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Seatbelt Use as a Police Avoidance Strategy: A Test Using the Legality of Medical Marijuana

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Abstract: One way to avoid detection of law enforcement officials if you are engaging in illegal activities is to wear a seatbelt. Therefore, an unintended consequence of laws allowing people to possess marijuana for medical purposes is that seatbelt use may decline among groups whose possession of marijuana is now legal. We find a decrease in seatbelt use among middle-aged males, providing evidence that drivers use seatbelts as a means to avoid police interaction. We find no such reduction in seatbelt use among those less likely to possess medical marijuana cards. Our evidence supports the contention that drivers use seatbelts more if they fear interaction with law enforcement officials, which is consistent with evidence of heightened seatbelt use among drunk drivers. These findings are important in understanding how to best design traffic safety laws and enforce them.

Keywords: seatbelts; marijuana legality

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1. Introduction

Road traffic injuries are the 9th leading cause of death worldwide [1], and the vast majority of deaths are among unbelted drivers [2]. These deadly crashes impose a monumental financial toll. In the U.S. alone, with one year's worth of crashes costing nearly $100 billion in lost wages and medical expenses [1]. There is little doubt as to the human and economic benefits of increased seatbelt use, and the social benefit is sufficiently strong that all but one state has legal mandates on driver seatbelt use. At last count, 111 countries mandated comprehensive seatbelt use by front and rear passengers, although enforcement still varies dramatically across countries [3]. The consensus is that seatbelt laws increase use [4,5] and save lives [5].

The enforcement of seatbelt laws, as well as related laws, might lead to some otherwise risk-prone individuals to buckle-up as well. Carpenter and Stehr [6] showed that high risk drivers and heavy drinkers are more responsive to seatbelt laws. Luca [7] showed that "Click-It or Ticket" campaigns are more successful at night, suggesting that nighttime drivers would have more reason to avoid police, perhaps being under the influence of drugs or alcohol. Adams et al. [8] tested whether drivers operating vehicles under the influence of alcohol self-report that they are more likely to wear their seatbelts. They show an increase in seatbelt use among inebriated drivers if there is a lower minimum allowable blood alcohol content law in place, which increases the number of inebriated drivers potentially affected.

This paper takes the question a step farther, using observational data from controlled intersections to investigate whether a change in laws that alters the costs associated with police interaction affects observed seatbelt use. Currently, 24 states allow people to hold small amounts of medical marijuana for medical purposes, with well over 1 million legal users in these states [9]. Our main hypothesis is that prior to medical marijuana law (MML) enactment, seatbelt use was higher in these states than it is afterward as the fear of being caught with marijuana declines, particularly among population subgroups likely to have cards. Concealing your "stash" from law enforcement is indeed a widely held concern among marijuana users, and Google searches reveal endless tips. Once on the roadways, this becomes a difficult endeavor. Any interaction with police that raises suspicion could result in a search of your automobile, the end result of which could be fines in the thousands of dollars or prison time if marijuana is found in your car. Getting pulled over for not wearing a seatbelt and then getting charged for possession is a legitimate fear [10,11]. Therefore, legalizing such possession could reduce seatbelt use as drivers are no longer as vigilant about avoiding being pulled over. Recent evidence suggested that police presence and the contingencies associated with being pulled over is a driving force of seatbelt use [12].

The group in particular we most expect to be affected are middle aged men. From 2002–2014, there was a 65% increase in marijuana use among those ages 26 and over, with the greatest increase among those in their 50s. For those below 26, there was a decline in marijuana use. Moreover, males have experienced greater usage then women [13]. The primary drivers for such a change in use among middle aged males over the past decade are medical marijuana legalization and a more general acceptance in the population of marijuana use. We suspect that older males began using marijuana as it became more acceptable, but increased even more as its legal status began to change. Martins and colleagues [14] confirm that the relative surge in use is concentrated among older individuals in states that enacted MML.

One alternative explanation we explore is whether the lower seatbelt use following the MML allowances is a byproduct of more drivers being under the influence of marijuana, either through increased use after receiving the card or simply increased use overall because the drug is more readily available. The evidence does not support this explanation. First, the legitimate MML cardholders are likely to be older, and this is where the reduced seatbelt use we estimate is concentrated. Second, we directly test for a change in another behavior that we think should also be affected by being under the influence, specifically failure to use a child-safety restraint. We see no evidence that this is affected by MML enactment.

2. Methods

2.1. Data Sources and Data Collection

We use the National Occupant Protection Use Survey (NOPUS) of the National Highway and Safety Administration (NHTSA). The survey is collected annually and consists of two sub-surveys known as the Moving Traffic survey (MT) and the Controlled Intersection study (CI). We use the raw data from the CI study to identify observations of occupant seatbelt use. The data are collected at the intersections of Federal, State, and county highways, residential streets, and rural roads where stop signs or lights are present. This allows for observation of occupant seatbelt use and occupant demographic characteristics while the vehicle is stopped. The study is conducted in the month of June from 7 a.m. through 6 p.m. to provide adequate light and ensure the accuracy of data collected.

Data are collected from all 50 states; however, only approximately 30 states are included in any given survey year. Given the unique structure in which data are collected for the NOPUS, we elect to pursue a balanced panel of state data. As a result, the data used for estimation will be a subset of states which exist throughout the entirety of the sample period. Of that subset of states, we are still able to identify several states that legalize the use of medical marijuana. Additionally, in accordance with our agreement with NHTSA, specific sampling sites and state identities cannot be revealed to the reader in order to uphold the integrity of future NOPUS sampling. So, we must be purposefully vague in both the number of states we identify and the names of such states. We will make our computer code publically available for replication purposes in case NOPUS data are released in raw form to the public or a researcher is able to obtain these data from the NHTSA on their own. We do offer several robustness checks, however, to show that the unique sample selection is not driving our findings.

For this study, we link occupant seatbelt use to state-level legislation on medical marijuana. States that legalized the use of medical marijuana between 2004 through 2012 are branded as treatment states and are used to create our policy variable of interest in the form of a dummy variable. Table 1 provides summarized information on effective dates and state coverage of all MML states, including states and dates that are outside our estimation period, as well as states that are not part of our balanced panel. All MML state data were obtained from MedicalMarijuana.procon.org, which provides detailed information on MML states, passage dates, and effective dates. States vary somewhat in how widely cards are distributed and the extent to which marijuana is regulated. One limitation of our study is we cannot distinguish between these states. We do conduct a robustness check limiting the analysis to one treatment state that clearly had liberal regulation and many cardholders. We also cannot test the effects of recent state legalizations of marijuana for recreational use since the relatively few states with such allowances would violate our data agreement with NOPUS.

Table 1. States with legalized medical marijuana (and effective dates) and enforcement of seatbelt laws.

State	Year in which MML Became Effective	Seatbelt Law Time of MML Enactment
Alaska	1999	Secondary
Arizona	2010	Secondary
California	1996	Primary
Colorado	2001	Secondary
Connecticut	2012	Primary
District of Columbia	2010	Primary
Delaware	2011	Primary
Hawaii	2000	Primary
Illinois	2014	Primary
Maine	1999	Secondary
Maryland	2014	Primary
Massachusetts	2013	Secondary
Michigan	2008	Primary
Minnesota	2014	Primary
Montana	2004	Primary
Nevada	2001	Secondary
New Hampshire	2013	None
New Jersey	2010	Primary
New Mexico	2007	Primary
New York	2014	Primary
Oregon	1998	Primary
Rhode Island	2006	Secondary
Vermont	2004	Secondary
Washington	1998	Secondary

Note: Data used spans from 2004–2012.

Table 2 provides descriptive statistics observations from the MML treatment states and the non-MML control states that are usable in estimation. The final sample consists of 340,544 individual observations, or approximately 38,000 observations per year. Of this group, 57,445 are in treated MML states and the remainder are in states with no MML. The treatment group states all have seatbelt laws with primary enforcement. By primary enforcement, we mean that someone can be pulled over for not wearing a seatbelt exclusively. A secondary enforcement would be that a driver would be pulled over for another infraction, for example reckless driving or speeding, and then issued a secondary citation for not wearing a seatbelt. The control group is divided between states with primary and secondary belt laws, but our results are robust enough to including just primary seatbelt states in the treatment and control group.

Table 2. Weighted annual state means.

Variables	Control States	Treated States
Seatbelt use rates		
Overall	0.810	0.880
Drivers	0.820	0.890
Drivers over 24	0.830	0.890
Drivers under 24	0.780	0.840
Other variables		
Population	12,970,881	9,575,544
Age < 15	0.074	0.063
Age 16–24	0.132	0.143
Age > 24	0.794	0.796
White	0.763	0.890
Black	0.144	0.059
Other	0.093	0.051
Male	0.538	0.531
Female	0.462	0.469
Weekday	0.740	0.740
Weekend	0.260	0.260
Rain/Snow	0.100	0.110
Fog	0.003	0.006
Clear	0.897	0.884
Observations	283,099	57,445

Note: Average population size is used as a weight for the means of variables that are not age-specific or population itself.

Statistics in Table 2 include information on the rate of seatbelt use, including a breakdown by driver age. Given that the NOPUS is an observational study, the age variable is crude and inexact, with only broad age ranges beings observed (under 3, under 15, ages 16–24, ages 25–69, ages 70+). We think these broad categories serve our purposes well, however, as most marijuana cardholders will be over age 24. If there is any increase in illegal possession, it should be concentrated among those ages 16–24. Means of control variables for state population, age, race, and sex are provided. Race and sex are also judgment calls by NOPUS data collectors, but we expect these to be more accurate than age. There is also summary information on whether the individual was observed during the week or on the weekend and the driving conditions at the time of observation. We include those determinants in our analysis. Other research has shown these to be determinants of seatbelt use. In particular, male drivers, those driving in the evening, and those in places with non-primary enforcement were found to be less likely to wear seatbelts [12,15]. Comparison of the control variables for the MML and non-MML states reveals that there are no extreme differences in the age, gender, or time of the week the data were collected. There is a larger baseline rate of seatbelt use in the treatment states. This might be related to the somewhat larger share of whites in these states or the fact that these are both states with seatbelt laws that are primarily enforced. Both of these are major predictors of increased seatbelt use. Observations where seatbelt use was unable to be determined or where information regarding controls was missing were dropped.

2.2. Identifying Occupants Most Likely to Hold MML Cards

We suspect that those occupants in MML states with cards allowing them to carry marijuana will decrease their seatbelt use. The NOPUS data obviously has no indicator of who is carrying a card. Thus, we must identify those in our data more and less likely to possess these cards. The group that reports the heaviest use of marijuana for medicinal purposes is over 25 [16]. With regard to actual medical marijuana cardholders, another California study reports that the average age of their patients is 39.9 [17]. A study of registered users in 13 states also found that the vast majority of cardholders were over 25, with the greatest concentrations in their 40 s and 50 s [18]. That same study showed that users varied from between 60% and 73% male. Other estimates from the National Survey on Drug Use and Health showed that marijuana use increased among those over 25 and stayed constant for those age 25 and below in states passing MML [14]. Given this information, we would expect to find the most significant results among middle-aged males. We suspect much more limited to no effect for other groups.

2.3. Estimation Model

To estimate the effect of MML on occupant seatbelt use, we estimate a linear probability model (LPM) that utilizes a Difference in Difference identification strategy, allowing us to focus on the effect of MML on seatbelt use while controlling for fixed effects and existing trends. We are well aware of the limitations of the LPM model and assess the sensitivity of this model choice later. We prefer the LPM given its more easily interpretable coefficients and avoidance of the incidental parameters problem given our fixed effects research design.

Our dependent variable is a dichotomous variable indicating that the vehicle occupant was wearing their seatbelt at the time of observation. We include MML as an indicator variable that captures whether the state allowed individuals to carry small quantities of marijuana for medical purposes at the time the occupants' seatbelt use was observed. We include state and time fixed effects, which capture differences in seatbelt use across states and differences in use unique to every time period in the sample.

We add as control variables a number of factors that might affect whether the occupant wears a seatbelt. This includes the list of covariates from Table 2. We also include a control for annual state population, which, in a model with state fixed effects, reflects changes in relative population density.

With any policy analysis of this type, we assume that there are no differences in treatment states passing MML laws that are correlated over time with differential seatbelt use across treatment and control states. We have no reason to suspect that MML laws and seatbelt use are correlated for any reasons but the behavioral ones we posit above. That said, we engage in a number of checks of our exogeneity assumption. First, we add variables to our basic specification to test for lead effects of the MML legislation. That is, we aim to detect any differences in seatbelt activity in the years leading up to the legislation that might drive our findings. Lead effects are non-significant. Second, we also added a state-specific linear time trend to some estimations. These results are available on request but tend to suggest effects at least as large as those reported. Finally and most telling, we test for effects on vehicle occupants whose seatbelt use should be unaffected by MML laws. As we discuss later, we find no impact on these drivers.

Standard errors are corrected for correlation across states by means of clustering [19,20]. Additionally, we will provide alternative p-values for our key estimates by wild cluster bootstrap resampling method. The wild cluster bootstrap method helps to eliminate any additional bias in standard errors that may come from having relatively few clusters [21]. For robustness we also perform estimations using our most balanced treated state, meaning the years before and after the treatment period are equal, and generate an ideal control group using weights obtained from the synthetic control method. We also preform estimates using a probit models.

3. Results

3.1. Baseline Estimates

Results of these baseline estimates are reported in Table 3. All results in the table include state and year fixed effects, as well as a complete set of controls. Column (1) provides results for all passengers observed in the data including only state and time fixed effects. The estimate of the effect of MML passage is negative and suggests a nearly 1 percentage point reduction in seatbelt use after MML passage relative to states that did not pass an MML. In the second column, we add a full set of controls. We find that including controls for occupant demographics, road conditions, time of week, population and primary seatbelt laws mitigates our treatment effect and the results are no longer significant. In the third column, we estimate the full model using only observations of male vehicle occupants. As discussed earlier, previous analysis of medical marijuana applicants and cardholders show that they are predominantly male, thus we would expect this group to yield a result that is stronger than that of column (2). This is in fact the result we find, as our treatment variable MML returns to a negative 1 percentage point decrease in seatbelt use.

3.2. Estimates within Various Subsamples and Age Cohorts

The results of the previous section present rather modest and borderline significant effects. This may be the result of estimating treatment effects for a sample that contains many who are not likely to be affected by the law. For example, all passengers are included in the analysis in Table 3. Since the driver is likely the one most visible to officers and most likely to have knowledge that indeed there is marijuana in the car, we estimate separate effects by position in the vehicle.

In panel A of Table 4, we find that there is a statistically significant (p-value < 0.01) reduction in seatbelt use among drivers, which is consistent with our hypothesis. The effect diminishes but remains significant at the 0.10 level if we add in passengers in the front seat. Limiting the analysis to those in the back seat yields no effect and seems to prevent identifying statistical significance in the Table 3 estimates.

In panel B of Table 4, we provide estimates by various age groups. There are a number of reasons we undertake these estimates. First, we can test whether the effects are observed for those who are most likely to be affected by the legislation because of their legal possession of marijuana, namely those older than age 24. If we further limit the analysis to adult males and eliminate those age 70 or older, the reduction in seatbelt use is a substantial 2.3 percentage point reduction.

Table 3. Effect of MML on seatbelt use from linear probability models.

	Full Sample	Full Sample	Males Only
Policy variable			
MML in place	−0.008 * (0.005)	−0.006 (0.004)	−0.009 (0.006)
Control variables			
Population		−0.018 *** (0.004)	−0.018 *** (0.004)
Primary seatbelt law in place		0.052 *** (0.005)	0.063 *** (0.004)
Age			
<1		0.047 *** (0.008)	0.047 *** (0.012)
$1 \geq 3$		X	X
4–7		−0.157 *** (0.020)	−0.131 *** (0.014)
8–15		−0.134 *** (0.013)	−0.154 *** (0.018)
16–24		−0.176 *** (0.035)	−0.214 *** (0.039)
25–69		−0.102 *** (0.026)	−0.132 *** (0.030)
>70		−0.072 ** (0.025)	−0.092 *** (0.028)

Table 3. *Cont.*

	Full Sample	Full Sample	Males Only
Male		−0.064 *** (0.008)	X
White		0.040 *** (0.015)	0.033 ** (0.015)
Black		−0.069 *** (0.024)	−0.079 *** (0.026)
Weekend		0.009 (0.007)	0.015* (0.007)
Fog		0.011 (0.021)	−0.000 (0.024)
Clear		−0.012 (0.022)	−0.002 (0.003)
Full Set of Controls	NO	YES	YES
State &Year fixed Effects	YES	YES	YES
Sample size	340,544	340,544	181,957

Table 4. Effect of MML on seatbelt use by driver status.

Panel A: By Occupant Position in the Car				
	Driver	**Driver & Front Seat Passenger**		**Back-Seat Passenger**
MML in place	−0.012 *** (0.004)	−0.009 * (0.004)		0.017 (0.018)
Primary seatbelt law in place	0.056 *** (0.007)	0.053 *** (0.005)		0.0196 (0.022)
Number of Observations	243,016	309,423		29,894
Panel B: By Age of occupant				
	Adults >24	**Male Adults 25–69**	**Younger Adult 16–24**	**Under 3**
MML in place	−0.014 ** (0.008)	−0.023 ** (0.009)	0.023 (0.015)	−0.009 (0.014)
Primary seatbelt law in place	0.048 *** (0.001)	0.062 *** (0.005)	0.078 *** (0.0088)	0.031 ** (0.014)
Number of Observations	270,436	133,878	45,560	6699
Panel C: By Age of Driver				
	Driver Age > 24	**Driver Age 25–69**		**Male Driver Age 25–69**
MML in place	−0.018 *** (0.005)	−0.019 *** (0.005)		−0.025 *** (0.008)
Primary seatbelt law in place	0.049 *** (0.007)	0.049 *** (0.007)		0.058 *** (0.007)
Number of Observations	213,883	198,081		117,358

Note: Estimations include year and state fixed effects and all controls. Point estimates and clustered (on state) standard errors are reported. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 level, respectively.

Panel B also includes results for younger adults as well as a falsification test. First we investigate younger adults, and we conversely find a statistically insignificant 2.3 percentage point increase in the use of seatbelts for younger drivers ages 16–24. For those under the age of 3, we find a very small, non-significant change in the effect of their seatbelt/restraint use.

Finally, we focus our attention on just drivers, who are the group of individuals most likely to have interaction with law enforcement. These estimates can be seen in Panel C of Table 4. We again find results in support of the forwarded hypothesis. Specifically, we find that older drivers above the age of 24 are less likely to wear their seatbelt after the enactment of MMLs. We find that the group most likely to alter their behavior are male drivers between the ages of 25–69, which fits the description of medical marijuana cardholders described earlier as middle-aged men. Results for this group indicate that they are 2.5 percentage point decrease in seatbelt use after MML enactment. This result is highly significant, with test statistics nearly twice as large as other significant treatment estimates in this table.

3.3. Additional Robustness Checks

In this section, we review some potential issues with our modelling approach and identifying assumptions. We offer some robustness checks to test for their importance. We begin by noting our use of the linear probability model is potentially problematic for well-documented reasons. We estimate our specification with the full set of controls using a probit model for the two most meaningful outcomes—seatbelt use for drivers age 25–29 and seatbelt use for male drivers age 25–69. The use of the probit model has the benefit of providing predictions that will not exceed one but comes at a cost in terms of the incidental parameters problem. We also include the marginal effects (DY/DX) of our treatment variable for each estimate. These results can be seen in the panel A of Table 5. They are if anything stronger than the result provided up until this point. In particular, there is a substantial and significant approximate 2 percentage point increase in seatbelt use among these groups with the magnitude of the result increasing in size as we isolate results to the group most likely to be cardholders.

As a second concern, we note that we are limited in the number of clusters we can use since the collection of the NOPUS data does not reach every state in each period. To ensure some comparability in the comparison groups before and after MML implementation, we imposed a balanced panel. This led to the potential of biased inference stemming from too few clusters. To test the importance of the issue, we followed the suggestions of Cameron et al. [21] regarding binary dependent variable estimates with few clusters in panel B of Table 5. The first two rows of the panel repeat the previous tables' findings for both drivers age 25–69 and male drivers age 25–69. We then provide p-values obtained from the wild-bootstrapping process. In this process, we run the initial regression, imposing the null hypothesis that the treatment dummy has no effect on the dependent variable. We then use the restricted residuals and restricted coefficients to generate bootstrapped dependent variables and calculate the t-statistics for each replication. P-values are then generated using one of the following equations:

$$\mathrm{P}* \;=\; \frac{1}{\mathrm{B}}\sum\nolimits_{i=1}^{B} I\left(\left|t_k^j\right| > |t_k^*|\right) \tag{1}$$

or

$$\mathrm{P}* \;=\; 2\min\left(\frac{1}{\mathrm{B}}\sum\nolimits_{i=1}^{B}\; I\left(t_k^j \le t_k^*\right), \frac{1}{\mathrm{B}}\sum\nolimits_{i=1}^{B}\; I\left(t_k^j > t_k^*\right)\right), \tag{2}$$

where B indicates the number of bootstrapped results. In our case, this equals 1000. I is the indicator function, t_k^j are the bootstrapped t-statistics, and t_k^* is the initial t-statistic. For a detail description of p-value creation using the wild clustered bootstrapped method, see MacKinnon and Webb [22]. The *p*-values for the wild bootstrap can be seen in panel B. The results indicate that even after correction for any additional bias in our standard errors, from having few clusters, it is apparent that middle-aged male drivers altered their seatbelt use behavior after the passage of MMLs. Specifically, both groups maintain *p*-values that indicate significance at the 5 percent level.

Table 5. Alternative models.

	Driver Age 25–69	Male Driver Age 25–69
A. Probit model		
Effect of MML being in place on seatbelt use	−0.077 ***	−0.091 ***
	(0.027)	(0.034)
DY/DX	−0.019	−0.024
Number of observations	198,081	117,358
B. Wild-bootstrapped standard errors		
Effect of MML being in place on seatbelt use	−0.019 ***	−0.025 ***
	(0.003)	(0.005)
Wild bootstrapped p-value	0.036 **	0.046 **
Number of observations	198,081	117,358
C: Synthetic control		
Effect of MML being in place on seatbelt use	−0.030 ***	−0.038 ***
	(0.006)	(0.009)
Wild bootstrapped *p*-value	0.002 ***	0.002 ***
Number of observations	68,929	40,722
D. Results with young adults as control group		
Effect of MML being in place on seatbelt use	−0.022 **	−0.023 **
	(0.008)	(0.009)
Number of observations	243,641	162,918
E. Results for high and low cardholder states		
High number of cardholders	−0.021 ***	−0.029 ***
	(0.005)	(0.001)
Low number of cardholders	−0.014*	−0.016
	(0.007)	(0.010)
Number of observations	198,081	117,358

Note: Estimations include year and state fixed effects and all controls. Point estimates and clustered (on state) standard errors are reported. ***, **, and * denote significance at the 0.01, 0.05, and 0.10 level, respectively.

In panel C, we engage in an alternative test of our hypotheses. The nature of the NOPUS sampling left us with just a subset of states for our analysis. Again, we reiterate that our agreement with the NHTSA precludes us from revealing the exact number or identity of these states. To provide an additional test to allay concerns that our subsample of treatment or control states are not comparable in some way, we engage in a synthetic control approach. Specifically, we identify what we believe to be the most ideal treatment state in our analysis, which we refer to as "Treatment State A." Treatment A is a large MML state with many cardholders and many observations both before and after treatment. The synthetic control process then uses the outcome variable and control variables to determine which states provide the best possible control for our Treatment State A. We use the weights generated from the synthetic control process and estimate a weighted LPM for our previously discussed groups of interest. The results indicate that middle-aged male driver seatbelt use behavior was negatively impacted by the passage of MMLs. Specifically, the weighted LPM model shows that this group was nearly 3.8 percentage points less likely to wear their seatbelt and the result is significant at the 1 percent level when using clustered standard errors. Additionally, once again bootstrapped bias corrected standard errors yield highly significant results.

Results presented in Panel D again focus on the two groups we identify most likely to change their seatbelt use behavior upon treatment. However, we isolate our control group to contain only young adults' age 16–24 to compare with our ideal treated groups. Once again, we find that these groups decrease seatbelt use by approximately 2 percent which is significant at the 5 percent level.

3.4. Results Considering Number of Cardholders in the State

Panel E presents the results for treatment states with high (vs. low) number of cardholders. It is first important to note that the release of information by states of the number of medical marijuana cards issued is spotty at best. We relied on a wide variety of sources to determine the number of patients in our treatment states, beginning with the reasonable set of estimates provided by Medical Marijuana Procon [9]. Further investigation revealed that the application and renewal processes of patients, caregivers, physicians, and dispensaries makes the number of cardholders or those permitted to transport marijuana at any one time impossible to determine for a given state. Acknowledging this, we use a 2% cutoff to delineate low and high cardholding across states. That is, if the estimated number of cards allowing for medical transport in the state that exceeded 2% of licensed drivers. This allowed for a clear cutoff, as high use states were well above this and low use states well below.

Panel E summarizes results for our key estimates dividing the treatment by high and low cardholder states. We find that the effect on those in states with a high number of cardholders is more significant than in low-cardholder states. We verified this was true in an unbalanced panel as well that allowed for some additional states in the treatment group. We also find the effects on male drivers age 25–69 is larger and more statistically significant than all drivers age 25–69.

4. Discussion

We are the first to use observational data to suggest medical marijuana users likely use their seatbelts less once possession laws are relaxed. The implication is that vehicle occupants carefully consider factors other than just personal safety when choosing whether to wear a seatbelt. Occupants are in fact heavily influenced by additional costs and benefits imposed upon them from other sources, specifically stemming from potential interaction with law enforcement. In this sense, our paper fits well within the very recent literature that has assessed other external considerations on individual seatbelt use [7,8,12].

It is worthwhile to translate our paper's estimates into actual projected reductions in seatbelt use among the driving population and MML cardholders. Our estimate in panel E of Table 5 shows that there is a 2.9 percentage point reduction in seatbelt use among male drivers between ages 25–69 in states with a large number of cardholders once MMLs are enacted. For a hypothetical state of 5 million people, we assume 3.5 million are drivers. Our NOPUS sample suggests that 48% of those who drive during the day are males between the ages of 25 and 69 or about. A 2.9 percentage point reduction would then mean that we would have 48,270 fewer drivers wearing their seatbelts in this 25–69 male age group. If a state of this size is a high issuance state, there would be over 100,000 cardholders and the vast majority would be in the male age 25–69 group. So, our estimates certainly suggest a major reduction in seatbelt use among this group, perhaps even as much as cutting their use in half. We add that our statistically significant results are therefore substantially large in a practical sense. The plausibility of this estimate would hinge on whether these cardholders are driving more than the typical person in this age range or are particularly prone to not wearing their seatbelts. The size of the estimates become more plausible if non-cardholders in this age group recognize that police are less likely to stop them because of the new legal environment. This latter effect may be reflected in the fact that there is a non-trivial but statistically insignificant 1.6 percentage point reduction in the low-cardholder states.

Although 1 or 2 percentage point changes barely makes a dent in a nearly 90 percent seatbelt usage rate, the above discussion does show that it represents a potentially fatal decision for tens of thousands in a typical state. For instance, the National Highway and Traffic Administration (NHTSA) reported that the use of three-point seatbelts can reduce the probability of fatality in an accident of front-seat passengers by 45 percent for passenger cars and 60 percent in light-duty trucks [23].

An alternative explanation for the reduction in seatbelt use among older males might be that the increased prevalence of marijuana may suggest that more drivers are under the influence of marijuana and this may increase forgetfulness or reduce safety fears leading to less buckling up. There are a few reasons to doubt this as a mechanism underlying our estimates. First, despite the possible increased use of marijuana among those ages 16–24, there is if anything an increase in seatbelt use among this group when treated. This is consistent with the legality and police avoidance explanation and inconsistent with being under the influence. More directly, we also tested the cognitive impairment explanation by assessing whether there is any impact on the use of child-safety restraints. There is no impact observed on children under 3 being restrained. We acknowledge this is an imperfect placebo test because parents might always be highly concerned about child safety above their own, even if under the influence.

At first, the positive effect for those ages 16–24 may seem odd. Some prior research on medical marijuana showed use increasing among younger adults [24] and substitution between alcohol and marijuana [25]. The evidence on teenage use after MML implementation is not settled by any means; however, a number of studies show no effect [26,27]. Although it is impossible to further decompose the age groups given the nature of the data, we hypothesize based on previous research [25] that the potentially significant younger adult result is likely driven by individuals 21 years and older. However, we reiterate it is difficult to define the above result given the mixed evidence of teenage use in previous MML literature.

Our paper also fits into the literature on the impact of the passage of MMLs on individual behavior. We are only the second paper to our knowledge that looks at driving. Anderson et al. [25] showed that since the passage of MMLs the number of alcohol-related fatal crashes for any blood alcohol content (BAC) and high-BAC accidents have significantly reduced by nearly 12% and 14%, respectively. This effect is attributed to a decrease in alcohol consumption as people likely switch away from self-medicating through alcohol. Our paper is not interested in the interplay between alcohol and marijuana *per se*. We are more interested in the cost-benefit calculations undertaken by marijuana users when deciding to use a belt. Nevertheless, the pattern of our findings fits well with those of Anderson et al. [25]. They show that older drivers have a less pronounced reduction in fatalities. Perhaps the effect they observe is attenuated by the decreased seatbelt use of this older group. Younger people see the largest reductions in fatalities after MML are allowed. They attribute this to alcohol consumption and marijuana being substitutes. Our results suggest that some part of the reduction might also be caused by the modest increase in seatbelt use among this group.

There are several limitations of our study. First, we do not have sufficient information on the number of cardholders per state and enforcement to delineate effects for states with high and low numbers of users. The extent to which the latter are in our treatment group will understate the effect of the legislation. When we look at one specific high-use state in our synthetic control estimation, this shows stronger negative results. Moreover, we do not address potentially even larger effects in states with complete relaxation of marijuana laws. We think future research can address this issue when more and better data become available. Finally, the NOPUS data are not fine enough to know important details about each car where a seatbelt may or may not be worn. For example, there is no data on which passenger, if any, is carrying the marijuana. Moreover, the age groups reported are very wide. We would be able to more exactly establish causality if we knew drivers were carrying marijuana in the car or know more exactly their age. Our effect concentrated on middle age men match their greater use of MML programs, but the link is not perfect. For this reason, our data are more suggestive than proof.

The implications of the results of our work are far-reaching. Evidence clearly supports that drivers adjust their behavior given the combination of regulations in place and their own personal circumstances. They are more selective in following laws if they face a higher cost of not complying because they fear interaction with law enforcement officials, which is important in understanding how to best design traffic safety laws.

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