Behavioral Policies and Teen Traffic Safety
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By Thomas S. Dee and William N. Evans*

Traffic fatalities are the leading cause of death among teens and young adults, accounting for one-third of all deaths among those 15–20 years of age. The large share of teen mortality attributed to car travel is not entirely unexpected. Driving is an inherently risky activity, and teens rarely die of other nonviolent causes. However, teens also face levels of traffic-related risk that are substantially higher than those of older, more experienced drivers. For example, the teen traffic fatality rate (defined as deaths of 16–19-year-olds per population) is nearly double the rate for adults aged 25 and older. Since teens drive less than adults, this ratio increases to nearly 2.5 when denominated by miles of travel. While these are sobering numbers, teen traffic safety has improved considerably over the past 20 years. Since 1979, the teen traffic fatality rate has fallen by 37 percent. Much of this drop occurred in the 1986–1992 period when rates fell 25 percent. These decreases in teen fatality rates are much larger than the contemporaneous changes for adults aged 25 and older, whose fatality rates fell by 22 percent in the 1979–1997 period, and by 13 percent over the 1986–1992 time frame. The relative improvements of teens are even more impressive when one considers that they have become increasingly dependent on the automobile. Between 1983 and 1995, vehicle miles traveled by teens aged 16–19 nearly doubled. When denominated by vehicle miles traveled, teen fatality rates have fallen by 50 percent since 1983.[1]

The gains in teen traffic safety are likely to reflect a number of causes. For example, over this period, there were several advances in car crash-worthiness (e.g., improved designs, increased car weight, the introduction of air bags).

However, these improvements also appear to reflect a reduction in risk-taking behind the wheel, in particular, increases in seat-belt use and reductions in drunk driving.[2] In this study, we present some evidence on the efficacy of key state policies in promoting these gains by discussing reduced-form models of traffic fatalities. We also consider whether the life-saving effects of an important policy, minimum legal drinking ages, have been attenuated by a possible shift of alcohol-related traffic risks to young adulthood.

I. Can Behavioral Policies Explain These Improvements?

An extensive literature has attributed much of the improvement in teen traffic safety to the broad new state regulations aimed at altering the behavior of drivers. This section presents a critical overview of the impact of these laws on traffic safety, focusing on four classes of state-level policies: laws mandating seat-belt use, policies that influence youth access to alcohol, policies directed at the specific and general deterrence of drunk driving, and highway speed limits. Beginning with New York in late 1984, every state but New Hampshire has adopted a law mandating seat-belt use. However, most states implemented "secondary" enforcement of these laws, which allowed a citation for a seat-belt violation only if the driver had been stopped for another infraction. Studies based on observed and self-reported seat-belt usage indicate that primary and secondary enforcement increased use rates by roughly 30 and 15 percentage points, respectively (Dee and Evans, 2001). Given the technological efficacy of seat belts, these policy-induced increases in use

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[1] The numbers in this paragraph are taken from Thomas S. Dee and William N. Evans (2001).

[2] A seat belt increases the probability of crash survival by 50–60 percent (Leonard Evans, 1986; Steven D. Levitt and Jack Porter, 1999a). Using a novel empirical approach, Levitt and Porter (1999b) estimate that drinking drivers are at least eight times more likely than sober drivers to cause fatal crashes.

should generate reduced fatalities as long as there is little or no risk-compensating behavior by drivers (Sam Peltzman, 1975). The most critical policy influencing youth access to alcohol has been state minimum legal drinking ages (MLDA). In the late 1960's and 1970's, many states had lowered their MLDA in response to a general sentiment toward the enfranchisement of young adults as well as considerable doubt about the efficacy of prohibiting alcohol. By 1977, 30 states had an MLDA of only 18. In response to growing concerns about the risks of drunk driving as well as strong financial pressure by the federal government, all states increased their MLDA to 21 by the late 1980's. Several studies have established a clear link between the state-specific timing of movements to higher MLDA and reductions in teen traffic fatalities.[3]

Another set of policies that may have influenced recent trends in youth traffic fatalities are those aimed at the deterrence of drunk driving. Such policies have proliferated over the last 20 years. One important type of state-level drunk-driving law made it "illegal per se" to drive with a specific blood alcohol concentration (BAC). All states except two currently have such a limit. Most states initially established their BAC limit at 0.10 or more. However, an increasing number of states have established a stricter definition at a BAC of 0.08. Recent federal legislation should compel all states to adopt the 0.08-BAC standard. Another major drunk-driving policy is a regulation allowing "administrative license revocations." This policy, which has been adopted in most states, allows state licensing agencies to suspend or revoke the driving license of an allegedly drunk driver prior to any court action. All states have also now adopted "zero tolerance" laws that make it illegal per se for underage drivers to have a positive BAC regardless of its value. Other drunk-driving policies include "dram shop" statutes that allow injured parties to sue the servers of alcohol and regulations that mandate jail time for first-time offenders. Recent reviews

of the efficacy of such drunk-driving policies (e.g., William DeJong and Ralph Hingson, 1998) typically conclude that each of these policies has been highly effective. However, there is evidence that several of these results are sensitive to model specification. The fourth set of policies evaluated here reflects the changes in states' maximum speed limits. In response to the Arab oil embargo, a national maximum speed limit (NMSL) of 55 miles per hour (MPH) was established in the early 1970's. In 1987, these regulations were relaxed, and states were allowed to raise their speed limits to 65 MPH on portions of the rural interstate system (and in that year alone, 38 states did so). In 1995, federal regulation of speed limits was eliminated, and most states raised their maximum speed limit above 65 MPH. The prior empirical evidence on the effects of higher speed limits is mixed. The particular relevance of this policy for teens is unclear, since teens are less likely to drive on highways, but their inexperience and risk-taking can make higher speeds particularly dangerous.

The panel nature of the available state-level data on traffic fatalities provides a straightforward way to evaluate the effects of these state policies in models that purge the confounding influence of determinants specific to each state and to each year. Since changes in laws such as the MLDA are discrete, we can compare fatalities in states before and after the law change with similar values from states with no such change in laws. These later states form a control group, providing an estimate of the secular change in fatalities that would have occurred in the absence of the law change. The outcome of interest is a fatality count for a state in a particular year. Because these counts are often small integers and subject to over-dispersion, we model the data as generated by a negative binomial distribution. To exploit the treatment/control design outlined above but to avoid the problem of incidental parameters, we adopt the conditional maximum-likelihood approach for negative binomial models, which was developed by Jerry Hausman et al. (1984). The estimates generated by these models can be interpreted as the proportionate change in fatality counts. All of these models include the following state–year variables as additional controls: the natural log of the population for

[3] Several prior studies have concluded that beer taxes also have a substantive influence on abusive teen drinking and traffic fatalities. However, some recent studies have suggested these links may be spurious (Dee, 1999; Dee and Evans, 2001).

TABLE 1—CONDITIONAL MAXIMUM-LIKELIHOOD ESTIMATES OF A FIXED-EFFECTS NEGATIVE BINOMIAL MODEL FOR PASSENGER-VEHICLE FATALITIES, AGES 16–19

Covariates	Ages 16–17	Ages 18–19
Mandatory seat-belt use		
Primary enforcement	−0.078	−0.096
	(0.031)	(0.029)
Secondary enforcement	−0.043	−0.070
	(0.029)	(0.028)
MLDA of 18	−0.043	0.046
	(0.027)	(0.025)
MLDA of 19	0.036	0.052
	(0.026)	(0.024)
MLDA of 20	0.034	0.033
	(0.051)	(0.048)
65-MPH speed limit	0.046	0.025
	(0.040)	(0.036)
Dependent-variable mean:	48.2	69.2

Notes: Standard errors are reported in parentheses. There are 768 observations in each model (48 states over the 1977–1992 period). Each model includes state and year fixed effects, the unemployment rate, real state personal income per capita, and the natural log of the population for the given age.

each age group, the unemployment rate, real state personal income per capita, and year fixed effects to control for changes in safety that are common to all states (e.g., crash-worthiness of cars, declining drunk-driving due to nonlegislative factors).

In Table 1, we present evidence on how laws mandating seat-belt use, minimum legal drinking ages, and 65 MPH speed limits influenced passenger-vehicle fatality counts among both 16–17-year-olds and 18–19-year-olds. These models are based on annual state-level data (Alaska and Hawaii omitted) from the 1977–1992 period, since nearly all of the within-state variation in two key policies (laws mandating seat-belt use and MLDA) had ended by the early 1990's. The estimated coefficients in the first row suggest that a seat-belt-use law with primary enforcement significantly reduced fatalities among 16–17-year-olds by nearly 8 percent and among 18–19-year-olds by almost 10 percent. These estimated effects are smaller in states that only had secondary enforcement. These estimates are roughly consistent with the associated increases in seat-belt usage and the

technological efficacy of seat belts, suggesting that risk-compensating behavior has not dramatically attenuated the life-saving benefits of these laws. The coefficients on the MLDA variables indicate that lower MLDA (i.e., easier access to alcohol) was associated with significantly higher counts of traffic fatalities among 18–19-year-olds. In contrast, the evidence linking the MLDA variation to traffic fatalities among 16–17-year-olds is at best limited. Although the estimated effects of seat-belt-use laws and MLDA increases are both statistically precise and quantitatively large for 18–19-year-olds, simulations by Dee and Evans (2001) suggest that these two policies can only explain 20 percent of the decline in traffic-fatality rates for this group.

The remaining results in Table 1 indicate that the initial movement to 65-MPH speed limits did not significantly influence teen traffic fatalities. However, similarly specified models extended to more recent years suggest that the movement to maximum speed limits above 65 MPH did significantly increase counts of traffic fatalities among 16–17-year-olds and female teens (Dee and Evans, 2001). Furthermore, these models also imply that illegal per se laws generated large reductions in teen traffic fatalities, perhaps through their interaction with administrative license revocations. In particular, these estimates suggest that the combination of a 0.08-BAC law and administrative license revocations reduced traffic fatalities among 18–19-year-olds by 25 percent. It should be noted that, though these estimated effects are large, they are only marginally significant. However, these effects are also plausibly concentrated in reductions of nighttime and not daytime fatalities. The other results provide little support for the hypothesis that the other drunk-driving policies (zero-tolerance laws, dram-shop case law or statutes, mandatory jail time for DUI offenders) had any detectable effects. Although some drunk-driving policies may have reduced teen traffic fatalities, these policies probably cannot explain the large drop in teen traffic fatalities since 1979. Consider the case of the BAC limit of 0.10. Roughly 90 percent of the country was covered by a BAC of 0.10 by 1988, yet teen fatalities have fallen by 25 percent since then. Likewise, only 27 percent of the country was covered by a BAC of 0.08 by 1997, with most

of this change due to states with a BAC of 0.10 dropping the legal limit to 0.08. Overall, the evidence from Table 1 suggests that there are a number of behavioral policies that have greatly improved teen traffic safety over the past 20 years. However, these policies can explain only a modest fraction of the change in the fatality rate. From a behavioral standpoint, there appears to be a long-term secular decline in teen drunk-driving that is unrelated to the direct effect of any particular state policy.

II. Has the MLDA Reduced or Shifted Deaths?

Alcohol use and driving (while either drunk or sober) are both activities where experiential learning is likely to be important. The potential impact of learning-by-doing raises some important and often overlooked questions about the overall efficacy of the nationwide movement to a higher MLDA. A seemingly implicit assumption in most studies of teen traffic safety is that the increased MLDA unambiguously saved lives by delaying alcohol availability until young adulthood when alcohol would be consumed responsibly. However, this perspective may overstate the gains to higher MLDA if young drivers learn about the responsible use of alcohol largely through their own experiences and those of their peers. More specifically, the existence of learning-by-doing raises the disturbing possibility that policies, which keep teens away from alcohol, may to some degree simply shift the attendant mortality risks to young adulthood (Michael A. Males, 1986; Peter Asch and David T. Levy, 1987, 1990).

In Figure 1, we present some illustrative descriptive evidence on the potential existence of this phenomenon. This figure shows the age profiles of population-weighted traffic fatality rates for two distinct groups of states in 1977 and in 1997. The top line in the figure identifies the 1977 fatality risk by age for the 12 states that had an MLDA of 21 since 1971.[4] In these states, all cohorts faced an MLDA of 21, and the traffic fatality risk increased as teens aged from 16 to 18, declined slightly though age 20, in-
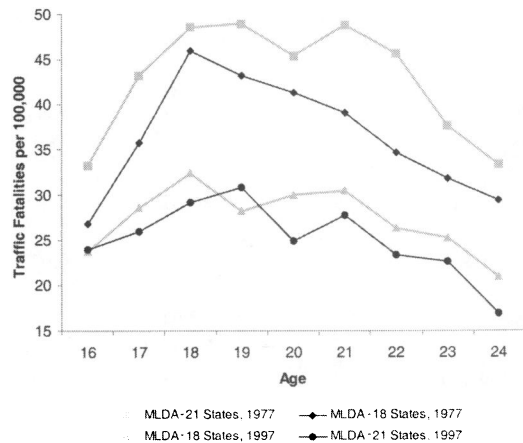

FIGURE 1. AGE PROFILE OF PASSENGER-VEHICLE FATALITY RISK BY STATE MINIMUM LEGAL DRINKING AGE (MLDA), 1977 AND 1997

creased again at age 21, then declined monotonically afterwards. The next line in this figure provides a telling contrast by identifying the contemporaneous fatality risk by age for the 12 states that had an MLDA of 18 from 1971 until it was raised to 21 in the 1980's.[5] Every age cohort in this group faced an MLDA of 18 since they were 18. In these states, traffic-fatality risk also increased as teens aged from 16 to 18 but declined monotonically for the remaining six age groups. The unique bimodal age profile in states with an MLDA of 21 suggests that delaying alcohol availability delays the fatalities associated with drunk-driving. This evidence implies that the nationwide increases in MLDA may have merely shifted some of the fatality risks from teens to young adults. The age profiles for each group of states in 1997 are also suggestive of this, since the bimodal age profile is evident for both groups in current data. In this section we revisit the age-substitution hypothesis using our extended state-level panel data from above.

The learning-by-doing hypothesis suggests that more experience with alcohol should reduce current traffic-related mortality. A variety of evidence indicates that teen exposure to low MLDA implies an increased experience with

[4] Alaska, California, Indiana, Kentucky, Missouri, New Mexico, Nevada, North Dakota, Oregon, Pennsylvania, Utah, and Washington.

[5] Colorado, Kansas, Louisiana, Mississippi, New York, North Carolina, Ohio, South Carolina, Tennessee, Virginia, West Virginia, and Wisconsin.

YOUTHS AND RISKY BEHAVIOR

TABLE 2—CONDITIONAL MAXIMUM-LIKELIHOOD ESTIMATES
OF A FIXED-EFFECTS NEGATIVE BINOMIAL MODEL
FOR PASSENGER-VEHICLE FATALITIES, AGES 22–24

State MLDA when cohort was 18	Age 22	Age 23	Age 24
18	−0.054 (0.038)	−0.027 (0.040)	−0.020 (0.041)
19	−0.075 (0.036)	−0.089 (0.038)	−0.037 (0.038)
20	0.046 (0.077)	−0.013 (0.084)	0.028 (0.083)
Dependent-variable mean:	25.5	22.9	20.6

Notes: Standard errors are reported in parentheses. There are 768 observations in each model (48 states over 16 years). The 22-year-old model is based on data from 1981 to 1996, the 23 year-old model on data from 1982 to 1997, and the 24 year-old model on data from 1983 to 1998. Each model also includes state and year fixed effects, two seat-belt-use-law variables, two speed-limit variables, the state unemployment rate, real state personal income per capita, and the natural log of the population for the given age.

alcohol and, in particular, drunk driving among teens. By implication, we would expect those at older ages (say 22) who faced an MLDA of 18 when they were 18 to have on average more experience with alcohol and drunk driving than those who faced an MLDA of 21 when they were 18. Therefore, we can test the learning-by-doing hypothesis by exploiting the changes in experience with alcohol generated by variation in state MLDA in effect in each state when a given age cohort was age 18. The results of such a test are reported in Table 2. Using state and year counts of passenger-vehicle fatalities as the dependent variable, we estimate a conditional maximum-likelihood fixed-effects negative binomial model for young adults aged 22, 23, and 24. In each case, the outcomes of interest are counts of passenger-vehicle fatalities. We include as covariates those variables used in the models from Table 1, with the exception that we do not include drinking-age variables, but we do introduce a variable for maximum state speed limits over 65 MPH. All groups can legally drink, but what varies across people is exposure to drinking at an early age. Subsequently, we include three indicators for the MLDA when the particular cohort was 18 years of age. The indicators represent MLDA's of 18, 19, and 20 at age 18 with the reference group being an MLDA of 21. These models correspond in time

period to the models in Table 1, so as a result, we adjust the time period of the sample for each age group. Whereas we used 1977–1992 period for those aged 16–19 in Table 1, we use the 1981–1996 period for 22-year-olds, 1982–1997 for the 23-year-olds, and 1983–1998 for the 24-year-olds.

In Table 2, we see a fairly persistent negative impact on fatalities of an MLDA of 18 and 19 when respondents were 18, with the largest and most precise impact being for an MLDA of 19 at age 18. Among 23- and 22-year-olds, those who faced an MLDA of 19 at age 18 had, respectively, 8.9- and 7.5-percent fewer passenger-vehicle fatalities than those who could drink legally at age 21. It may appear odd that exposure at age 18 to an MLDA of 19 should have a larger impact on fatalities later on in life than exposure to an MLDA of 18. This could reflect the relative lack of parental supervision at this age, which could have accelerated the learning-by-doing that occurred for those who started legal drinking at this age.

These estimates suggest that the magnitude of the mortality redistribution generated by movement from an MLDA of 19 to 21 is quite large. From Table 1, we see that an MLDA of 19 increases fatalities among 18- and 19-year-olds by 5.2 percent. On a mean fatality rate of 69.2, this is an increase of 3.6 fatalities per 100,000 people. Among 22- and 23-year-olds, an MLDA of 19 reduces fatalities by 7.5 percent and 8.9 percent, respectively. Given the sample means for these two groups, this is roughly a reduction of 3.9 fatalities per 100,000 people. In this one case, we find that moving from an MLDA of 19 to 21 simply shifts deaths into the future by a few years. While a higher MLDA will add life years to the population, such age-redistribution of deaths would certainly alter the perceived benefits of such policy. We should note, however, that for an MLDA of 18 at age 18, there is a persistent negative impact that diminishes over age, but none of these coefficients is statistically significant. Therefore, this evidence is only suggestive of age-redistribution of mortality in this case.

III. Conclusions

Behavioral policies such as seat-belt-use laws, minimum legal drinking ages, and some policies designed to limit drunk driving have

improved teen traffic safety over the past 20 years. However, these policies appear to explain only a modest fraction of the enormous gains in teen traffic safety. Furthermore, a sobering note of caution is warranted by evidence that some of the life-saving benefits of a higher MLDA may be attenuated by a redistribution of deaths over the life cycle. More generally, the existence of this phenomenon suggests that experiential learning may be an important component of teens' maturation through a variety of risky driving behaviors. The relevance of such learning-by-doing implies that the new "graduated licensing" systems may be an effective policy for generating further gains in teen traffic safety. Such licensing regulations require that new drivers acquire experience in low-risk settings before moving into more complex driving environments. These systems vary in their details (e.g., supervision requirements, driving curfews) but generally consist of three distinct stages: a learning period during which direct supervision is required, an intermediate period that may allow for unsupervised driving in low-risk situations, and full licensure. In recent years, these regulations have been widely adopted in the United States. Since 1996, nearly all states have implemented at least some component of graduated licensing. Unfortunately, these experiences are too recent to evaluate with the currently available data. The results presented here suggest that these policies could be effective, but also that a full evaluation should track the treated cohorts over several years.

REFERENCES

Asch, Peter and Levy, David T. "Does the Minimum Drinking Age Affect Traffic Fatalities?" *Journal of Policy Analysis and Management*, Winter 1987, *6*(2), pp. 80–92.

_____ . "Young Driver Fatalities: The Role of Drinking Age and Drinking Experience." *Southern Economic Journal*, October 1990, *57*(2), pp. 512–20.

Dee, Thomas S. "State Alcohol Policies, Teen Drinking and Traffic Fatalities." *Journal of Public Economics*, May 1999, *72*(2), pp. 289–315.

Dee, Thomas S. and Evans, William N. "Teens and Traffic Safety," in Jonathan Gruber, ed., *An economic analysis of risky behavior among youths*. Chicago: University of Chicago Press, 2001 (forthcoming).

DeJong, William and Hingson, Ralph. "Strategies to Reduce Driving Under the Influence of Alcohol." *Annual Review of Public Health*, 1998, *19*, pp. 359–78.

Evans, Leonard. "The Effectiveness of Safety Belts in Preventing Fatalities." *Accident Analysis and Prevention*, June 1986, *18*(3), pp. 229–41.

Hausman, Jerry; Hall, Bronwyn H. and Griliches, Zvi. "Econometric Models for Count Data with an Application to the Patents–R&D Relationship." *Econometrica*, July 1984, *52*(4), pp. 909–38.

Levitt, Steven D. and Porter, Jack. "Estimating the Effect of Alcohol on Driver Risk Using Only Fatal Accident Statistics." National Bureau of Economic Research (Cambridge, MA) Working Paper No. 6944, February 1999a.

_____ . "Sample Selection in the Estimation of Air Bags and Seat Belt Effectiveness." National Bureau of Economic Research (Cambridge, MA) Working Paper No. 7210, July 1999b.

Males, Michael A. "The Minimum Purchase Age for Alcohol and Young-Driver Fatal Crashes: A Long-Term View." *Journal of Legal Studies*, January 1986, *15*(1), pp. 181–211.

Peltzman, Sam. "The Effects of Automobile Safety Regulation." *Journal of Political Economy*, August 1975, *83*(4), pp. 677–725.