DOES THE MINIMUM LEGAL DRINKING AGE SAVE LIVES?

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The minimum legal drinking age (MLDA) is widely believed to save lives by reducing traffic fatalities among underage drivers. Further, the Federal Uniform Drinking Age Act, which pressured all states to adopt an MLDA of 21, is regarded as having contributed enormously to this life-saving effect. This article challenges both claims. State-level panel data for the past 30 yr show that any nationwide impact of the MLDA is driven by states that increased their MLDA prior to any inducement from the federal government. Even in early-adopting states, the impact of the MLDA did not persist much past the year of adoption. The MLDA appears to have only a minor impact on teen drinking. (*JEL* H11, K42)

I. INTRODUCTION

The Federal Uniform Drinking Age Act (FUDAA), signed by President Ronald Reagan on July 17, 1984, threatened to withhold highway construction funds from states that failed to increase their minimum legal drinking age (MLDA) to 21 by October 1, 1986. Some states complied without protest, but many states balked and sued the federal government to prevent implementation of the Act. In *South Dakota v. Dole (1987)*, however, the U.S. Supreme Court ruled the Act constitutional. The Court decided that the "relatively small financial inducement offered by Congress" was not so coercive "as to pass the point at which pressure turns into compulsion." The Court argued, in particular, that reducing traffic fatalities among 18- to 20-yr-olds was sufficient reason for the federal government to intervene in an arena traditionally reserved to states.[1]

Research subsequent to the Court's decision appears to confirm that raising the MLDA saves lives and much of it points to the FUDAA in particular. Relying on this research, the National Highway Traffic Safety Administration (NHTSA) attributes substantial declines in motor vehicle fatalities to federal and state traffic safety policies, particularly the MLDA21. For example, NHTSA estimates the cumulative number of lives saved by the MLDA21 at 21,887 through 2002 (NHTSA's National Center for Statistics and Analysis 2005a).

We challenge the view that MLDAs reduce traffic fatalities based on three findings. First, the overall impact estimated in earlier research is driven by states that increased their MLDA prior to any inducement from the federal government. Second, even in early-adopting states, the impact of the MLDA did not persist much past the year of adoption. Third, the MLDA has at most a minor impact on teen drinking.

ABBREVIATIONS

BAC: Blood Alcohol Concentration
FARS: Fatality Analysis Reporting System
FUDAA: Federal Uniform Drinking Age Act
MLDA: Minimum Legal Drinking Age
NCLB: No Child Left Behind Act
NHTSA: National Highway Traffic Safety Administration
TFR: Traffic Fatality Rate
VMT: Vehicle Miles Traveled

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1. In her dissent, Justice Sandra Day O'Connor expressed skepticism that a uniform drinking age of 21 across the United States would have the "life-saving" effects that might justify federal encroachment on rights afforded to states under the Tenth Amendment to the Constitution (*South Dakota v. Dole 1987*). At least one of the authors of this article believes that irrespective of whether the MLDA saves lives, the FUDAA violates states' rights to legislate MLDAs, which are preserved by the Tenth and Twenty-First Amendments to the U.S. Constitution.

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The remainder of the article is organized as follows. Section II outlines the history of the MLDA and reviews the preexisting literature. Section III examines aggregate trends in the key variables. Section IV describes the state-level data set and presents panel estimates of the relation between the MLDA and the traffic fatalities. Section V investigates the effects of the MLDA on teen drinking.

II. HISTORICAL BACKGROUND AND PRIOR LITERATURE

When the United States repealed Alcohol Prohibition in 1933, the Twenty-First Amendment left states free to legalize, regulate, or prohibit alcohol as they saw fit. Most legalized but also enacted substantial regulation. This new regulation typically included an MLDA.

Table 1 gives the MLDA set by each state after Prohibition ended.[2] State reactions to federal repeal varied from Alabama maintaining state-level prohibition to Colorado legalizing alcohol without a minimum drinking age. In general, states set an MLDA between 18 and 21. In 1933, 32 states had an MLDA of 21 and 16 states had an MLDA between 18 and 20. With few exceptions, these MLDAs persisted through the late 1960s.

Between 1970 and 1976, 30 states lowered their MLDA from 21 to 18. These policy changes coincided with national efforts toward greater enfranchisement of youth, exemplified by the Twenty-Sixth Amendment granting 18- to 20-yr-olds the right to vote. The reasons for lowering the MLDA are not well understood and may have varied by state. Perhaps the changes reflected Vietnam-era logic that a person old enough to die for America is old enough to drink (Asch and Levy 1987; Mosher 1980). Whatever the reasons, the lower MLDAs "enfranchised" over five million 18- to 20-yr-olds to buy alcohol (Males 1986, p. 183).

Soon after the reductions in the MLDAs, empirical studies claimed that traffic collisions and fatalities were increasing in states that lowered their MLDA. Most prominently featured in congressional discussion were two comprehensive, multistate studies on the "life-saving" effects of raising the MLDA—the Insurance Institute for Highway Safety study and the National Transportation Safety Board study. According to Males (1986), both studies were referred to more than 50 times in the House and Senate debates, "almost to the exclusion of all other research on the question" (p. 182).[3] These research findings played a key role in reversing the trend toward lower MLDAs. The justification for the FUDAA, espoused by organizations including the Presidential Commission on Drunk Driving, the American Medical Association, and the National Safety Council, was that higher MLDAs resulted in fewer traffic fatalities among 18- to 20-yr-olds (Males 1986).

TABLE 1
MLDA Levels in States after Repeal of Prohibition, 1933

AL	Alcohol prohibited	KY	21	ND	21
AK	18	LA	21	OH	16
AZ	21	ME	18	OK	21
AR	21	MD	21	OR	21
CA	21	MA	21	PA	21
CO	None	MI	18	RI	21
CT	21	MN	21	SC	18
DE	21	MS	18	SD	18
DC	18	MO	21	TN	21
FL	21	MT	21	TX	21
GA	21	NE	20	UT	21
HI	20	NV	21	VT	18
ID	20	NH	21	VA	18
IL	21	NJ	21	WA	21
IN	21	NM	21	WV	18
IA	21	NY	21	WI	18
KS	18	NC	18	WY	21

After passage of the FUDAA, all states adopted an MLDA21 by the end of 1988. Table 2 gives the most recent date each state switched to an MLDA21. Several states were early adopters (Michigan, Illinois, Maryland, and New Jersey), increasing their MLDAs before passage of the FUDAA. Other states were less eager to change. For example, Colorado, Iowa, Louisiana, Montana, South Dakota, Texas, and West Virginia passed MLDA21 legislation, but each provided for repeal if the FUDAA were held unconstitutional (DISCUS Office of Strategic and Policy Analysis 1996). Texas and Kansas enacted "sunset provisions" allowing

2. This table indicates the MLDA for beer with greater than 3.2% alcohol content. The previous literature has generally ignored that different alcohol types have different MLDAs. We consider this issue below.

3. Males (1986) argues that the two studies suffered from methodological and data limitations and had undeserved influence over the federal decision to intervene in state drinking age laws.

TABLE 2
States' Most Recent Date of Adopting an MLDA of 21 (month/year)

AL	10/85	KY	05/38	ND	12/36
AK	10/83	LA	03/87	OH	08/87
AZ	01/85	ME	07/85	OK	09/83
AR	03/35	MD	07/82	OR	12/33
CA	12/33	MA	06/85	PA	07/35
CO	07/87	MI	12/78	RI	07/84
CT	09/85	MN	09/86	SC	09/86
DE	01/84	MS	10/86	SD	04/88
DC	10/86	MO	05/45	TN	08/84
FL	07/85	MT	05/87	TX	09/86
GA	09/86	NE	01/85	UT	03/35
HI	10/86	NV	12/33	VT	07/86
ID	04/87	NH	06/85	VA	07/85
IL	01/80	NJ	01/83	WA	01/34
IN	01/34	NM	12/34	WV	07/86
IA	07/86	NY	12/85	WI	09/86
KS	07/85	NC	09/86	WY	07/88

the MLDA to drop back to previous levels once federal sanctions expired (DISCUS Office of Strategic and Policy Analysis 1996). When the Supreme Court upheld the constitutionality of the FUDAA, states faced a strong incentive to maintain an MLDA21. Nevertheless, the differences in how states initially responded suggest a policy endogeneity that needs to be addressed.

Several authors have recently summarized the MLDA literature, so we do not review specific articles in detail (Shults et al. 2001; Wagenaar and Toomey 2002). Overall, the existing research finds a negative relationship between the MLDA and traffic fatalities, but most studies omit key variables and mainly analyze either cross-sectional data from 1 yr or time series data in one state (Ruhm 1996).[4]

The most important exception to this summary is Dee (1999), who uses state-level panel data and controls for state fixed effects, state trends, year dummies, and other variables. Dee's estimates "suggest that the movement to [a] higher MLDA reduced ... traffic fatalities by at least 9%" (Dee 1999, p. 314). Dee's analysis forms the starting point for the empirical work below.

In addition to considering the impact of the MLDA on traffic fatalities, earlier literature also considers how the MLDA affects teen drinking.[5] Kaestner (2000) explains that most studies use cross-sectional data and fail to control for unmeasured state characteristics affecting both alcohol consumption and minimum drinking ages. Again, Dee (1999) is an exception. Using the same techniques just described, Dee concludes that moving away from an MLDA of 18 is associated with a reduction in heavy teen drinking of 8.4%. More recently, Carpenter et al. (2007) extend Dee's sample by 11 yr to include data through 2003. They find that "nationwide increases in the MLDA ... reduced youth drinking by about four percent relative to pre-existing levels" (p. 2).[6] They acknowledge, however, that adoption of the MLDA21 might have increased underreporting.

III. AN OVERVIEW OF THE AGGREGATE DATA

Before examining state-level regressions that relate traffic fatality rates (TFRs) to MLDAs, we examine aggregate plots of the key variables. The reason is that state-level data on traffic fatalities are not available until the mid-1970s, but aggregate data on total and 15- to 24-yr-old fatalities exist back to 1913. The 18- to 20-yr-old population is most relevant for the issues in this article, but data for this age range are not available until 1975. The 18–20 fatality rate and the 15–24 fatality rate are highly correlated, however, as shown in Figure 1, so examination of the 15–24 TFR is likely informative.

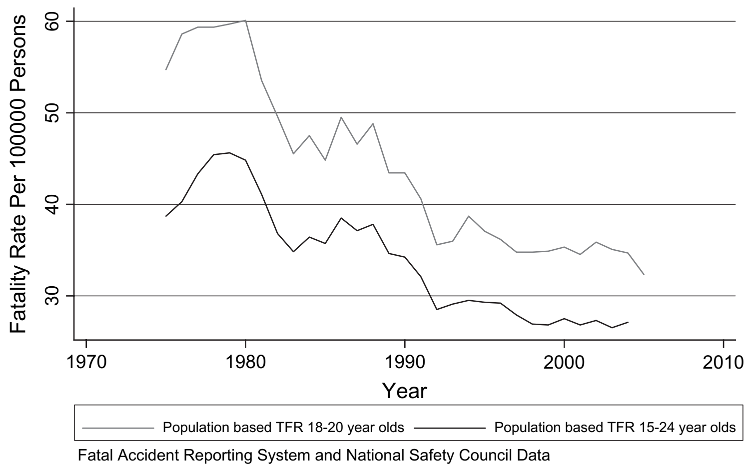
Figure 2 presents the TFR for the total population and for 15- to 24-yr-olds for the period 1913–2004. These two series follow

4. Several recent articles have also examined the impact of the MLDA. Ponicki, Gruenewald, and LaScala (2007) find a negative effect of MLDAs on fatalities, but they do not control for preexisting trends. Lovenheim and Slemrod (2008) find heterogeneous impacts depending on the distance of a given jurisdiction from a lower MLDA location; when a lower MLDA location is close to a higher MLDA location, the disparity in MLDAs increases fatalities. These results imply that equalization of MLDAs across locations is a crucial policy parameter. Carpenter and Dobkin (2007) employ a regression discontinuity design and find that both alcohol consumption and alcohol-related causes of death jump at age 21. Their results do not indicate, however, whether this effect would occur at any age at which youths discretely gained increased access to alcohol. It is also possible that underlying determinants of alcohol-related deaths (e.g., driving to work, experiencing work-related pressure that might increase suicide) are strongly correlated with turning 21.

5. These studies rely on self-reports of alcohol consumption. Outlawing a behavior, however, might reduce the degree of self-reporting.

6. An MLDA of 18 is the most permissive MLDA in the sample.

FIGURE 1
Population-Based TFR18–20 & TFR15–24, 1975–2004



similar patterns over the past 90 yr. Both TFRs increased from 1913 to 1969 and then decreased thereafter. This similarity fails to suggest a major impact of the MLDA, which should have affected the 15–24 TFR more than the total TFR. The marked decline in the TFR during this period also contravenes claims of a rapid increase in traffic fatalities after several states decreased their MLDAs between 1970 and 1973. The declines in the total and 15–24 TFR that began around 1969 long precede the adoptions of an MLDA of 21 in the mid-1980s.

The data in Figure 2 do not control for the vehicle miles traveled (VMT) each year, which have increased enormously over the past century. Figure 3 shows that fatalities per VMT exhibit a persistent downward

FIGURE 2
Population-Based Fatality Rate 1913–2004, Total Population and 15- to 24-Yr-Olds

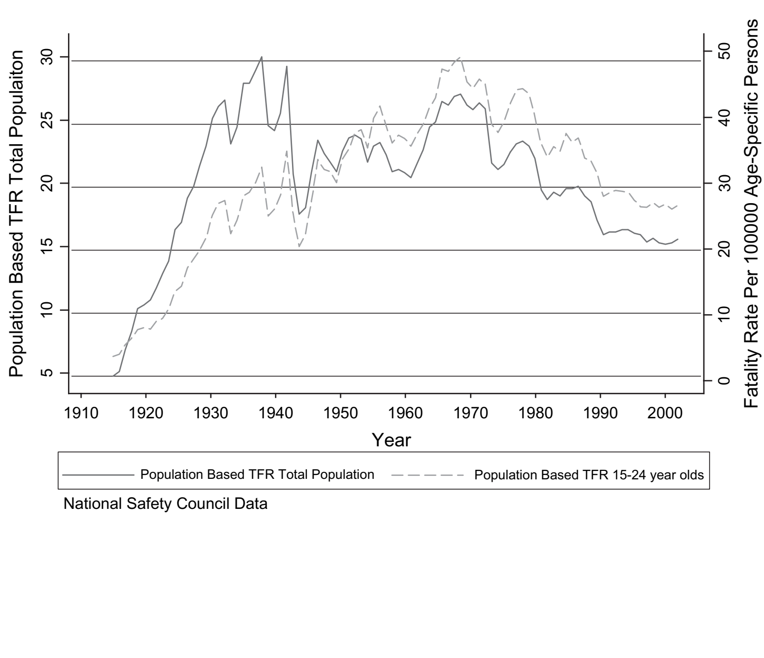
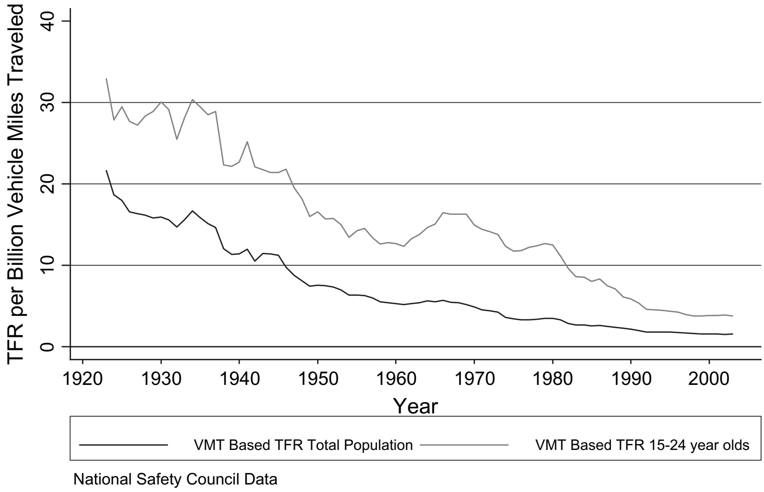


FIGURE 3
TFR per VMT 1923–2003, Total Population and 15- to 24-Yr-Olds



trend over the entire sample period. The 15–24 TFR does seem to increase slightly beginning in the 1960s, even when controlling for VMT, but the decline returns around 1969 prior to passage of the FUDAA.

Figure 4 plots the average MLDA for all 50 states against the (VMT based) TFR for the 15- to 24-yr-old age cohort.[7] While the average MLDA remained at approximately 20 between 1944 and 1970, traffic fatalities continued to decrease for years and then increased. Then, in the early 1970s, several states lowered their MLDAs, reducing the average to below 19. Yet, the brief increase in TFRs that occurred in the latter half of the 1970s looks modest in comparison to the larger, downward trend that preceded these changes to the MLDA. Previous studies that focused on the late 1970s and the early 1980s were unlikely to see this longstanding trend. Overall, the TFR has been decreasing steadily since 1969, but most of the variation in the MLDA occurred in the 1980s. The one major increase in traffic fatalities, from 1961 to 1967, occurred while the average MLDA remained constant.

The key fact about TFRs, therefore, is that they have been trending downward for decades and have been poorly correlated with the MLDAs. Moreover, several other factors likely played a role in this downward movement. These factors include advances in medical technology, advances in car design (air bags, antilock brakes, seat belts, and safety glass), and improved education about driving strategies and the risks associated with motor vehicles (Houston, Richardson, and Neeley 1995).[8]

The aggregate data thus provide little confirmation that MLDAs reduce traffic fatalities. These data also suggest the importance of controlling for preexisting trends. We address this concern in the analysis that follows.

IV. DATA AND RESULTS

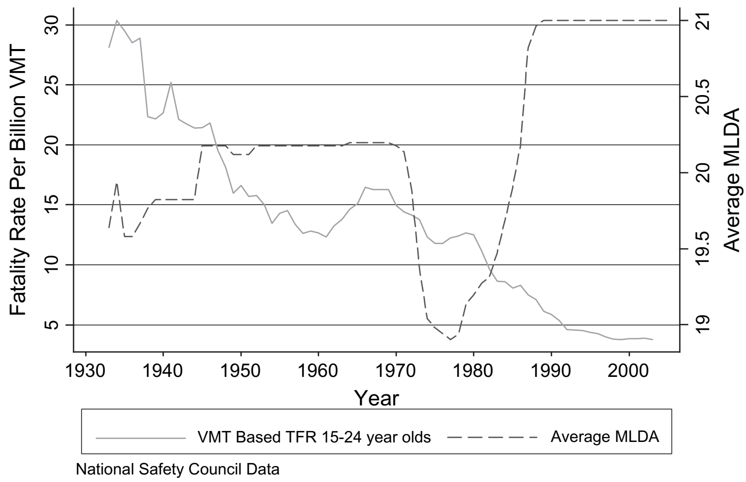
We next examine the relation between MLDAs and traffic fatalities using state-level panel data. This approach is better targeted than the aggregate approach considered above since it allows us to compare fatalities within each state to changes in the MLDA in that state.

We measure traffic fatalities using the Fatality Analysis Reporting System (FARS). FARS contains the characteristics of vehicles, drivers, occupants, and nonoccupants involved in all

7. We obtain similar results with a population-weighted, average MLDA.

8. Harris et al. (2002) find that "the downward trend in lethality [of criminal assault] involves parallel developments in medical technology and related medical support services." These appear to have brought down the homicide rate even as aggravated assault rates remained constant.

FIGURE 4
VMT-Based TFR 15- to 24-Yr-Olds versus Average MLDA, 1933–2004



recorded fatal motor vehicle accidents in the United States. Dee (1999) uses the FARS to construct a panel data set for the 48 contiguous states over the period 1977–1992.[9] We reconstruct Dee's (1999) data set and extend it to include Alaska, Hawaii, and Washington, DC, and the years 1976 and 1993–2005. We focus on 18- to 20-yr-old fatalities because this group is most directly affected by changes in MLDA laws. Robustness checks reported later examine younger and older age groups.

We merge the FARS data with population information from the Census Bureau to construct age-specific vehicular fatality rates. We also include the unemployment rate, real per capita personal income, a binary indicator for whether a state has a mandatory seat belt law, the blood alcohol concentration (BAC) limit for legal driving, beer taxes, and total VMT. The last variable is a proxy for the VMT by 18- to 20-yr-olds, as mileage data are not age specific. The Data Appendix provides details on construction of the data set. Table 3 presents summary statistics.[10,11]

We omit several potentially relevant policies, in part because of data availability, in part to conform with Dee (1999), and in part because previous studies have found limited evidence of any impact on TFRs. These variables include dram shop liability laws, mandatory sentences for driving under the influence, sobriety check points, antiplea bargaining statutes, changes in tort liability laws that place greater responsibility with intoxicated drivers, happy hour regulations, and alcohol education programs.[12]

Using this data set, we estimate:

$$\begin{aligned}\ln(\mathrm{TFR}_{\mathrm{st}}/(1-\mathrm{TFR}_{\mathrm{st}})) = {} & \beta_1 \mathrm{MLDA}_{\mathrm{st}} \\ & + \beta_2 Controls_{\mathrm{st}} \\ & + \beta_3(\text{state trend}) \\ & + u_{\mathrm{s}} + v_t + e_{\mathrm{st}},\end{aligned} \tag{1}$$

where β_1 is the point estimate of how MLDA laws influence traffic fatalities, *Controls* is a vector of determinants of traffic fatalities, β_3 measures the impact of linear trends for each state, u_{s} is a state fixed effect, v_t is a year effect, and e_{st} is a mean zero random error.

9. We thank Dee for generously providing us with some of the data used to replicate his 1999 article.

10. We also investigated specifications that included the percent urban and the percent urban interacted with MLDA21. This had no significant impact on the results.

11. For recent research on some of these determinants of alcohol consumption, see Freeman (2007), Carpenter and Stehr (2007), and Grant (2008a, 2008b).

12. An additional variable to consider is a measure of enforcement of MLDAs. The evidence in Wagenaar and Wolfson (1994), however, suggests that enforcement is too low to have any impact on the results examined here.

TABLE 3
Summary Statistics for Variables Used in the Construction of the Dependent Variables and Endogenous Regressors, 1976–2005

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
MLDA	1,530	20.39	1.11	18	21
Total fatality rate	1,530	19.39	7.12	5.52	59.51
18–20 fatality rate	1,530	43.36	18.53	0	168.41
17 and under fatality rate	1,530	9.87	3.98	0.79	31.28
21–23 fatality rate	1,530	38.55	15.92	0	161.72
25–29 fatality rate	1,530	26.83	11.41	1.50	95.28
Per capita personal income	1,530	19,165.38	8,603.89	4,744	54,985
State unemployment rate	1,530	5.96	2.00	2.30	17.4
Total VMT	1,530	42,410.23	46,065.99	2,527	32,9267
BAC .08 Limit	1,530	0.20	0.40	0	1
Seat belt law	1,530	0.57	0.49	0	1
Beer tax	1,520	0.52	0.18	0.24	1.86

Note: Fatality rates are per hundred thousand members of the age-specific state population.

We choose this form for the dependent variable to follow Dee (1999). We estimate this specification using weighted least squares. If TFR_{st} is the traffic fatality rate and the regressand is $\ln(TFR_{st}/(1 - TFR_{st}))$, then the error term is heteroscedastic, with variance $(TFR_{st}(1 - TFR_{st})n_{st})^{-1}$, where n_{st} is the age-specific population for the fatality rate (Ruhm 1996). In contrast to Dee, we cluster standard errors by state, although this makes little difference to the results. We model the MLDA using separate variables for an MLDA of 19, 20, or 21 (all other states have 18).

Table 4 reports estimates of Equation (1).[13] Model (1) uses Dee's sample and replicates his results closely. In this specification, an MLDA21 reduces traffic fatalities by 11.7%.[14] The insignificant coefficients on an MLDA19 and an MLDA20 are in accordance with Dee's findings. Model (2) extends the sample to include Alaska, Hawaii, and the District of Columbia, as well as the years 1976 and 1993–2005. This confirms Dee's findings that an MLDA21 reduces total traffic fatalities among 18- to 20-yr-olds by about 11%. Model (3) adds VMT, one variable that is available by state but that Dee did not include, and a dummy for whether the state has a BAC .08 per se law. This reduces the magnitude of the coefficient on MLDA21 to roughly 8%, but the significance remains. Models (2) and (3) report standard errors clustered by state. The significance of MLDA21 persists, though neither MLDA19 nor MLDA20 is significant.

The small and insignificant coefficients on MLDA19 and MLDA20 present a mild challenge to the claim that the MLDA reduces traffic fatalities. If restricting access to alcohol works as typically assumed, then although the MLDA21 should have the largest impact, the MLDA19 and MLDA20 should also reduce fatalities. This anomaly is not decisive because few states used an MLDA of 19 or 20, so the weak results might just reflect noise. Nevertheless, the coefficients are not always negative and never significant.

The results so far support two claims. Panel data estimates suggest a substantial and statistically significant impact of the MLDA21. Aggregate data, however, make at most a weak case, so the overall conclusion is not clear. To reconcile these different estimates, we conduct a state-by-state analysis of how the MLDA affects traffic fatalities.

Figure 5 graphs TFR18–20 in several states, along with an indicator for whether the state adopted an MLDA21. In South Carolina, TFR18–20 was increasing rapidly prior to adoption and then began a marked decline, consistent with an effect of the MLDA21 in reducing 18- to 20-yr-old fatalities. In California, however,

13. The panel data set begins in 1976 because state unemployment rates are not available prior to that year.

14. The slight difference between our findings and Dee's likely results from revised Census Bureau population data.

TABLE 4
Weighted Least Squares Estimates of Teen Traffic Fatality Equation, 18- to 20-Yr-Olds

Specification	Dee (1999) Published Results	Model (1) Replication of Dee (1999)	Model (2) Dee (1999) Extended 13 yr, plus Hawaii, Alaska, and District of Columbia	Model (3) Model (2) Controlling for VMT and BAC .08
MLDA19	−0.022 (1.06)	−0.028 (0.022)	−0.021 (0.023)	−0.014 (0.021)
MLDA20	−0.009 (0.22)	0.007 (0.053)	−0.012 (0.036)	−0.004 (0.034)
MLDA21	−0.110 (3.98)***	−0.117 (0.031)***	−0.110 (0.032)***	−0.08 (0.032)**
BEERTAX	0.351 (1.66)	0.352 (0.237)	−0.223 (0.134)*	
Constant		128.318 (32.287)***	65.950 (23.788)***	75.177 (19.260)***
State fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
State trends	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Clustered standard errors	No	No	Yes	Yes
Observations	758	758	1,519	1,519
R^2	.88	.88	.87	.87
Years	1977–1992	1977–1992	1976–2005	1976–2005

Notes: The dependent variable is the natural logarithm of $\mathrm{TFR}_{st}/(1 - \mathrm{TFR}_{st})$, where TFR_{st} is the 18- to 20-yr-old total fatality rate for state s at time t. The estimations are weighted by $n(\mathrm{TFR}_{st})(1 - \mathrm{TFR}_{st})$, where n is 18- to 20-yr-old population in state s at time t. Dee's results, as well as Models (1) and (2), include variables controlling for the state unemployment rate, state average per capita personal income, the beer tax rate in the state, and a binary indicator for any mandatory seat belt law. Additionally, Model (3) controls for whether the state has a BAC .08 law and VMT within the state. Robust standard errors are reported below point estimates for Models (1)–(3). Standard errors clustered by state are reported for Models (2) and (3). Dee's original results were reported with t statistics instead of standard errors and are reproduced as such.

*Significant at 10%; **significant at 5%; ***significant at 1%.

TFR18–20 also declined dramatically even though the MLDA was 21 throughout. In South Dakota and Louisiana, TFR18–20 declined prior to the increase in the MLDA and seems to have decreased at a slower rate after MLDA21 adoption.[15] These four graphs, therefore, show a wide range of "impacts" of the MLDA. Plots for all 50 states confirm substantial heterogeneity in MLDA21's effect.

To examine this in more detail, Table 5 presents state-by-state estimates of the effects of the MLDA. Of the 38 states that increased their MLDA over the post-1975 time period, the MLDA21 reduced fatalities in six at the 5% level and in nine at the 10% level. At the same time, however, the MLDA21 increased fatalities in four states at the 5% level and in five at the 10% level. In 11 states, the coefficient on MLDA is positive but insignificant, while in 13, it is negative but insignificant.

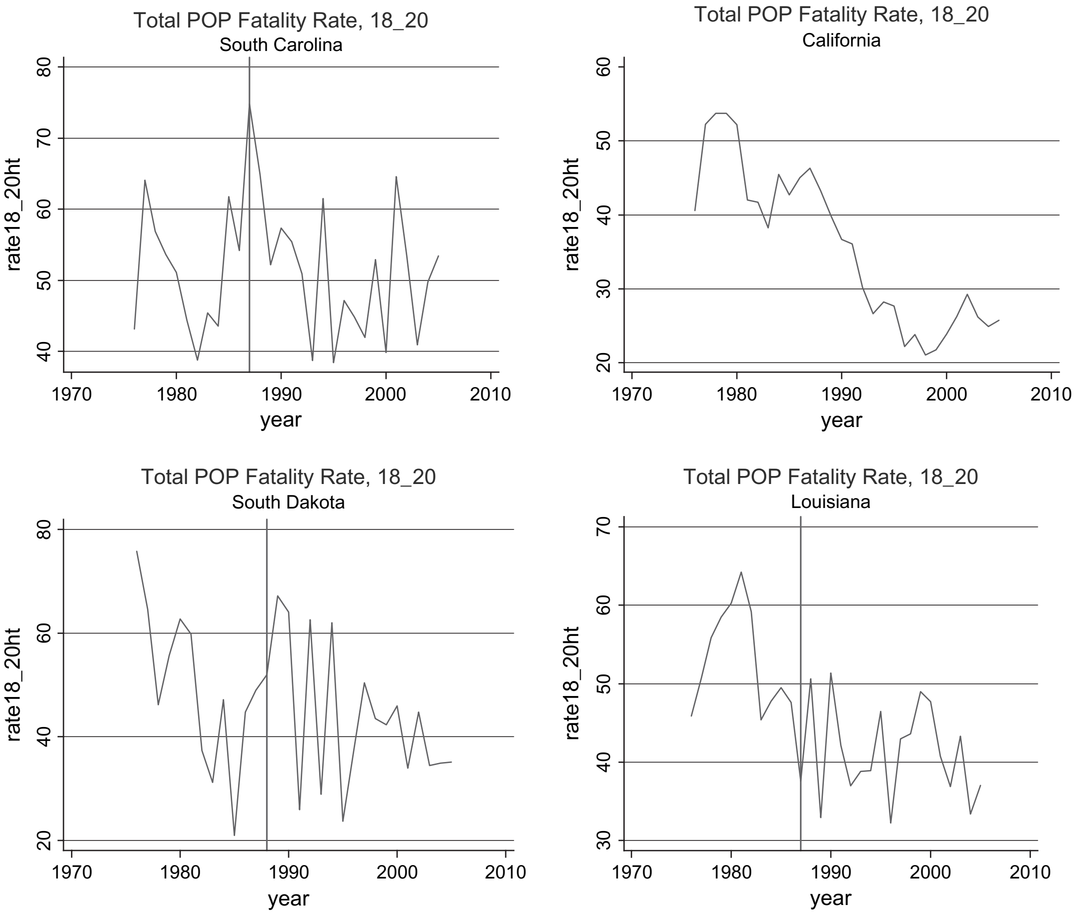
This heterogeneity suggests Dee's results are driven by a few states in which the impact is sufficiently negative to outweigh the positive or small impact in most states. The question is whether this heterogeneity is just sampling variation or something more systematic. We show below that the overall negative impact results from states that adopted the MLDA21 before 1984—that is, before the FUDAA.

Table 6 presents evidence for this claim. Model (1) repeats Model (1) from Table 4 for ease of comparison. Model (2) restricts the sample to those states that adopted the MLDA21 after 1979; this eliminates all states that had an MLDA21 prior to when FARS began collecting data. The results are robust across this change in specification. Model (3) restricts the sample to those states that changed to an MLDA21 during or after 1983.[16] Again the MLDA21 is significant, with a point estimate of −0.07.

15. South Dakota and Louisiana were two states that challenged the constitutionality of the FUDAA.

16. No states changed their MLDA to 21 in 1981 or 1982.

FIGURE 5
Average Total Fatality Rate per 100,000 18- to 20-Yr-Olds, 1976–2005



POP, population.

Model (4), however, which restricts the sample to states that changed their MLDA to 21 during or after 1984, results in a lower point estimate (−0.058) that is not significant at even the 10% level. Model (5), which restricts the sample to those states that changed the MLDA after 1984, produces a coefficient on MLDA21 near zero with a *t* statistic of −.21.[17] Model (6) excludes, Illinois, Maryland, Michigan, and New Jersey, the four earliest states to change their MLDA back to 21, each doing so on or before January 1983. When the sample excludes these states, the significance of MLDA21 disappears and its magnitude drops to −0.035.[18]

The year 1984 is when the federal government became directly involved in state-level MLDA legislation. The federal government's threat to withhold highway funding from states is arguably an exogenous shock to state-level MLDA policy. Thus, if causality is to be attributed to the MLDA, inference should focus especially on states that increased their MLDAs in response to this exogenous pressure. Yet, the results for these states show virtually no effect of the MLDA21. Those states driving the relation between MLDA21 and

17. The MLDA laws were coded such that a year cell has an MLDA21 indicator of 1 if the MLDA of 21 was in effect for at least half that year. As the FUDAA was passed in July, Model (4) includes states that adopted an MLDA21 before its passage. Model (5) differs in including states that adopted an MLDA21 after 1984.

18. These results are robust across specifications that allow for quadratic state trends.

TABLE 5
State-by-State Ordinary Least Squares Estimates with Newey-West HAC Standard Errors of MLDA Regressed on Total Traffic Fatalities among 18- to 20-Yr-Olds, 1976–2005

State	MLDA	Standard Errors	State	MLDA	Standard Errors
AL	0.065	0.054	MT	0.168	0.054***
AK	−0.406	0.206*	NE	−0.034	0.127
AZ	−0.065	0.054	NV		
AR			NH	−0.153	0.146
CA			NJ	−0.176	0.032***
CO	0.063	0.031*	NM		
CT	−0.244	0.071***	NY	0.007	0.053
DE	0.092	0.158	NC	−0.124	0.024***
FL	0.076	0.07	ND		
GA	−0.018	0.028	OH	−0.012	0.028
HI	0.356	0.144**	OK	−0.055	0.024**
ID	−0.023	0.093	OR		
IL	−0.066	0.059	PA		
IN			RI	−0.31	0.123**
IA	−0.102	0.068	SC	0.166	0.052***
KS	0.102	0.034***	SD	0.092	0.11
KY			TN	0.015	0.086
LA	−0.05	0.029	TX	−0.056	0.035
ME	0.078	0.091	UT		
MD	−0.104	0.025***	VT	0.038	0.031
MA	0.04	0.129	VA	0.097	0.075
MI	−0.1	0.053*	WA		
MN	−0.116	0.128	WV	−0.176	0.126
MS	0.013	0.033	WI	−0.055	0.034
MO			WY	−0.142	0.089

Notes: The dependent variable is the natural logarithm of $\text{TFR}_t/(1 - \text{TFR}_t)$, where TFR_t is the 18- to 20-yr-old total fatality rate at time t. States with blank cells are ones that had already had in place an MLDA of 21 before 1976 and thus had no variation in MLDA over the past 30 yr. The regressions include controls for the state unemployment rate, state average per capita personal income, the beer tax rate in the state, total vehicle miles traveled in the state, the BAC limit for driving in a state, and a binary indicator for any mandatory seat belt law. Newey-West HAC (heteroskedasticity and autocorrelation consistent) standard errors are reported.

*Significant at 10%; **significant at 5%; ***significant at 1%.

TFR18–20 are the ones that proactively changed their MLDA legislation prior to federal involvement.

These results suggest that, at most, the MLDA21 reduced TFR18–20 in states that adopted the policy on their own. This raises the question of endogeneity. The MLDA21 in these states may have been enacted in response to grassroots concern against drunk driving or implemented alongside other efforts to reduce traffic fatalities. Relatedly, states that adopted on their own may have been states that devoted significant resources to enforcement.

To address the possible endogeneity of MLDA legislation, we modify the specification of the MLDA variable. Instead of a dummy for years in which it is in effect, we include several binary variables representing an interval of time in relation to the date a state enacted an MLDA21. For example, the binary variable "5-6 Before" is equal to 1 for every state year that is 5–6 yr before a state adopted an MLDA of 21. The other intervals included in the regressions are "3-4 Before," "1-2 Before," "Year of Enactment," "1-2 After," "3-4 After," "5-6 After," "7-8 After," and "9-10 After." This empirical strategy improves on the approach in Section IV because the time pattern of policy effects informs both the extent of policy endogeneity and the persistence of the policy's effect.

Table 7 gives estimates of this alternative specification; Figures 6–9 plot the coefficients and standard error bands on the MLDA21 variables. Model (1) supports the claim that

TABLE 6

Weighted Least Squares Estimates of Total Traffic Fatality Equation 18- to 20-Yr-Olds, 1976–2005, Samples Restricted by Year States Adopted an MLDA of 21

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Specification	**Not Restricted**	**States that Changed MLDA to 21 before 1980**	**States that Changed MLDA to 21 before 1983**	**States that Changed MLDA to 21 between 1984 and 2005**	**States that Changed MLDA to 21 between 1985 and 2005**	**All States 1975–2005, without Illinois, Michigan, Maryland, New Jersey**
MLDA19	−0.014 (0.021)	−0.01 (0.019)	−0.011 (0.021)	−0.01 (0.021)	−0.008 (0.022)	−0.013 (0.022)
MLDA20	−0.004 (0.034)	0.001 (0.036)	0.003 (0.036)	0.004 (0.036)	0.014 (0.039)	0.004 (0.035)
MLDA21	−0.08 (0.032)**	−0.087 (0.030)***	−0.069 (0.034)**	−0.058 (0.037)	−0.008 (0.037)	−0.035 (0.037)
Constant	75.177 (19.260)***	67.985 (24.944)***	71.45 (25.074)***	74.904 (25.271)***	73.781 (28.895)**	79.8 (20.110)***
State fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
State trends	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Clustered standard errors	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,519	1,129	1,099	1,069	949	1,399
R^2	.87	.87	.86	.86	.86	.86

Notes: The dependent variable is the natural logarithm of $TFR_{st}/(1 - TFR_{st})$, where TFR_{st} is the 18- to 20-yr-old total fatality rate for state s at time t. The estimations are weighted by $n(TFR_{st})(1 - TFR_{st})$, where n is 18- to 20-yr-old population in state s at time t. All models include variables controlling for the state unemployment rate, state average per capita personal income, the beer tax rate in the state, VMT within state, the BAC limit for driving in a state, and a binary indicator for any mandatory seat belt law. They also allow for linear state trends. Robust standard errors are reported below point estimates.

**Significant at 5%; ***significant at 1%.

TABLE 7
Weighted Least Squares Estimates of Total TFR 18- to 20-Yr-Olds, 1976–2005, Samples Restricted by Year States Adopted an MLDA of 21

Specification	Model (1) Not Restricted	Model (2) States that Changed MLDA to 21 before 1983	Model (3) States that Changed MLDA to 21 between 1984 and 2005	Model (4) States that Changed MLDA to 21 between 1985 and 2005
5–6 yr before	0.022 (0.026)	−0.061 (0.059)	0.023 (0.034)	0.023 (0.044)
3–4 yr before	0.014 (0.02)	−0.019 (0.059)	0.039 (0.046)	0.004 (0.054)
1–2 yr before	0.022 (0.023)	−0.014 (0.059)	0.073 (0.041)*	0.029 (0.045)
Year of enactment	−0.042 (0.033)	−0.167 (0.054)***	0.055 (0.044)	0.045 (0.051)
1–2 yr after	−0.016 (0.024)	−0.054 (0.038)	0.08 (0.041)*	0.102 (0.036)***
3–4 yr after	−0.012 (0.026)	0.017 (0.053)	0.061 (0.059)	0.094 (0.049)*
5–6 yr after	−0.006 (0.026)	0.025 (0.041)	0.016 (0.046)	0.038 (0.042)
7–8 yr after	−0.027 (0.032)	0.06 (0.031)*	−0.04 (0.042)	−0.043 (0.052)
9–10 yr after	0.002 (0.022)	0.042 (0.037)	0.006 (0.027)	0.005 (0.036)
Constant	81.07 (19.929)***	77.964 (38.567)*	87.804 (27.225)***	74.012 (28.653)**
State fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
State trends	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Clustered standard errors	Yes	Yes	Yes	Yes
Observations	1,519	450	1,069	949
R^2	.87	.89	.86	.86

Notes: The dependent variable is the natural logarithm of $\text{TFR}_{st}/(1 - \text{TFR}_{st})$, where TFR_{st} is the 18- to 20-yr-old total fatality rate for state *s* at time *t*. The estimations are weighted by $n(\text{TFR}_{st})(1 - \text{TFR}_{st})$, where *n* is 18- to 20-yr-old population in state *s* at time *t*. All models include variables controlling for the state unemployment rate, state average per capita personal income, the beer tax rate in the state, VMT within state, the BAC limit for driving in a state, and a binary indicator for any mandatory seat belt law. They also allow for linear state trends. Robust standard errors are reported below point estimates.

*Significant at 10%; **significant at 5%; ***significant at 1%.

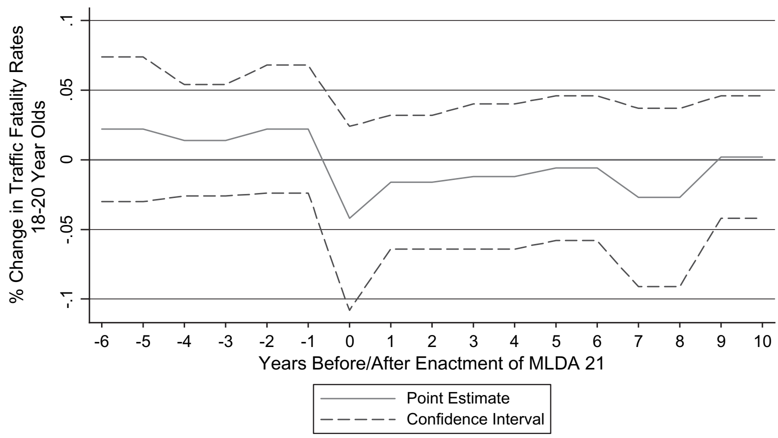
the MLDA legislation was not a significant determinant of TFRs, as none of the coefficients is significant at even the 10% level. The pattern of coefficients mildly suggests that the MLDA reduces TFR18–20, but the preadoption coefficients are positive, and the effect approaches zero in the years following enactment.

In Model (2), which includes only the states that adopted their MLDA21 during or prior to 1983, there does seem to be a significant and large drop in fatalities during the year of MLDA increase. Though not significant, this decrease predates the adoption of the MLDA21 across states, as illustrated by the negative coefficients on the binary indicators dating back 6 yr before policy enactment. In the year of adoption, fatalities declined 16.7% at the 5% significance level. Yet, as early as 1–2 yr after enactment, the MLDA is no longer significant and the point estimate increases from −16.7% to −5.4%. More interestingly, the MLDA21 seems to increase fatalities from 3 to 6 yr after enactment, although the result is not significant. This suggests that the fatality reductions due to MLDA21 policies were transient or even perverse. One possible explanation is that adoption of the MLDA disrupted supply networks for 18- to 20-yr-olds but that these were reestablished fairly quickly.

Model (3) restricts the sample to those states that enacted an MLDA21 during or after 1984. Those states experienced increases in 18- to 20-yr-old fatalities leading up to enactment of an MLDA21; upon the adoption, there was no significant decrease in fatalities, and as soon as 1–2 yr after adoption, the increase in traffic fatalities became significant at the 10% level. As with the early adopters, the coefficient on MLDA21 approaches zero 5 yr beyond adoption.

Model (4) restricts the sample to states that adopted the MLDA21 after 1984. The estimates

FIGURE 6
Timing of MLDA21 Effect, 1976–2005 All States



suggest that 1–2 yr after adoption, states experienced a 10% increase in 18–20 traffic fatalities, significant at the 1% level. The effect persists at the 10% significance level 3–4 yr after the adoption. In these states, the TFR of 18- to 20-yr-olds seems to have been increasing prior to the adoption of the MLDA21. Thus, in states that were pressured to change their MLDAs, the changes were likely inconsequential or even counterproductive.[19,20]

Several additional findings are also inconsistent with the claim that the MLDA reduces traffic fatalities. Table 8 presents regressions analogous to those in Table 6, but using the 17-yr-old driver fatalities as the dependent variable. These regressions find that MLDA19, MLDA20, and MLDA21 all *increase* traffic fatalities at the 5% level of significance.

One explanation is that when the MLDA is 18, more high school students have access to alcohol through peer networks, including 18-yr-olds. When the MLDA is higher, these peer networks are less effective at obtaining alcohol, so individuals younger than 18 yr feel pressure to drink intensely at each drinking occasion. Alternatively, when the MLDA is 18, law enforcement monitors the drinking behavior of individuals aged 17 yr and younger. When the MLDA is 21, this monitoring is spread more thinly, resulting in more drinking among 17-yr-olds.

An alternative explanation is that teenagers care both about respecting the law and about how long they must postpone drinking to comply with the law. If the drinking age is 18 yr, 17-yr-olds know that they can obey the law by postponing for only 1 yr and some choose this path. If the drinking age is 21 yr, however, 17-yr-olds know that they have to postpone drinking for 4 yr to comply with the law, so more decide it is worth becoming a lawbreaker.[21]

A final result concerns construction of the MLDA variable. Many states employ different MLDAs for different categories of alcoholic beverages. For example, as of October 1983, North Carolina had an MLDA of 19 for beer and table wine, but an MLDA of 21 for fortified wine and distilled spirits. Historically, states have been most willing to lower their MLDAs for beer. When it happens that only one alcohol category has an MLDA below 21, the MLDA variable used in earlier literature and our regressions has been set to that value. This might provide a misleading picture of the MLDA's impact.

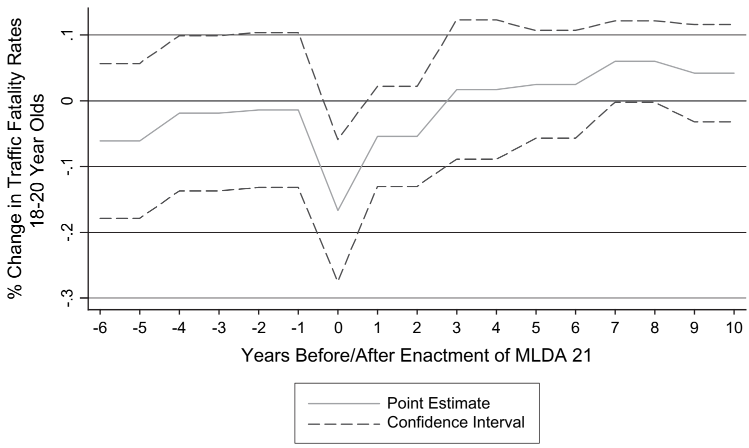
To address this, we estimate models that include an MLDA variable for strong beer, weak beer, fortified wine, table wine, and spirits. Table 9 presents results. In this specification,

19. These results are robust across specifications that allow for quadratic state trends.

20. Another possible reason for differences in impacts of the MLDA across early versus late adopters is that the two set of states exhibited different preexisting trends. Plots of the data reveal no evidence of any such difference, however.

21. We are indebted to an anonymous referee for this interpretation.

FIGURE 7
Timing of MLDA21 Effect, 1976–2005 States Adopting MLDA21 prior to Dec./83



none of the coefficients on an MLDA variable is significant, and no single coefficient has an absolute value greater than .03. The coefficients on the MLDA for strong beer and fortified wine are positive, while the coefficients on the MLDA for weak beer, table wine, and spirits are negative. This lack of consistency reaffirms the tenuous relationship between the MLDA and the traffic fatalities.

V. THE MLDA AND TEEN ALCOHOL CONSUMPTION

The final question we address is why the MLDA does not appear to have had much effect on traffic fatalities. One possibility is that although the MLDA reduces 18- to 20-yr-old drinking, it does so mainly for those who drink responsibly. Another possibility is that the MLDA does not reduce drinking to a substantial degree. The previous literature has suggested that the MLDA does reduce teen drinking. We revisit that question here.

We use data from Monitoring the Future survey, an annual survey of high school seniors that contains measures of drinking habits. We employ the two specific measures common in the literature, “drinker” (having any drink of alcohol in the last month) and “heavy episodic drinker” (having five or more

FIGURE 8
Timing of MLDA21 Effect, 1976–2005 States Adopting MLDA21 on or after Jan./84

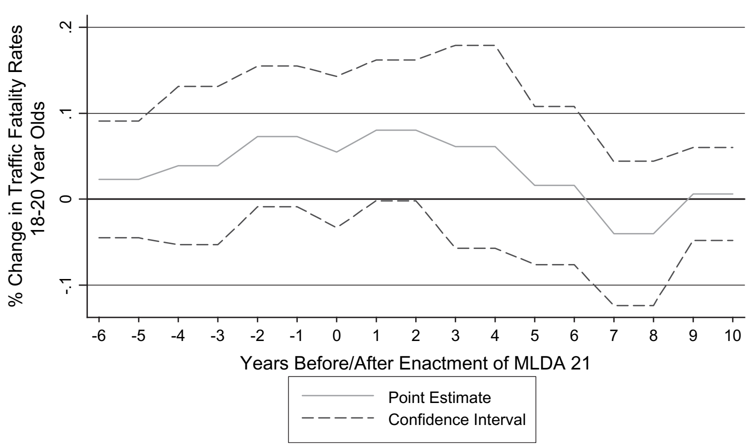
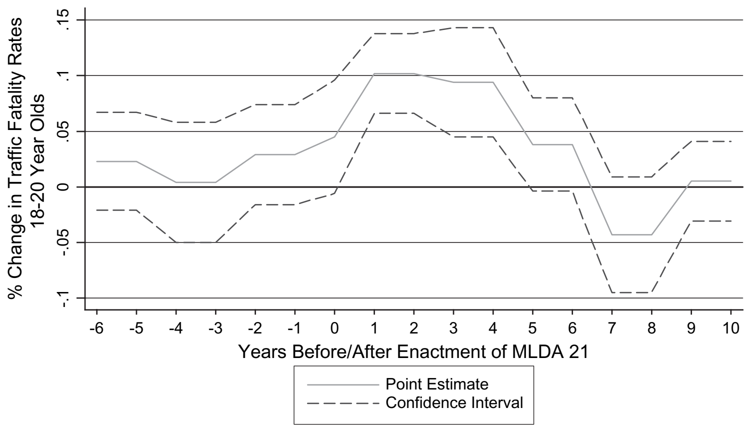


FIGURE 9

Timing of MLDA21 Effect, 1976–2005 States Adopting MLDA21 on or after Jan./85



drinks in a row at some point in the last 2 wk). We also examine the number of motor vehicle accidents that respondents report as occurring after consuming alcohol. We estimate regressions similar to those considered above but with these dependent variables. The measure of the MLDA is identical to that used in previous literature, a dummy for having a drinking age of 18 yr.

Tables 10 and 11 give the results. Though we use slightly different data than Carpenter et al. (2007), we approximate their findings. Models (1) and (2) in Tables 10 and 11 show that an MLDA18 is associated with an almost 4% increase in drinking participation rates and approximately a 3% increase in heavy episodic drinking rates, both significant at the 1% level.

TABLE 8

Weighted Least Squares Estimates of Total Driver Fatality Rate, Selected Age Groups, 1976–2005

Specification	Model (1)	Model (2)	Model (3)
Dependent Variable	Driver Fatality Rate, Persons Aged 17 and Younger	Driver Fatality Rate, Persons Aged 18- to 20-Yr-Olds	Driver Fatality Rate, Persons Aged 21- to 23-Yr-olds
MLDA19	0.073 (0.032)**	-0.007 (0.023)	0.015 (0.027)
MLDA20	0.102 (0.036)***	0.007 (0.04)	0.026 (0.052)
MLDA21	0.092 (0.035)**	-0.08 (0.034)**	-0.029 (0.031)
Constant	71.496 (35.141)**	72.571 (25.698)***	83.494 (21.259)***
State fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
State trends	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Clustered standard errors	Yes	Yes	Yes
Observations	1,501	1,516	1,517
R^2	0.85	0.85	0.82

Notes: The dependent variable is the natural logarithm of $TFR_{st}/(1 - TFR_{st})$, where TFR_{st} is the age-specific fatality rate for drivers in state *s* at time *t*. The estimations are weighted by $n(TFR_{st})(1 - TFR_{st})$, where *n* is age-specific population in state *s* at time *t*. All models include variables controlling for the state unemployment rate, state average per capita personal income, the beer tax rate in the state, VMT within state, the BAC limit for driving in a state, and a binary indicator for any mandatory seat belt law. They also allow for linear state trends. Robust standard errors are reported below point estimates.

**Significant at 5%; ***significant at 1%.

TABLE 9
Weighted Least Squares Estimates of Fatality Rates of 18- to 20-Yr-Olds by Various MLDA Laws, 1977–2005

Dependent Variable	Total TFR 18- to 20-Yr-Olds
MLDA near beer	−0.017 (0.02)
MLDA strong beer	0.028 (0.019)
MLDA table wine	−0.031 (0.018)
MLDA fortified wine	0.009 (0.047)
MLDA spirits	−0.028 (0.046)
Constant	71.503 (17.921)***
State fixed effects	Yes
Year fixed effects	Yes
State trends	Yes
Controls	Yes
Clustered standard errors	Yes
Observations	1519
R^2	.87

Notes: The dependent variable is the natural logarithm of $TFR_{st}/(1 - TFR_{st})$, where TFR_{st} is the 18- to 20-yr-old total fatality rate for state *s* at time *t*. The estimations are weighted by $n(TFR_{st})(1 - TFR_{st})$, where *n* is 18- to 20-yr-old population in state *s* at time *t*. All models include variables controlling for the state unemployment rate, state average per capita personal income, the beer tax rate in the state, VMT within state, the BAC limit for driving in a state, and a binary indicator for any mandatory seat belt law. They also allow for linear state trends. Robust standard errors are reported below point estimates.

***Significant at 1%.

Models (3) and (4), however, suggest that these reductions derive mainly from states that adopted the MLDA21 before enactment of the FUDAA.[22] Model (3) shows that in the early-adopting states, the MLDA18 is associated with a 5% increase in drinking participation and a 3.7% increase in heavy drinking, both significant at the 1% level. In later adopting states, exposure to an MLDA of 18 has a weaker and insignificant effect on alcohol consumption.

Two interpretations of these results are possible. The absence of any meaningful effect of MLDA18 in reducing drinking in the coerced adopters is consistent with the absence of any effect of MLDA21 on traffic fatalities. The negative effects found for early adopters might reflect a true reduction in alcohol consumption and also explain a reduction in fatalities in these states. Yet, these negative effects might also reflect an increase in underreporting in the Monitoring the Future (MTF) data due to enactment of MLDA21.

One mechanism for resolving this is to examine the number of alcohol-related traffic accidents reported by MTF respondents. If the MLDA works as predicted and underage persons are deterred from drinking, the number of accidents postalcohol consumption should decline when a state adopts an MLDA21. The results in Table 12 are telling. The panel estimates reveal that movement away from an MLDA of 18 is associated with a statistically insignificant −.0007 change in reporting of alcohol-related traffic accidents. Given these findings, it is not surprising that Higson et al. (1983) found that "although the modes of procuring alcohol changed, no significant changes were observed in Massachusetts relative to New York in the proportion of surveyed teenagers who reported that they drank or in the volume of their consumption" (p. 163).

IV. CONCLUSIONS

The MLDA21 is predicated on the belief that it reduces alcohol-related teen traffic fatalities. We challenge that claim showing that the MLDA fails to have the fatality-reducing effects that previous articles have reported.

If not the MLDA, then what might explain the drastic reductions in traffic fatalities over the past half century? Figure 2 suggests that the decline began in the year 1969, the year in which several landmark improvements were made in the accident avoidance and crash protection features of passenger cars. Table 13, taken from Crandall et al. (1986), shows just how many federal safety standards were introduced in the 1968 model year. They explain that "most of these standards for new automobiles were in place by 1970," which allowed for improvements in over three dozen safety measures not previously found in automobiles (Crandall et al. 1986, p. 47). Further research might operationalize these advancements in vehicle safety as they are likely to be major determinants of the declining traffic fatality trends.

The same effort should be made to measure and control for advances in medical technology. In this way, researchers can ascertain

22. The relevance of the FUDAA to consumption patterns among high school seniors is that in a large number of states, movement away from a drinking age of 18 was brought about by the adoption of an MLDA of 21.

TABLE 10
Weighted Least Squares Estimates of MLDA18 Effects on Drinking Participation Rates in High School Seniors, 1976–2004 MTF

		Model (1)	**Model (2)**	**Model (3)**	**Model (4)**
	Carpenter et al. (2007) Estimates: 1976–2003	**Replicating Carpenter et al. (2007) Estimates: 1976–2003**	**Adding Control Variables to Carpenter et al. (2007), Extending to Include 2004**	**Modified Specification, Limited to States that Changed MLDA to 21 before 1984**	**Modified Specification, Limited to States that Changed MLDA to 21 between 1985 and 2004**
MLDA18	0.039 (0.010)***	0.038 (0.015)***	0.037 (0.014)***	0.05 (0.013)***	0.028 (0.018)
State fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
State trends	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes
Clustered standard errors	Yes	Yes	Yes	Yes	Yes
R^2	.086	.080	.081	.084	.80
Observations	394,547	451,747	466,969	207,036	259,933

***Significant at 1%.

whether traffic fatalities are declining because traffic crashes are becoming less frequent or becoming less lethal. Future studies estimating the relationship between the MLDA and the TFRs might use as control variables the number of blood banks, the number of hospital admissions, the number of hospitals that provide open-heart surgery, the number of hospital-affiliated physicians, or the number of hospital beds in the state (Harris et al. 2002).

TABLE 11
Weighted Least Squares Estimates of MLDA18 Effects on Heavy Episodic Drinking Participation Rates in High School Seniors, 1976–2004 MTF

		Model (1)	**Model (2)**	**Model (3)**	**Model (4)**
	Carpenter et al. (2007) Estimates: 1976–2003	**Replicating Carpenter et al. (2007) Estimates: 1976–2003**	**Adding Control Variables to Carpenter et al. (2007), Extending to Include 2004**	**Modified Specification, Limited to States that Changed MLDA to 21 before 1984**	**Modified Specification, Limited to States that Changed MLDA to 21 between 1985 and 2004**
MLDA18	0.032 (0.008)***	0.034 (0.011)***	0.033 (0.011)***	0.037 (0.013)***	0.025 (0.016)
State fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
State trends	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes
Clustered standard errors	Yes	Yes	Yes	Yes	Yes
R^2	.075	.068	.068	.70	.69
Observations	394,547	451,747	466,969	207,036	259,933

Notes: Carpenter et al. (2007) include controls for demographic covariates, including age, a male indicator, an indicator for Hispanic ethnicity, an indicator for African American race, and an indicator for "other race," as well as levels of the beer tax and presence of zero tolerance laws in a state year. Our controls include presence of BAC .08 per se law, state unemployment rates, per capita personal income rates, beer tax rates, and age of respondent. All models allow for linear state trends. Robust standard errors are reported below point estimates.

***Significant at 1%.

TABLE 12
Weighted Least Squares Estimates of MLDA18 Effects on Alcohol-Related Accidents in High School Seniors, 1976–2004 MTF

	Dependent Variable: Number of Traffic-Related Accidents after Alcohol Consumption
MLDA18	−0.0007 (0.02)
State fixed effects	Yes
Year fixed effects	Yes
State trends	Yes
Controls	Yes
Clustered standard errors	Yes
R^2	.18
Observations	457,145

Notes: The model includes variables controlling for the age of the respondent, the state unemployment rate, state average per capita personal income, the beer tax rate in the state, VMT within state, the BAC limit for driving in a state, and a binary indicator for any mandatory seat belt law. They also allow for linear state trends. Robust standard errors are reported below point estimates.

In arguing against an MLDA of 21, this article also challenges the desirability of coercive federalism. The case of the drinking age informs several other public policy debates, including the appropriateness of the No Child Left Behind Act (NCLB). When the governor of Utah attempted to ignore NCLB's provisions that conflicted with Utah's own education policy, the Department of Education threatened to withhold federal education funding (Fusarelli 2005). Fusarelli (2005) argues that such actions demonstrate that in just "a few short years, federal education policy had shifted from minimal federal involvement (President Reagan wanted to abolish the U.S. Department of Education) to the development of voluntary national standards (under President Clinton) to the new law mandating testing of all students in Grades 3–8" (p. 121). The empirical strategy employed in this article might tease out whether the successes attributed to the NCLB are similarly driven by states that proactively adopted its standards of education reform prior to the

TABLE 13
Traffic Safety Features of Cars

Standard Number	Standard Title	Effective Date
Accident avoidance		
101	Control location, identification, and illumination	January 1, 1968
102	Transmission shift level sequence, starter interlock, and transmission braking effect	January 1, 1968
103	Windshield defrosting and defogging systems	January 1, 1968
104	Windshield wiping and washing systems	January 1, 1968
105	Hydraulic brake—passenger cars	January 1, 1968
106	Hydraulic brake hoses	September 1, 1974
107	Reflecting surfaces	January 1, 1968
108	Lamps, reflective devices, and associated equipment	January 1, 1968
109	New pneumatic tires	January 1, 1968
110	Tire selection and rims	April 1, 1968
111	Rearview mirrors	January 1, 1968
112	Headlamp concealment devices	January 1, 1969
113	Hood latch systems	January 1, 1969
114	Theft protection	January 1, 1970
115	Vehicle identification number	January 1, 1969
116	Hydraulic brake fluids	March 1, 1972
117	Retreaded pneumatic tires	January 1, 1972
118	Power-operated window systems	February 1, 1971
119	Tires for vehicles other than passenger cars	September 1, 1974
121	Air brake systems—trucks, buses, and trailers	September 1, 1974
122	Motorcycle brake systems	January 1, 1974
123	Motorcycle controls and displays	September 1, 1974

continued

TABLE 13
Continued

Standard Number	Standard Title	Effective Date
124	Accelerator control systems	September 1, 1973
125	Warning devices	January 1, 1974
126	Truck-camper loading	January 1, 1973
Crash protection and survivability		
201	Occupant protection in interior impact	January 1, 1968
202	Head restrains	January 1, 1969
203	Impact protection for driver from steering control system	January 1, 1968
204	Steering control rearward displacement	January 1, 1968
205	Glazing materials	January 1, 1968
206	Door locks and door retention components	January 1, 1968
207	Seating systems	January 1, 1968
208	Occupant crash protection—passenger cars	January 1, 1968
209	Seatbelt assemblies	March 1, 1967
210	Seatbelt assembly anchorages	January 1, 1968
211	Wheel nuts, wheel discs, and hub caps	January 1, 1968
212	Windshield mounting	January 1, 1970
213	Child seating systems	April 1, 1971
214	Side door strength	January 1, 1973
215	Exterior protection	September 1, 1972
216	Roof crush resistance	August 15, 1973
217	Bus window retention and release	September 1, 1973
218	Motorcycle helmets	March 1, 1974
301	Fuel system integrity	January 1, 1968
302	Flammability of interior materials	September 1, 1972

federal mandate. Additionally, the empirical approach might help establish whether other federal policies promote "the general welfare" enough to satisfy the *South Dakota v. Dole* restrictions on when Congress can condition funding for states.[23] If the case of the FUDAA is any indication, the federal government may at times be working against its own policy objectives and against the general welfare.

APPENDIX: DATA SOURCES

The sources of all the variables used in the reported regressions are listed below.

Fatalities:

Data obtained from the FARS.

Consumption:

Data obtained from private-use extract from the Monitoring the Future surveys, contractually granted by the Institute for Social Research at the University of Michigan.

Population:

Data obtained from the U.S. Census Bureau.

Fatality Rates 1913–2005:

Data obtained from the National Safety Council (2005) publication of *Injury Facts*.

VMT:

Data obtained from 30 issues of the Federal Highway Administration's annual publication, *Highway Statistics*.

Per Capita Personal Income Rates:

Data obtained from the Bureau of Labor Statistics (BLS).

Beer Tax:

Data obtained from the U.S. Brewers' Association, *Brewers Almanac*, published annually, 1941—present.

Unemployment Rates:

Data obtained from the BLS.

BAC .08 Laws:

Data obtained from several issues of *The Insurance Fact Book*, published annually by the Insurance Information Institute.

MLDA Laws:

Data obtained from Distilled Spirits Council of United States.

Mandatory Seat Belt Laws:

Data obtained from several issues of *The Insurance Fact Book*, published annually by the Insurance Information Institute.

23. Congress's spending power to make conditional grants of federal funds is not unlimited. The legitimacy of the condition is subject to a four-factor test: it must be in the pursuit of the general welfare, must be unambiguous, must be related to the federal interest in particular national projects or programs, and must not violate the constitution on other grounds.

REFERENCES

Asch, P., and D. T. Levy. "Does the Minimum Drinking Age Affect Traffic Fatalities?" *Journal of Policy Analysis and Management*, (1986–1998), 6, 1987, 180–91.

Carpenter, C., and C. Dobkin. "The Effect of Alcohol Consumption on Mortality: Regression Discontinuity Evidence from the Minimum Drinking Age." NBER Working Paper No. 13374, 2007.

Carpenter, C., D. Kloska, P. O'Malley, and L. Johnston. "Alcohol Control Policies and Youth Alcohol Consumption: Evidence from 28 Years of Monitoring the Future." *B.E. Journal of Economic Analysis & Policy*, 7, 2007, 1–21.

Carpenter, C. S., and M. Stehr. "The Effects of Mandatory Seatbelt Laws on Seatbelt Use, Motor Vehicle Fatalities, and Crash-Related Injuries Among Youths." NBER Working Paper No. 13408, 2007.

Crandall, R. W., H. K. Gruenspecht, T. E. Keeler, and L. B. Lave. *Regulating the Automobile: Studies in the Regulation of Economic Activity*. Washington, DC: The Brookings Institution, 1986.

Dee, T. "State Alcohol Policies, Teen Drinking and Traffic Fatalities." *Journal of Public Economics*, 72, 1999, 289–315.

DISCUS Office of Strategic and Policy Analysis. *Minimum Purchase Age By State and Beverage, 1933—present*. Washington, DC: Distilled Spirits Council, 1996.

Freeman, D. G. "Drunk Driving Legislation and Traffic Fatalities: New Evidence on BAC 08 Laws." *Contemporary Economic Policy*, 25, 2007, 293–308.

Fusarelli, L. "Gubernatorial Reactions to No Child Left Behind: Politics, Pressure, and Educational Reform." *Peabody Journal of Education*, 80, 2005, 120–36

Grant, D. *Optimal Drunk Driving Penalty Structure*. Manuscript, Sam Houston State University, 2008a.

———. *Dead on Arrival: Zero Tolerance Laws Don't Work*. Manuscript, University of Texas-Arlington, 2008b.

Harris, A. R., S. H. Thomas, G. A. Fisher, and D. J. Hirsch. "Murder and Medicine: The Lethality of Criminal Assault 1960-1999." *Homicide Studies*, 6(2), 2002, 128–66.

Higson, R. W., N. Scotch, T. Mangione, A. Meyers, L. Glantz, T. Heeren, N. Lin, M. Mucatel, and G. Pierce. "Impact of Legislation Raising the Legal Drinking Age in Massachusetts from 18 to 20." *American Journal of Public Health*, 73, 1983, 163–70.

Houston, D. J., L. E. Richardson, and G. W. Neeley. "Legislating Traffic Safety: A Pooled Time Series Analysis." *Social Science Quarterly*, 76, 1995, 329–45.

Kaestner, R. "A Note on the Effect of Minimum Drinking Age Laws on Youth Alcohol Consumption." *Contemporary Economic Policy*, 18, 2000, 315. ABI/INFORM Global.

Lovenheim, M. F., and J. Slemrod. *The Fatal Toll of Driving to Drink: The Effect of Minimum Legal Drinking Age Evasion on Traffic Fatalities*. Manuscript, Stanford University, 2008.

Males, M. "The Minimum Purchase Age for Alcohol and Young-Driver Fatal Crashes: A Long-term View." *Journal of Legal Studies*, 15, 1986, 181–211.

Mosher, J. F. "The History of Youthful-Drinking Laws: Implications for Current Policy," in *Minimum Drinking Age Laws*, edited by H. Wechsler. Toronto, Ontario, Canada: Lexington Books, 1980, 11–38.

National Safety Council. *Injury Facts*. Itasca, IL: National Safety Council, 2005.

———. *Calculating Lives Saved Due to Minimum Drinking Age Laws*. Washington, DC: U.S. Department of Transportation, 2005a.

Ponicki, W. R., P. J. Gruenewald, and E. A. LaScala. "Joint Impacts of Minimum Legal Drinking Age and Beer Taxes on US Youth Traffic Fatalities, 1975-2001." *Alcoholism: Clinical and Experimental Research*, 31, 2007, 804–13.

Ruhm, C. J. "Alcohol Policies and Highway Vehicle Fatalities." *Journal of Health Economics*, 15, 1996, 435–54.

Shults, R. A., R. W. Elder, D. A. Sleet, J. L. Nichols, M. O. Alao, V. G. Carande-Kulis, S. Zaza, D. M. Sosin, R. S. Thompson, and The Task Force on Community Preventive Services. "Reviews of Evidence Regarding Interventions to Reduce Alcohol-Impaired Driving." *American Journal of Preventive Medicine*, 21, 2001, 66–84.

South Dakota v. Dole. 483 U.S. 203. 1987.

Wagenaar, A. C., Toomey, T. L. "Effects of Minimum Drinking Age Laws: Review and Analyses of the Literature from 1960 to 2000." *Journal of Studies on Alcohol*, 14, 2002, 206–25.

Wagenaar, A. C., and M. Wolfson. *Journal of Public. Health Policy*, 15(1), 1994, 37–53.