - 1998	seat belt use	primary or secondary seat belt law, per capita income, age levels in the population, per capita alcohol consumption, variables characterizing the infrastructure of the state.	fixed effects cross-sectional time series analysis -OLS Regression	Both types of laws are related to increased Seat belt use but primary laws have a more of an effect

Appendix B

Summary Statistics

Variables	Coding	Observation	Mean	Standard Deviation	Minimum	Maximum
Outcome	Coefficient on seat belt law from each study	10	16.279	7.714	9.2	35.1
Primary law	not primary = 0 primary = 1	10	0.5	0.516	0	1
Secondary law	not secondary = 0 secondary = 1	10	0.4	0.516	0	1
Switch from primary to secondary	no switch = 0 switch = 1	10	0.1	0.316	0	1
Number of observations	raw number	10	124154.5	240278.1	432	577422
Race	not included = 0 included = 1	10	0.7	0.483	0	1
Gender	not included = 0 included = 1	10	0.5	0.527	0	1
Number of years included in the study	raw number	10	10.8	3.333	5	15
Year Published	time frame	10	2002.5	2.549	1998	2005
Data source	NHTSA data not included = 0 NHTSA data included = 1	10	.9	.316	1	7
Unit of interest	state = 0 city = 1	10	0.2	.422	0	1
Fixed effects	year = 0 month = 1	10	0.7	0.483	0	1

Appendix C.

Multiple Regression Model 1: Coefficients and P-values

Variable	Coefficient	P-value
Pl	dropped	dropped
sl***	-8.73	.002
sspl***	-7.41	.020
ob***	0.000029	.022
r	Dropped	dropped
g	Dropped	dropped
y	0.804	.174
yp	1.33	.133
ui	Dropped	dropped
NHTSA	Dropped	dropped
fe	2.24	.165
constant	-2652.05	.134

Note: the dependent variable in this model is increase in seat belt usage rate. This variable was obtained from the coefficient on seat belt law in the included studies when the dependent variable was seat belt use.
*** Significant at the 95% confidence level
pl= primary seat belt law
sl = secondary seat belt law
sspl = switch from primary to secondary seat belt law
ls = lives saved
ob = observations
r = race
g= gender
y = number of years
yp = year published
NHTSA = indicates whether a study used NHTSA data or not
ui= unit of interest
dropped = indicates variables that were dropped from the regression

Appendix D

<u>Statistical Output: Bivariate Regressions</u>

(Percentage point increase in seat belt usage rate) = $B_0 + B_1$pl

```
Source |       SS       df       MS                  Number of obs =      10
-------------+------------------------------          F(  1,     8) =    5.29
 Model |  109.561009     1  109.561009       Prob > F      =  0.0505
 Residual |  165.784008     8   20.723001     R-squared     =  0.3979
-------------+------------------------------          Adj R-squared =  0.3226
  Total |  275.345017     9  30.5938907       Root MSE      =  4.5523
------------------------------------------------------------------------------
    outcome |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         pl |       6.62   2.879097     2.30   0.051    -.0192097    13.25921
     _cons |   12.24   2.035829     6.01   0.000     7.545369    16.93463
------------------------------------------------------------------------------
```

(Percentage point increase in seat belt usage rate) = $B_0 + B_1$sl

```
     Source |       SS       df       MS              Number of obs =      10
-------------+------------------------------          F(  1,     8) =    3.73
    Model |  87.6041759     1  87.6041759     Prob > F      =  0.0894
   Residual |  187.740841     8  23.4676051   R-squared     =  0.3182
-------------+------------------------------          Adj R-squared =  0.2329
      Total |  275.345017     9  30.5938907      Root MSE      =  4.8443
------------------------------------------------------------------------------
    outcome |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       sl |  -6.041667   3.127006    -1.93   0.089    -13.25256    1.169223
 _cons |   17.96667   1.977692     9.08   0.000     13.4061    22.52723
------------------------------------------------------------------------------
```

(Percentage point increase in seat belt usage rate) = $B_0 + B_1$sspl

```
      Source |       SS       df       MS              Number of obs =      10
-------------+------------------------------           F(  1,     8) =    0.14
       Model |  4.66944401     1  4.66944401           Prob > F      =  0.7199
    Residual |  270.675573     8  33.8344466           R-squared     =  0.0170
-------------+------------------------------           Adj R-squared = -0.1059
       Total |  275.345017     9  30.5938907           Root MSE      =  5.8167
------------------------------------------------------------------------------
     outcome |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        sspl |  -2.277778   6.131381    -0.37   0.720    -16.41677    11.86121
       _cons |   15.77778   1.938913     8.14   0.000     11.30664    20.24892
------------------------------------------------------------------------------
```

(Percentage point increase in seat belt usage rate) = $B_0 + B_1$ob

```
      Source |       SS       df       MS              Number of obs =      10
-------------+------------------------------           F(  1,     8) =    3.98
       Model |  91.4593919     1  91.4593919           Prob > F      =  0.0812
    Residual |  183.885625     8  22.9857031           R-squared     =  0.3322
-------------+------------------------------           Adj R-squared =  0.2487
       Total |  275.345017     9  30.5938907           Root MSE      =  4.7943
------------------------------------------------------------------------------
     outcome |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ob |   .0000133   6.65e-06     1.99   0.081    -2.07e-06    .0000286
       _cons |   13.90282     1.7264     8.05   0.000     9.921735     17.8839
------------------------------------------------------------------------------
```

(Percentage point increase in seat belt usage rate) = $B_0 + B_1 r$

```
      Source |       SS       df       MS              Number of obs =      10
-------------+------------------------------           F(  1,     8) =    1.25
       Model |  37.2964246     1  37.2964246           Prob > F      =  0.2954
    Residual |  238.048592     8   29.756074           R-squared     =  0.1355
-------------+------------------------------           Adj R-squared =  0.0274
       Total |  275.345017     9  30.5938907           Root MSE      =  5.4549
------------------------------------------------------------------------------
     outcome |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           r |   4.214285   3.764247     1.12   0.295    -4.466085    12.89466
       _cons |       12.6   3.149395     4.00   0.004     5.337481    19.86252
------------------------------------------------------------------------------
```

. **(Percentage point increase in seat belt usage rate) = $B_0 + B_1 g$**

```
      Source |       SS       df       MS              Number of obs =      10
-------------+------------------------------           F(  1,     8) =    0.31
       Model |  10.2009988     1  10.2009988           Prob > F      =  0.5942
    Residual |  265.144018     8  33.1430022           R-squared     =  0.0370
-------------+------------------------------           Adj R-squared = -0.0833
       Total |  275.345017     9  30.5938907           Root MSE      =   5.757
------------------------------------------------------------------------------
     outcome |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           g |       2.02   3.641044     0.55   0.594    -6.376262    10.41626
       _cons |      14.54   2.574607     5.65   0.000     8.602946    20.47705
```

(Percentage point increase in seat belt usage rate) = $B_0 + B_1$y

```
     Source |       SS       df       MS              Number of obs =      10
-------------+------------------------------           F(  1,     8) =    0.02
      Model |  .626605972     1  .626605972            Prob > F      =  0.8959
   Residual |  274.718411     8  34.3398013            R-squared     =  0.0023
-------------+------------------------------           Adj R-squared = -0.1224
      Total |  275.345017     9  30.5938907            Root MSE      =    5.86
------------------------------------------------------------------------------
    outcome |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          y |   .0793172   .5871772     0.14   0.896    -1.274716     1.43335
      _cons |   14.69337   6.606723     2.22   0.057    -.5417559     29.9285
------------------------------------------------------------------------------
```

(Percentage point increase in seat belt usage rate) = $B_0 + B_1$yp

```
     Source |       SS       df       MS              Number of obs =      10
-------------+------------------------------           F(  1,     8) =    3.62
      Model |  85.8072312     1  85.8072312            Prob > F      =  0.0935
   Residual |  189.537785     8  23.6922232            R-squared     =  0.3116
-------------+------------------------------           Adj R-squared =  0.2256
      Total |  275.345017     9  30.5938907            Root MSE      =  4.8675
------------------------------------------------------------------------------
    outcome |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         yp |  -1.211111   .6363924    -1.90   0.094    -2.678635    .2564123
      _cons |     2440.8   1274.377     1.92   0.092    -497.9178    5379.518
------------------------------------------------------------------------------
```

(Percentage point increase in seat belt usage rate) = B_0 + B_1nhtsa

```
      Source |       SS       df       MS              Number of obs =      10
-------------+------------------------------           F(  1,     8) =    0.51
       Model |  16.4694453     1  16.4694453           Prob > F      =  0.4959
    Residual |  258.875571     8  32.3594464           R-squared     =  0.0598
-------------+------------------------------           Adj R-squared = -0.0577
       Total |  275.345017     9  30.5938907           Root MSE      =  5.6885
------------------------------------------------------------------------------
     outcome |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       nhtsa |   4.277778   5.996244     0.71   0.496    -9.549585    18.10514
       _cons |       11.7   5.688536     2.06   0.074    -1.417789    24.81779
------------------------------------------------------------------------------
```

(Percentage point increase in seat belt usage rate) = B_0 + B_1fe

```
      Source |       SS       df       MS              Number of obs =      10
-------------+------------------------------           F(  1,     8) =    0.85
       Model |   26.429768     1   26.429768           Prob > F      =  0.3837
    Residual |  248.915249     8  31.1144061           R-squared     =  0.0960
-------------+------------------------------           Adj R-squared = -0.0170
       Total |  275.345017     9  30.5938907           Root MSE      =   5.578
------------------------------------------------------------------------------
     outcome |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          fe |   3.547619   3.849206     0.92   0.384    -5.328665     12.4239
       _cons |   13.06667   3.220476     4.06   0.004     5.640234     20.4931
------------------------------------------------------------------------------
```

(Percentage point increase in seat belt usage rate) = $B_0 + B_1 ui$

```
     Source |       SS       df       MS                  Number of obs =      10
-------------+------------------------------             F(  1,     8) =    4.40
      Model |   97.6562589    1   97.6562589     Prob > F      =  0.0693
   Residual |  177.688758     8   2.2110947     R-squared     =  0.3547
-------------+------------------------------              Adj R-squared = -0.2740
      Total |  275.345017     9  30.5938907        Root MSE      =   4.7129
------------------------------------------------------------------------------
   outcome |      Coef.   Std. Err.       t         P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         ui    |   7.8125      3.725847     2.10   0.069    -.7793177     16.40432
      _cons |   13.9875   3.220476     8.39   0.000     10.141512     17.82988
------------------------------------------------------------------------------
```

Appendix E

Statistical Output: Multiple Regression Model 2

(Percentage point increase in seat belt usage rate) = $B_0 + B_1pl + B_2sl + B_3ob + B_4yp + B_5ui$

```
      Source |       SS       df       MS              Number of obs =      10
-------------+------------------------------           F(  5,     4) =   19.38
       Model |   264.43086     5   52.886172           Prob > F      =  0.0066
    Residual |  10.9141565     4  2.72853912           R-squared     =  0.9604
-------------+------------------------------           Adj R-squared =  0.9108
       Total |  275.345017     9  30.5938907           Root MSE      =  1.6518
------------------------------------------------------------------------------
     outcome |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          pl |   6.705502    2.05053     3.27   0.031     1.012318    12.39869
          sl |  -2.018608   2.050671    -0.98   0.381    -7.712183    3.674967
          ob |  -.0001199   .0000303    -3.96   0.017     -.000204   -.0000359
          yp |  -1.400557   .8263037    -1.69   0.165    -3.694744    .8936304
          ui |   68.12889   14.51376     4.69   0.009     27.83224    108.4256
       _cons |   2818.881   1655.098     1.70   0.164    -1776.408    7414.171
------------------------------------------------------------------------------
```