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The effects of medical marijuana laws on cannabis-involved driving

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ABSTRACT

This study uses data from the Fatality Analysis Reporting System and a differences-in-differences model to examine the effect of state medical marijuana laws (MMLs) on cannabis-involved driving among U.S. drivers involved in a fatal crash between 1993–2014. Findings indicate that MMLs in general have a null effect on cannabis-positive driving, as do state laws with specific supply provisions including home cultivation and unlicensed or quasi-legal dispensaries. Only in jurisdictions with state-licensed medical marijuana dispensaries did the odds of marijuana-involved driving increase significantly by 14 percent, translating into an additional 87 to 113 drivers testing positive for marijuana per year. Sensitivity analyses reveal these findings to be generally robust to alternate specifications, although an observed spillover effect consistent with elevated drugged driving enforcement in bordering states weakens a causal interpretation. Still, reasonable policy implications are drawn regarding drugged driving prevention/enforcement and regulations governing dispensary delivery services and business siting decisions.

1. Introduction

The growing prevalence of marijuana-involved driving in the U.S., along with increasingly robust evidence that cannabis-impaired driving significantly increases traffic crash risk, has heightened public concerns over roadway safety (Rogeberg and Elvik, 2016). These concerns are particularly salient in light of the ongoing liberalization of state marijuana laws allowing legal access to cannabis for medical and recreational purposes (Hall, 2015; Huestis, 2015; Pacula and Sevigny, 2014). As of year-end 2016, twenty-eight states and the District of Columbia have passed medical marijuana laws granting authorized patients the right to use marijuana therapeutically, and eight states plus the District of Columbia have outright legalized adult recreational marijuana use. With states continuing to enact and amend these laws at a rapid pace, policymakers require reliable evidence of their impact on marijuana-involved driving and roadway safety. Despite intense public interest, however, evidence in this policy space remains limited, as only a handful of empirical studies have directly investigated this association. To help fill this gap, this paper uses individual-level data from the Fatality Analysis Reporting System (FARS) and a differences-in-differences specification to examine the effect of state medical marijuana laws (MMLs) on marijuana-involved driving among all drivers involved in a fatal crash in the U.S. between 1993–2014.

1.1. Medical marijuana laws, marijuana-involved driving, and roadway safety

Marijuana is the most commonly detected illicit substance among drivers (Berning et al., 2015; Brady and Li (2014); Romano and Pollini, 2013; Rudisill et al. 2014). Toxicological evidence from the National Roadside Survey indicates that marijuana positivity rates jumped from 8.6% to 12.6% between 2007 and 2013–2014 among weekend nighttime drivers aged 16 or older (Berning et al., 2015), and the Fatality Analysis Reporting System reveals significant longer-term increases in marijuana use detected in drivers involved in fatal vehicle accidents, increasing from 29% to 37% between 1993 and 2010 among drug-positive drivers (Wilson et al., 2014). This evidence raises substantial public safety concerns, particularly against the backdrop of marijuana liberalization laws that increase legal access to cannabis, as cannabis-impaired driving has been shown to significantly increase individual traffic crash risk by roughly 20–30% (Rogeberg and Elvik, 2016).

Despite the apparent links between medical marijuana laws, impaired driving, and crash risk, just a handful empirical studies have investigated the effects of MMLs on roadway safety. Three studies use data from the National Highway Traffic Safety Administration's (NHTSA) Fatality Analysis Reporting System (FARS) to examine cannabis-positive driving among drivers involved in fatal vehicle crashes. Masten and Guenzburger (2014) analyzed changes in cannabis-positive driving for the period 1992–2009 using a series of interrupted time series analyses for twelve MML states, finding significant increases in

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cannabis-positive driving in just three states (California, Hawaii, and Washington). Similarly, Salomonsen-Sautel et al. (2014) employed time series methods to compare changes in driver marijuana positivity between 1994–2011 in Colorado relative to aggregate toxicological data on drivers from 34 non-MML states. Their analysis, which used the 2009 commercial expansion of the Colorado medical marijuana industry as the analytic break point rather than the state's MML enactment year of 2001, found Colorado driver positivity rates increased significantly post-commercialization relative to non-MML states. Most recently, Hamzeie et al. (2017) used a driver-level panel dataset for the years 2010–2014 to investigate the effects of MMLs on cannabis positivity among drivers, controlling for driver, crash, and vehicle characteristics. Unfortunately, because the authors employed a stepwise regression procedure in which the MML indicator was dropped from the model due to nonsignificance, we can only conclude there was a null policy effect.

Two other studies of MMLs also use FARS data, but investigate changes in traffic fatality rates. Performing a differences-in-differences analysis of state-level data for the years 1990–2010, Anderson et al. (2013), found no statistical evidence that MMLs affect overall crash risk after controlling for state-level demographics, competing state policies, and state-specific time trends. However, supplemental analyses showed MMLs were associated with statistically significant declines in alcohol-involved fatal accidents, which the authors interpreted as evidence that MMLs reduce crash risk through the individual-level mechanism of marijuana-for-alcohol substitution. Lastly, Santaella-Tenorio et al. (2017) investigated the effects of MMLs on the traffic fatality rate for the period 1985–2014, finding an 11% reduction in the traffic fatality rate post-MML implementation, net of controls for rival state policies, annual highway safety expenditures, vehicle miles travelled, and alcohol consumption. Additional analyses focusing on the impact of dispensaries revealed null effects on the traffic fatality rate, suggesting that this supply mechanism has no direct effect on aggregate traffic crash rates.

Overall, these five studies provide inconsistent evidence on the impact of MMLs on marijuana-involved driving and associated crash risk. On the one hand, MMLs appear to have null effects on the prevalence of cannabis-positive driving, although some states with more commercialized medical marijuana industries seem to have experienced significant increases in driving proximal to marijuana use. Conversely, studies examining traffic fatalities suggest that MMLs do not increase crash risk and, in fact, may lower the traffic fatality rate through the mechanism of alcohol-to-marijuana substitution.

1.2. Current study

Using driver-level data from the Fatality Analysis Reporting System (FARS), I perform a differences-in-differences analysis within a multiple imputation framework to investigate the effect of state medical marijuana laws on marijuana-involved driving among all U.S. drivers involved in a fatal vehicle crash between 1993–2014. The present study extends prior research in several ways. First, the use of driver-level FARS data provides a more granular level of control over individual and contextual factors that may confound the association between MMLs and driving behavior. Among prior studies, only Hamzeie et al. (2017) analyzed microlevel data, but they focused on a relatively limited period (i.e., 2010–2014) that did not completely encompass pre-policy years. Second, the study employs multiple imputation to address missing FARS data; no prior studies have addressed missing data issues with a similar degree of rigor. Third, the study investigates heterogeneous effects of MMLs by examining the impact of legal provisions governing the supply of medical marijuana (i.e., cultivation, dispensaries). Among prior studies, only Santaella-Tenorio et al. (2017) investigated the policy effects of dispensaries (but not personal cultivation).

2. Methods

2.1. Data and measures

FARS data represent a census of all motor vehicle crashes on public roadways that result in a motorist or non-motorist fatality within 30 days of the crash. Information is coded on more than 100 data elements for each fatal accident from a variety of sources, including police reports, death certificates and medical examiner reports, vehicle registration and driver licensing files, emergency medical service and hospital records, and highway department data (National Highway Traffic Safety Administration, 2015). For this study, I merged annual FARS data files at the driver level of analysis for the years 1993–2014, excluding operators less than 12 years old, resulting in an analytic file of nearly 1.2 million drivers who were involved in a fatal vehicle accident over the 22-year study period. Relevant driver and contextual factors were then coded for each case, carefully accounting for annual changes in FARS coding practices (National Highway Traffic Safety Administration, 2015). Full coding syntax documenting operationalization of measures is provided in the online supplement.

The primary dependent variable, *cannabis+*, measures whether the driver tested positive for THC or related metabolite on up to three recorded drug tests. Policy variables were operationalized based on a comprehensive review of state statutes, regulations, and relevant court cases; legal summaries of state laws; and published reports (e.g., Governor's Highway Safety Association, 2015; Lacey et al., 2010). Given that specific crash dates are reported in FARS, policy indicators were "turned on" as of the effective date of these laws. Table 1 displays the effective dates used to code these policy variables as of December 31, 2014. Coding of the focal medical marijuana laws was based on the author's review of state statutes and regulations, supplemented by additional secondary sources (Klieger et al., 2017; Marijuana Policy Project, 2016). *Medical marijuana* codes state laws that extend legal protections to medical marijuana patients (whether through exemption from arrest/prosecution or an affirmative defense).[1] Additionally, *home cultivation* codes the effective date of provisions allowing patients to cultivate their own marijuana, whether universally or by special permit,[2] and *dispensaries* identifies states with either (i) legally permitted and regulated medical marijuana dispensaries or (ii) illegal or quasi-legal medical dispensaries operating without licensure from the state.[3]

For the rival policy variables, *marijuana decriminalization* indicates state laws that eliminate jail time for the simple possession of small amounts of marijuana.[4] *Recreational marijuana* identifies states that

[1] In most states, this coincides with the law's nominal effective data, but in four states (i.e., DC, IL, NH, VT) legal protections commenced by statute or rule only when patients were in possession of a registry card; for these states, the effective date is set when the state began issuing patient ID cards.

[2] Most states have universal patient cultivation allowances. Arizona did until licensed dispensaries opened, whereupon patients were permitted to grow only if they resided more than 25 miles from a dispensary (which essentially eliminated home cultivation since most patients fell within this radius). New Mexico requires patients to obtain a personal production license (PPL). Two other states (MA, NV) allow patient cultivation only with a hardship exemption, but these provisions were not operational during the study period. Finally, although universal home cultivation was implicitly authorized in its original legislation, Washington did not explicitly authorize patient cultivation until a decade after initial law passage.

[3] The effective date is coded according to when dispensaries first opened for business in order to capture actual supply effects. For legal dispensaries, identifying this date was relatively straightforward because state oversight agencies often report openings for both patient and general public knowledge, and the associated media coverage tends to be intense. For illegal and quasi-legal dispensaries seeking to avoid law enforcement attention, we had to rely on less reliable media accounts, law enforcement press releases, and other information to determine the operational dates of these storefront dispensaries. Additional state-specific historical or documentary research would improve our understanding of these developments.

[4] Note that California's new decriminalization law, which went into effect on January 1, 2011, further reduced the penalty for possessing less than an ounce of marijuana from a