ECON 4355 Course Project

Replication of McCarthy (1994):

Relaxed speed limits and highway safety

New evidence from California

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Introduction

Since 1987, states have had the option to relax rural interstate highway speed limits. One could expect to find numerous studies analyzing the potential effects this increase of speed limits has on highway safety. The purpose of this report is to analyze one such study, (McCarthy, 1994), and replicate its observations regarding speed laws on highways. Specifically, the goal is to replicate the paper's finding that relaxed speed laws do not have a statistically significant effect on the number of highway accidents.

Data

The data used in the regressions was sourced from McCarthy (1994). The data in question was used to replicate a model, Table 1, from McCarthy's report on speed laws and highway accidents in California. The data was recorded over the course of a 9-year period, monthly, from 1981 through 1989. With regards to the regressions, the dependent variable was the number of accidents in each category that depended on damages sustained and classifications of highways. These accident variables can be understood via 4 basic categories. These are fatal, injury, property damage, and total accidents, with abbreviations listed as fata, inja, pdoa, and tota respectively. Letters at the beginning of these variables will denote what section of highway is being analyzed, with 'other-interstate highways' being a result of the difference between the other categories of roads. Explanatory variables included number of weekends per month, quadratic time trend and time trend squared and monthly unemployment rate. Dummy explanatory variables were also used and these were based on season, status of mandatory seat belt law, and speed limit. It should be noted that for 'spdlaw', it has an assigned value of 1 representing after the speed law was put into effect. This applies to belt law as well, which is assigned a value of 1 if the mandatory use seatbelt law is in effect. The summary statistics for the data are presented below, along with a description for each variable.

Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
totacc	108	42831.26	4608.328	32699	52971
fatacc	108	377.9352	48.54678	266	500
injacc	108	17861.48	1963.107	13268	21741
pdoacc	108	24591.84	2773.219	19162	31425
ntotacc	108	39522.97	3797.032	30759	47874
nfatacc	108	335.3056	41.12971	237	434
ninjacc	108	16578.78	1695.411	12492	19963
npdoacc	108	22608.89	2252.886	18030	28338
rtotacc	108	324.8241	82.20715	181	555
rfatacc	108	13.25	5.37235	3	31
rinjacc	108	146.213	41.33317	71	261
rpdoacc	108	165.3611	39.44983	90	267
t	108	54.5	31.32092	1	108
tsq	108	3942.167	3523.893	1	11664
unem	108	7.200926	1.790134	4.3	11.9
spdlaw	108	.2962963	.4587521	0	1
beltlaw	108	.4444444	.4992206	0	1
wkends	108	13.07407	1.011187	12	15
feb	108	.0833333	.2776739	0	1

mar	108	.0833333	.2776739	0	1
apr	108	.0833333	.2776739	0	1
may	108	.0833333	.2776739	0	1
jun	108	.0833333	.2776739	0	1
jul	108	.0833333	.2776739	0	1
aug	108	.0833333	.2776739	0	1
sep	108	.0833333	.2776739	0	1
oct	108	.0833333	.2776739	0	1
nov	108	.0833333	.2776739	0	1
dec	108	.0833333	.2776739	0	1

Model and Results

Table 1

	(1) Rural Interstate Highways	(2) Other Interstate Highways	(3) Non-Interstate Highways	(4) All Roads
Fatal Accidents	1.794366 (0.98)	3.052278 (1.13)	5.2303 (0.52)	10.07697 (0.94)
Adjusted R	0.4909	0.5464	0.7324	0.7842
Injury Accidents	8.676864(1.25)	-3.920784 (-0.12)	-217.1135 (-1.00)	-212.3574 (-0.90)
Adjusted R	0.876	0.9304	0.9276	0.9358
Property Damage Accidents	7.187763 (0.92)	60.94322 (1.31)	-252.7299 (-0.59)	-184.5989 (-0.40)
Adjusted R	0.8274	0.9697	0.8383	0.8750
Total Accidents	17.65899 (1.35)	60.07471 (0.82)	-464.6131 (-0.76)	-386.8794 (-0.58)
Adjusted R	0.8883	0.9644	0.8856	0.9069

Results

The results from Table 1 show that speed law is statistically insignificant with regards to accidents. This is because the t-statistics are not statistically significant. Additional two-tailed hypothesis testing also determines that ‘spdlaw’ is not significant. The null hypothesis was only rejected 3 times throughout every regression. Increased speed limits in California were found to have no overall effect on highway safety. The net effect of ‘spdlaw’, explained by the regression for “all roads” and “total accidents “, shows that a relaxed speed limit has led to a 386-monthly accident decrease, but this still is not statistically significant.

The unemployment coefficient is expected to be negative, because a poor economic state means less people travelling, as well as significant. The number of weekends days was found to be generally insignificant, withholding results from rural interstate accidents. The passing of the seatbelt law generated positive coefficients and proved to be significant in all but two regressions, fatal and injury accidents on rural highways. Speculation of this variable might indicate another relation not modeled, and that other variables might have more significance than previously thought. (McCarthy, 1994)

The OLS result for "All roads" and "Total Accidents" is as follows:

$\widehat{totacc}$ = 41850.31 + 106.3862t – 0.8492737tsq – 1252.997feb + 3255.08mar +458.9327apr +842.4762may +827.4043jun +2107.356jul +2354.602aug +1760.913sep +3558.283oct +3327.986nov +4458.709dec – 964.8489unem +131.6937wkends +4642.449beltlaw – 386.8794spdlaw

The coefficient for time trend, t, is positive and has a direct correlation with the dependent variable, $\widehat{totacc}$. On the contrary, 'tsq' is inversely related to the dependent variable, and an increase in this variable will have a negative effect on statewide total accidents. With regards to seasonal dummy variables, all months, except for February, will have a positive effect on statewide total accidents if they hold a value of 1. February will have a negative effect on $\widehat{totacc}$. January does not relate to a designated variable in order to avoid multicollinearity. Unemployment rate is expected to be negative since less people travel and are driving on the road when the economy is poor. The coefficient for 'beltlaw' has a positive effect on the total number of statewide accidents when it is imposed, and no effect when not imposed. An explanation for this could be that using seat belts reduces people's perceived risk, so they end up engaging in more risk-taking behavior on the road. So, while fatal and injury accidents might be

reduced, total accidents will have increased. Finally, ‘spdlaw’ is inversely related to the number of total statewide accidents. Specifically, if the speed law is enacted (i.e. ‘spdlaw’ holds a value=1), then the amount of statewide total accidents will decrease by 386.87.

Conclusion

The results of the time-series data presented in Table 1, regarding accident frequency and categories of highways across California, argue that general highway safety in California was marginally affected after rural interstate speed limits were relaxed in 1986. The analysis from Table 1 could not detect a significant increase in all accident categories because of the law. (McCarthy, 1994) The similarity between the original report and this replication allowed for additional confidence when reaching this conclusion. It should be noted that while the time series analysis from Table 1 has reached this conclusion, the analysis has not considered redistributive effects that might have occurred. For example, while the Table 1 results for accidents on rural highways do show a positive effect, an increase, on the number of accidents, they did not lie within the levels of significance. Per the report, this could be because of specification problems within the monthly trend term, and its influence on the effects of speed limit. (McCarthy, 1994)

It should also be noted that the results from the time-series analysis ignores the substitution effect that relaxed speed limits have on roads where the speed limits were not altered. Actual policy implementation proved that the effects of speed limit were to be negated, compared to the analysis which showed damaging effects, albeit statistically insignificant.

Given the absence of acknowledgement of potential substitution effects caused by the speed law, in addition to specification issues of the time trend, it is recommended that additional studies be conducted to reach a more consistent solution.

References

McCarthy, P.S. (1994), Relaxed speed limits and highway safety: New evidence from California, *Economics Letters*, 46: 173–179.