The Effectiveness of Seat-Belt Legislation in Reducing Injury Rates in Texas

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The effects of seat-belt regulations on automobile-related fatality and injury rates have been of great interest to economists and policy-makers over the past few years.[1] The effects of the laws have been evaluated by various statistical techniques using time-series data for particular states and pooled time-series data for national models.[2] The results of these studies provide some evidence that seat-belt laws (SBL) reduce injury and fatality rates. However, the effects of seat-belt laws vary across states and time periods as well as across the levels of injuries.

This study assesses the effects of the Texas seat-belt law on injury rates using police-reported accident data. The data are from the U.S. Department of Transportation State Traffic Accident Files and are compiled monthly for the period 1982–1987 for driver-involved accidents. Furthermore, the data comprise single- and multiple-vehicle accidents. Only accidents involving towed vehicles are used in the analysis so as to normalize for changes in accident-reporting thresholds over time.[3] The analysis was conducted for several sets of injury classifications using the KABCO scale, which indicates the numbers of fatalities (K), severe injuries (A), moderate injuries (B), complaints of injuries (C), and no injuries (O).

I. The Model

The Texas seat-belt law went into effect on September 1, 1985, and fines associated with violating the law were imposed three months later on December 1, 1985. Texas is a primary enforcement state which has one of the highest seat-belt usage rates in the country (see B. J. Campbell et al., 1987). A set of econometric models was developed to examine the effect of the Texas seat-belt law on driver-involved injury rates. These models were of the form

$$(1)\quad \ln Y = \beta_1 + \beta_2 \ln(\text{Trend}) + \sum_{j=3}^{13} \beta_j X_{j-2} + \beta_{14} D + \varepsilon$$

where $\ln Y$ is the natural log of the driver-involved injury rate defined as the number of drivers injured divided by the number of driver-involved accidents, ln(Trend) is the natural log of a linear time trend, X_{j-2} ($j = 3, 4, \ldots, 13$) are dummy variables to account for seasonality, D is a dummy variable to account for the existence of seat-belt regulations, and ε is a random error term. The model can be expanded to account for the potential dynamics of the seat-belt law, that is, to distinguish between the effect of the law during the first three months it is in place (the first-quarter effect) from its effect in later months (the subsequent-quarter effect). In addition, the model can be expanded to account for other socioeconomic and driving-related factors such as the unemployment rate, the imposition of a fine

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[1]Susan C. Partyka (1988) has estimated that seat belts are between 40-percent and 50-percent effective in preventing fatalities when worn.

[2]See Loeb (1993) for details.

[3]Towed vehicles were defined to be those of a particular level of vehicle damage as measured by the National Safety Council's Vehicle Damage Scale. Vehicle damage levels 5–7 were used to identify towed vehicles. See National Safety Council (1984).

for violating the seat-belt law, vehicle miles driven (estimated), and a companion-variable effect. The companion variable attempts to account for possible driver-involved injuries that are peculiar to Texas and not adjusted for by the trend variable.[4] Hence one can examine the sensitivity of the estimated effects of the seat-belt law on driver-involved injury rates due to the inclusion or exclusion of these other factors.

II. Regression Results

Table 1 provides definitions of variables and Table 2 provides a sample of regressions for $(A+K)$ driver-involved injury rates for single- and multiple-vehicle accidents.[5] The regressions were estimated by ordinary least squares. (To conserve space, the monthly dummy variables to account for seasonality are not reported.) The coefficients associated with the SBL variables in the $(A+K)$ regressions are stable across specifications. They are consistently negative and generally significant (at the 0.05 level or better).[6] The subsequent-quarter effect, as measured by MULDSQ, is not much different than the first-quarter effect as seen in equation (ii). A priori expectations would have suggested a smaller coefficient associated with MULDSQ (see Hoxie and Skinner, 1987). The results may be explained by the imposition of a fine for violating the law, starting in the second quarter after the imposition of the law. The remaining regressions support this, with the coefficients associated with FINE being consistently negative and generally significant (at the one-tail 0.05 level) and the coefficients for FINE2 being consistently negative and statistically significant. In addition, it appears that the impact of the fine (lagged three months) as measured by the coefficients associated with FINE2 is slightly larger than the initial impact of the seat-belt law.

The trend effect was included to account for factors not directly incorporated in the model such as possible changes in alcohol consumption over time.[7] The coefficients are never significant. The unemployment

TABLE 1—DEFINITIONS OF INDEPENDENT VARIABLES

Variable	Definition
MULDS	A dummy variable indicating when the seat-belt law was in effect. MULDS takes on the value of 1 when the seat-belt law was in effect and 0 otherwise.
MULDSQ	A dummy variable taking on the value of 1 for all months the seat-belt law was in effect other than the first three months and 0 otherwise. (MULDSQ = 1 corresponds to the period a fine was in effect.)
FSTQTR	A dummy variable taking on the value of 1 for the first three months the seat-belt law was in effect and 0 otherwise.
FINE	A dummy variable taking on the value of 1 for the fourth through the sixth month the seat-belt law was in effect and 0 otherwise. (This variable accounts for the first three months a fine was in effect in Texas.)
FINE2	A dummy variable taking on the value of 1 starting with the seventh month the seat-belt law was in effect (three months after a fine was initiated in Texas). FINE2 = 0 otherwise.
TRENDL	Natural log of a linear trend.
UNEMPL	Natural log of the unemployment rate.
MILESL	Natural log of the estimated vehicle miles driven in Texas.
COMPAL	A companion variable defined as the natural log of the ratio of the sum of motorcycle driver fatalities and other non-covered fatalities in Texas to the sum of all KABCO injuries from single- and multiple-vehicle accidents associated with vehicle-damage levels 5–7.
c	A constant term.

[4]The companion series looks at the influence of non-SBL-covered fatalities on driver-involved injury rates. Many different companion series were generated, and the companion variable that resulted in the highest adjusted R^2 was selected for presentation. See Paul Hoxie and David Skinner (1987) for a further discussion.

[5]Models for single-vehicle accidents and multiple-vehicle accidents separately were also developed and are available from the author upon request.

[6]These results remain intact when the companion variable is excluded and when other variations of the model are estimated. These results are available from the author upon request.

[7]Sam Peltzman (1975) suggests a time trend as a proxy for permanent income.

TABLE 2—TEXAS ($A + K$) REGRESSIONS, 1982–1987

	Regression			
Variable	(i)	(ii)	(iii)	(iv)
MULDS	−0.083			
	(−3.478)			
FSTQTR		−0.081	−0.086	−0.087
		(−2.599)	(−2.852)	(−2.806)
MULDSQ		−0.085		
		(−2.949)		
FINE			−0.054	−0.057
			(−1.759)	(−1.654)
FINE2			−0.102	−0.107
			(−4.955)	(−3.329)
TRENDL	0.003	0.002	−0.002	−0.005
	(0.200)	(0.142)	(−0.247)	(−0.287)
UNEMPL	−0.131	−0.129	−0.110	−0.160
	(−2.935)	(−2.683)	(−2.488)	(−2.112)
MILESL	−0.078	−0.064		0.054
	(−0.322)	(−0.235)		(0.191)
COMPAL	0.105	0.104	0.085	0.084
	(2.26)	(2.197)	(1.759)	(1.714)
c	−0.202	−0.333	−1.029	−1.531
	(−0.091)	(−0.132)	(−5.536)	(−0.582)
RBARSQ[a]	0.722	0.717	0.728	0.723
DW	1.939	1.925	2.093	2.065

Notes: The table reports logarithmic regressions of $A + K$ driver-involved injury rates associated with single- and multiple-vehicle accidents and vehicle-damage scale 5–7. All regressions include monthly dummy variables (not reported) to account for seasonality. Numbers shown within parentheses below the coefficients are t statistics.

[a]Adjusted R^2.

TABLE 3—TEXAS ($A + B + K$) REGRESSIONS, 1982–1987

	Regression			
Variable	(i)	(ii)	(iii)	(iv)
MULDS	−0.095			
	(−6.422)			
FSTQTR		−0.051	−0.056	−0.057
		(−3.023)	(−3.626)	(−3.553)
MULDSQ		−0.13		
		(−8.415)		
FINE			−0.102	−0.103
			(−6.494)	(−5.874)
FINE2			−0.149	−0.151
			(−14.09)	(−9.184)
TRENDL	0.026	0.011	0.005	0.004
	(2.633)	(1.225)	(1.244)	(0.451)
UNEMPL	−0.101	−0.063	−0.042	−0.040
	(−3.642)	(−2.415)	(−1.860)	(−1.565)
MILESL	−0.363	−0.088		0.025
	(−2.430)	(−0.598)		(0.175)
COMPAL	0.079	0.063	0.044	0.043
	(2.739)	(2.452)	(1.76)	(1.716)
c	3.136	0.494	−0.418	−0.653
	(2.28)	(0.363)	(−4.38)	(−0.484)
RBARSQ[a]	0.876	0.905	0.917	0.915
DW	1.804	1.652	1.929	1.912

Notes: The table reports logarithmic regressions of $A + B + K$ driver-involved injury rates associated with single- and multiple-vehicle accidents and vehicle-damage scale 5–7. All regressions include monthly dummy variables (not reported) to account for seasonality. Numbers shown within parentheses below the coefficients are t statistics.

[a]Adjusted R^2.

rate is included to account for economic conditions. The coefficients associated with this variable are consistently negative and statistically significant across models, as one would expect a priori (see Partyka, 1984). The coefficients associated with the variable accounting for estimated miles traveled are never statistically significant. The omission of this variable [as seen for example in equation (iii)] does not affect the estimates associated with the seat-belt variables. Finally, the coefficients associated with the companion variable (COMPAL) are consistently positive and appear to be significant (at the one-tail 0.05 level or better). These results conform with Hoxie and Skinner (1987). When the companion variable is excluded from the model, the coefficients associated with the seat-belt-law variables remain similar to those reported.

Table 3 examines regressions similar to those in the prior table for $(A + B + K)$ driver-involved injury rates. As such, the regressions evaluate the effect of the seat-belt law (and other factors) on $(A + B + K)$ injury rates associated with single- and multiple-vehicle accidents combined when the vehicles are towed away (damage scale 5–7).[8] The results are similar to those reported above. Most important, the estimated coefficients associated with the seat-belt-law variables are always negative and statistically significant. Once again the co-

[8]It is common to combine injury levels in the manner shown, i.e., $(A + K)$ and $(A + B + K)$. See, for example, Campbell et al., (1987).

efficient associated with MULDSQ is larger than that associated with FSTQTR, which may be attributed to the effect of the fine which was imposed three months after the SBL went into effect. The coefficients associated with the fine-related variables support this (i.e., the coefficients associated with FINE and FINE2). The coefficients associated with the time trend are significant in only one regression. The coefficients associated with the unemployment variable are again consistently negative and generally significant, while the coefficients associated with miles traveled vary in terms of significance from model to model. Finally, the coefficients associated with the companion variable are consistently positive and significant (at the one-tail 0.05 level or better).

III. Conclusion

This study has made use of econometric models to evaluate the effect of the Texas seat-belt law on various driver-involved injury rates using a large data set from the U.S. Department of Transportation's State Traffic Accident Files. The data are normalized for vehicle damage levels so as to attempt to account for accidents resulting in towed-away vehicles. The models account for the general impact of the seat-belt law in Texas as well as its dynamic effects (i.e., first-quarter versus subsequent-quarter effects), along with the effect of the fine imposed for violating the law. The models also accounts for seasonal factors, a trend, unemployment rates, miles traveled, and companion effects.

The models indicate that the Texas seat-belt law resulted in a reduction in the various driver-involved injury rates examined. The SBL coefficients are consistently negative and are generally statistically significant. It appears as if the estimated subsequent-quarter effect is larger in absolute value than the first-quarter effect, which may be attributed to the introduction of a fine in the second quarter.[9]

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[9]It is interesting to note that the first-quarter effect is smaller for the $(A+B+K)$ regressions than for the $(A+K)$ regressions. The reverse seems to be true for the subsequent-quarter effect.