

The highs and the lows: Recreational marijuana laws and mental health treatment

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Abstract

Recreational marijuana laws (RMLs) continue to grow in popularity, but the effects on mental health treatment are unclear. This paper uses an event-study within a difference-in-differences framework to study the short-run impact of state RMLs on admissions into mental health treatment facilities. The results indicate that shortly after a state adopts an RML, they experience a decrease in the average number of mental health treatment admissions. The findings are driven by white, Black, and Medicaid-funded admissions and are consistent for both male and female admissions. The results are robust to alternative specifications and sensitivity analysis.

KEYWORDS

medicaid, mental health treatment, recreational marijuana

1 | INTRODUCTION

Given the rising prevalence of mental illness, access to mental health treatment has become imperative for many Americans. About half of all Americans will be diagnosed with a mental health disorder (MHD) at some point in their lives (Kessler et al., 2007). The continued rise in MHDs has been coupled with a 35% increase in suicides since 1999 (Hedegaard et al., 2020), with 47,646 suicides in 2021 alone (Curtin et al., 2021). The CDC has deemed the growing prevalence of MHDs and suicides a “serious public health problem”.

Understanding the mental health effects of marijuana use has become increasingly important given that 13 states have legalized the recreational use of marijuana, most Americans support legalization as a federal policy (Van Green, 2022), and recent work suggests an increase in marijuana use among adults and adolescents after a state adopts a recreational marijuana law (RML) (Hollingsworth et al., 2022). However, the current literature finds mixed evidence on the relationship between marijuana use and mental health.¹ Some randomized control studies find evidence that cannabinoids improve sleep, reduce symptoms of stress, and can have antidepressant qualities (National Academies of Sciences et al., 2017). Other studies find that medical marijuana laws (MMLs) are associated with a decrease in suicides (Anderson et al., 2014; Bartos et al., 2019; Gruzca et al., 2015; Rich et al., 2022). Conversely, some studies find a weak relationship between state marijuana laws and mental health or suicide after accounting for confounding factors (Anderson et al., 2014; Anderson & Rees, 2021; Leung, 2019). Recent work finds that Recreational marijuana laws (RMLs) may lead to negative effects on mental health and sleep, particularly for younger individuals (Borbely et al., 2022; Sturman, 2022).²

Research on the effects of marijuana laws on mental health treatment is scarce. Some evidence points to MMLs leading to decreased prescriptions for antidepressants and sedatives among the elderly (Bradford & Bradford, 2018; Ozluk, 2017). However, it is unclear what the effect of RMLs is on mental health treatment. This paper contributes to this scant literature by

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employing an event-study within a difference-in-differences (DD) framework to examine the short-run impact of state RMLs on mental health treatment admissions data from the Substance Abuse and Mental Health Services Administration (SAMHSA). The results indicate that adopting an RML decreases the number of mental health treatment admissions. White, Black, and Medicaid-funded admissions drive the findings. The results are robust to various sensitivity analyses, including alternative estimators used to address bias associated with the traditional two-way-fixed effects model (Borusyak et al., 2021; Callaway & Sant'Anna, 2021; Goodman-Bacon, 2018). Although some mechanisms are discussed below, the pathways contributing to the decrease in treatment admissions remain unclear. Thus, the results should not be conflated with improved mental health. Future research should examine whether this decrease is due to RMLs leading to facilities deterring treatment, improved mental health, substitution to self-medication, or other factors.

2 | DATA

I collect data on mental health treatment admissions from SAMHSA's Uniform Reporting System (URS). Facilities report admissions information to receive pecuniary support from pro-grams operated or funded by the SAMHSA. This data contains aggregated patient demographic information at the state-level from 2007-2019.³

The URS allows for the analysis of treatment admissions by race, sex, and age. However, the latter is aggregated into large groupings. Thus, I examine the number of admissions for those 13–20, 21–64, and 65 and over. I also consider the number of admissions that use Medicaid insurance, given that these individuals comprise many of those admitted into the facilities covered in the URS (Ortega, 2023).⁴

The primary analysis also controls for state-level demographic characteristics reported in Table 1. In addition to state population and demographic controls, I also include an indicator for whether a state expanded Medicaid as part of the ACA, given that this led to increased access to mental health treatment (Cowell et al., 2018; Ortega, 2023; Saloner et al., 2017; Thomas et al., 2018). I also control for whether a state has an MML or allows for medical marijuana dispensaries (Hollingsworth et al., 2022). I also include an indicator if a state has a mandatory access prescription monitoring program since this policy restricted access to prescription opioids and led to increases in mental health treatment (Beheshti & Kim, 2022; Ellyson et al., 2021; Meinhofer, 2018).

Recreational marijuana law dates are collected from Anderson and Rees (2021). Ten states passed an RML during this study period, 2007–2019. Columns (1) and (2) of Table 1 provide mean characteristics for RML states, before adoption, and non-RML states, respectively. This comparison reveals differences between RML and non-RML states. For instance, RML states are more likely to have expanded Medicaid. Thus, the main model controls for the factors in Table 1.

3 | METHODS

To identify the causal effect of state RMLs on mental health treatment admissions, I consider the standard two-way fixed effect (TWFE) event-study model:

$$y_{st} = \alpha_s + \gamma_t + \theta_{r(s),t} + \sum_{\substack{j=-5 \\ j \neq -1}}^4 \beta_j RML_s \mathbb{1}\{j = t + t^*\}_s + \mathbf{X}_{st} \boldsymbol{\psi} + v_{st} \quad (1)$$

where y_{st} is the number of mental health treatment admissions (per 10,000) in state s at time t . The terms α_s , γ_t , and $\theta_{r(s),t}$ represent state, year, and region-by-year fixed effects, respectively. RML is an indicator variable equal to one if a state adopted a RML, and t_s^* is the year a state adopts an RML. $\mathbb{1}\{j = t + t_s^*\}_s$ is an indicator variable equal to one if the observation year is j years from the date of an RML. The vector \mathbf{X}_{st} includes state-level demographic and policy variables discussed in Section 2. The coefficients of interest are β_j , which capture the relationship between RML adoption and mental health treatment admissions over time, both before and after an RML.

An assumption of the DD model is “parallel trends,” where trends in the outcomes, y_{st} , should be common before RML. This test is embedded in the event-study framework, Equation (1), where the difference in pre-policy trends is captured by β_j for $j < -1$. The event-study design supports the common trends assumption if these pre-period coefficients are statistically insignificant and close to zero. The coefficients, β_j for $j \geq 0$, also allow me to examine the dynamic effects for the years post-RML.

TABLE 1 Summary statistics.

	RML	No RML
Treatment admissions (per 10,000)	183.996	239.810
Unemployment rate	6.241	5.951
Max monthly TANF benefit for 4	775.161	460.097
ACA medicaid expansion	0.907	0.394
Mandatory PDMP	0.134	0.301
Medical marijuana law	1.000	0.295
Medical marijuana dispensary	0.902	0.097
Democratic governor	0.710	0.320
Percent black	0.049	0.099
Percent hispanic	0.156	0.090
Percent asian	0.073	0.031
Percent white	0.499	0.483
Percent male	0.317	0.308
Percent age 0–17	22.790	23.185
Percent Age18–24	9.870	9.806
Percent age 25–44	27.233	26.043
Percent age 45–64	26.123	26.217
Population (10,000s)	2279.608	1151.084

Note: This table provides the averages for the main outcome and co-variables in RML and non-RML states. The averages are calculated for the pre-adoption year for RML states and 2014 for non-RML states. The Averages are weighted by state population. Unemployment rate data is from the Bureau of Labor Statistics Local Area Unemployment Database. Mandatory access prescription monitoring program dates are from Sacks et al. (2019) and Ellyson et al. (2021). Population data is from the Surveillance, Epidemiology, and End Results. The maximum monthly TANF benefit for four and Governor party affiliation is from the University of Kentucky Center for Poverty Research (2019).

A limitation of the standard TWFE model is that estimates may be biased due to states adopting an RML at different times (Goodman-Bacon, 2021). Thus, I present the main findings using a two-stage difference-in-differences (2SDID) as proposed by Gardner (2022). The first stage of the 2SDID estimates the relationship between the outcome y_{st} and fixed effects and other covariates using only untreated observations.⁵ The estimated parameters in the first stage are then used to impute the treated observations' counterfactual outcomes. These parameter estimates overcome the treatment effect heterogeneity bias because they are estimated using solely untreated observations. The second stage regresses the difference between the treated and imputed treated outcomes on the treatment variables (using all observations in the data). Standard errors are clustered at the state level and estimated using GMM following Hansen (1982). The main regressions are weighted by the state-level population (Angrist & Pischke, 2008). I also consider differing sample restrictions and unweighted estimates. In the Appendix, I also include estimates from alternative estimators (Borusyak et al., 2021; Callaway & Sant'Anna, 2021; Abraham & Sun, 2018), including the traditional TWFE model.

I summarize the average treatment effect using the following specification

$$y_{st} = \alpha_s + \gamma_t + \theta_{r(s),t} + \beta RML_{st} + \mathbf{X}_{st}\psi + u_{st} \quad (2)$$

where RML_{st} is an indicator equal to one if a state has adopted an RML at time t , and zero otherwise. All other variables are as discussed above, and β is estimated using the 2SDID approach.

4 | RESULTS

4.1 | Recreational marijuana laws and mental health treatment

Figure 1 plots the event-study pre- and post-treatment estimates (and 95% confidence intervals) of the effect of RML on the number of mental health treatment admissions. There is no pre-trend difference in mental health treatment admissions. Once

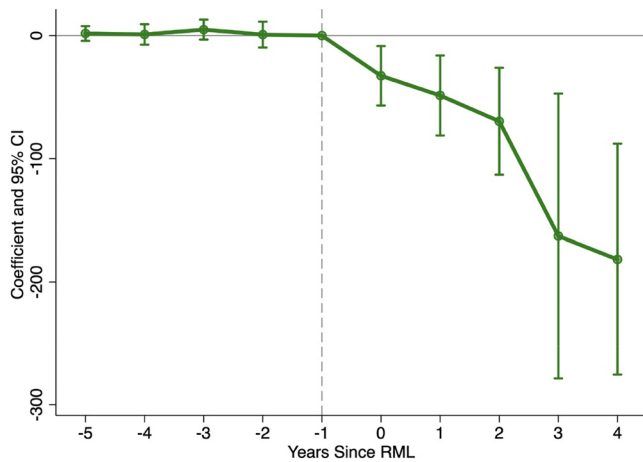


FIGURE 1 Recreational marijuana laws and total mental health treatment admissions. This figure uses Equation (1) and the 2SDID procedure from Gardner (2022) to plot the estimates from an event-study regression of mental health treatment admissions on indicators with years to and years since a RML was passed. [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 2 Recreational marijuana laws and mental health treatment admissions, heterogeneity.

	Total	Black	White	Hispanic	Male	Female	Medicaid	Non-Medicaid
RML	-92.463*** (22.309)	-87.034** (37.950)	-56.914*** (18.515)	15.342 (27.830)	-160.559*** (36.395)	-156.970*** (39.300)	-121.781*** (40.005)	-15.960 (9.787)
Observations	647	647	647	646	647	647	586	611
Mean DV	247.022	318.727	204.602	196.099	380.287	417.112	199.421	83.969
Demographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table reports the estimates for the effect of RMLs on the number of mental health treatment admissions (per 10,000) using Equation (2) and the 2SDID proposed by Gardner (2022). Column (1) includes all admissions. Columns (2)–(6) restrict the analysis to respective demographic groups. Columns (7) and (8) examine Medicaid-funded and non-Medicaid-funded admissions, respectively.

a state has an RML, there is a clear, immediate, statistically significant decrease in total admissions. The effect becomes more pronounced as time goes on and remains negative through event year four. I summarize the average post-treatment effect using Equation (2) in column (1) of Table 2. This estimate indicates that RMLs laws led to a roughly 37% decrease in total mental health treatment admissions or about 92 fewer admissions per 10,000 individuals in a state.⁶ These findings are in line with the large estimates found in Hollingsworth et al. (2022) where marijuana use increased by about 15%–25% after accounting for recreational dispensaries.⁷

4.2 | Heterogeneity in admissions

Columns (2)–(6) of Table 2 report the average effect by race, ethnicity, sex, and age. There is a 27% decrease in Black admissions and a 9% decrease in white admissions. The results are consistent for both males and females. The former experience a decrease of 42% and female admissions fell by 37% post-RML. Figures A4 and A5 plot the event-study estimates by race and gender, which are in line with the average treatment effects in Table 2.

Given that the reporting facilities in the URS service many Medicaid-insured individuals, I examine the effect of an RML on the number of Medicaid admissions (per 10,000 age 18–64) in Figure A7. Panel (a) shows a decrease in both Medicaid and non-Medicaid admissions. However, the effects are most pronounced and statistically significant for Medicaid recipients. Columns (7) and (8) of Table 2 report the post-RML average effect by insurance status. The estimate also indicate a reduction in Medicaid-funded mental health treatment admissions due to an RML. The average impact for those not insured by Medicaid is not statistically significant, and the point estimate is roughly three times smaller in magnitude.

In Appendix Figure A6 I plot the event-study estimates for the number of treatment admissions by age group. The effects are statistically significant for all age groups except those 65 and older. For those under 65, the average decrease is about 34%, comparable to the overall effect from column (1) of Table 2. Interestingly, I find a decrease among those age 13–20. Previous research suggests that MMLs have little effect on adolescent marijuana use (Anderson & Rees, 2021); however, recent

work suggests mixed evidence on the role of RMLs on adolescent use (Anderson et al., 2021). For instance, Hollingsworth et al. (2022) finds a 10% increase in marijuana use among youth.

Figure A2 presents the results for admissions into psychiatric hospitals and community mental health centers, respectively. Although there is a decrease in admissions to both types of facilities, the reduction in mental health treatment admissions is driven by community mental health centers.

4.3 | Alternative specifications, sensitivity, and robustness

Figure A8 plots estimates from other estimators commonly used to overcome the bias from the canonical TWFE model (Borusyak et al., 2021; Callaway & Sant'Anna, 2021; Abraham & Sun, 2018).⁸ The results suggest a similar effect consistent with the main findings. I also test for heterogeneity in the timing of an RML adoption by restricting the analysis to states treated before 2016 or states that expanded after 2015. Appendix Figure A9 plots these specifications and shows consistent effects after imposing either restriction.

Figure A10 plots estimates from additional models using Equation (1): unweighted estimates, excluding population controls, excluding all time-varying controls, using the levels of treatment admissions as the outcome (with and without Population weights), and a specification that drops three states with missing observations. In each case, the post-treatment effects are similar to the main findings. I also consider alternative TWFE specifications in Figure A12. This panel includes population-weighted and unweighted TWFE estimates, a Poisson specification, and a model that uses wild cluster bootstrapped standard errors. In each case, there is a clear trend break and decrease in total mental health treatment admissions resulting from RML. However, for some of these TWFE models, there is evidence of pre-trend differences likely resulting from the bias associated with the TWFE regression discussed above.

5 | DISCUSSION

This study finds that in the early years following states' adoption of RML, there was a 37% decrease in mental treatment admissions. The results are driven by those under 65, Black, and white individuals. There is also a significant decrease in Medicaid-funded treatment admissions, with a much smaller statistically insignificant effect for non-Medicaid admissions.

Due to data limitations, it is difficult to identify the mechanisms leading to the decrease in mental health treatment found above. One possibility is that RMLs increase marijuana use and that this improves mental health. Figure A11 analyzes self-reported mental health data from the Behavioral Risk Factor Surveillance System (BRFSS). These findings suggest no effect on mental health. The Behavioral Risk Factor Surveillance System is limited in that I cannot identify marijuana use or specific types of mental health disorders. The literature on the impact of cannabis on mental health is still unclear and is likely heterogeneous across mental health conditions and dosage frequency of use.

Another understudied aspect of RMLs relates to deterrence from access to treatment due to the marijuana being a Schedule I drug. Although the URS does not allow me to examine this mechanism directly, the data contains information on facility revenue. A change in government revenue resulting from RMLs may help explain the decrease in admissions found above if changes in funding encourage or discourage admissions. Figure A14 suggests no overall effect or change in revenue for mental health treatment facilities. Moreover, it is reasonable to expect deterrence from treatment to be relatively lower at substance-use treatment facilities. Given the co-occurrence of mental health and substance use disorders, if individuals are deterred from mental health treatment, there may be a spillover effect into admissions at substance use treatment facilities. Figure A13 examines this possibility using MHD admissions as reported in the Treatment Episodes Data Set (TEDS).⁹ The findings from Figure A13 indicate a suggestive decrease in some mental health disorders, which does not support the deterrence hypothesis. Nonetheless, future work should examine whether RMLs are leading to the deterrence of mental health treatment and whether any differences in access to treatment are disproportionately levied on any particular group (Grooms & Ortega, 2022; Saloner & Cook, 2013).

There is also the possibility that individuals needing mental health treatment can more readily substitute or self-medicate with marijuana, post-RML. For instance, Sarvet et al. (2018) find evidence of increased marijuana self-medication in states with MMLs. Leung et al. (2022) find similar evidence in RML states with over one-quarter of respondents reporting use for medical purposes. These authors also find that over 35% of those that use marijuana for medical purposes use it for mental health treatment. Given the evolving research in this space, it remains unclear what the appropriate guidance for self-medication should be for any mental health conditions.

My findings speak specifically to treatment admissions and should not be conflated with improving or declining mental health as the evidence on the effects of RMLs on mental health remains mixed. For instance, Borbely et al. (2022) find some evidence of poorer self-reported mental health among younger individuals residing in RML states but improvements among elderly individuals. Wang et al. (2022) find no effect on emergency department (ED) visits for schizophrenia but an increase in psychosis ED visits. Suppose marijuana is an imperfect substitute for mental health treatment, but individuals respond to an RML by treating it as such. In that case, this substitution away from treatment may only contribute to the growing prevalence of mental illness. However, it may also be that the appropriate use of marijuana can aid mental health treatment. Policymakers and future research should examine the proper role of marijuana in mental health treatment.

CONFLICT OF INTEREST STATEMENT

Dr. Ortega has nothing to disclose.

DATA AVAILABILITY STATEMENT

All data are publicly available: URS, TEDS, BRFSS, SEER Population, and BLS data.

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ENDNOTES

- ¹ For a thorough review of the public health effects of legalizing marijuana, see Anderson and Rees (2021).
- ² For additional discussion on the mental health effects of marijuana see the Appendix.
- ³ The data includes mental health treatment admissions (inpatient and outpatient). State mental health agencies (SMHAs) use the (URS) to report annual data as part of SAMHSA's Community Mental Health Services Block Grant. These reports provide an overview of state mental health delivery systems. For the main analysis, three state-years did not report treatment admissions: Alaska (2010), Iowa (2019), and New Mexico (2010). The results are robust to excluding these states entirely (see Figure A10). See Ortega (2023) for more information on these data.
- ⁴ There is no information on the insurance type of those in the non-Medicaid category (e.g., private insurance).
- ⁵ As in Powell (2021), I include the control variables in the first stage to estimate the parameters of the counterfactual.
- ⁶ Appendix Figure A3 considers admissions for individuals with serious mental illness. The results indicate a similar decrease to the main findings, although less precise.
- ⁷ Figure A1 replicates the findings in Hollingsworth et al. (2022) using the econometric specification outlined above.
- ⁸ In addition to fixed effects, the only control included in these specifications is for whether a state has a medical mari-juana law (Hollingsworth et al., 2022).
- ⁹ This data is commonly used to examine substance use treatment (Grooms & Ortega, 2019, 2022; Maclean et al., 2017; Saloner & Cook, 2013; Saloner & Le Cook, 2014). TEDS collects and compiles annual substance use admissions to all treatment facilities that receive federal funding.
- ¹⁰ For a comprehensive review of the public health effects of legalizing marijuana, see Anderson and Rees (2021). For a review of the medical literature, see Lowe et al. (2019).

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APPENDIX

A1 | Mixed evidence on the mental health effects of marijuana and recreational marijuana laws

Recreational marijuana laws have increased access and reported frequency in the use of marijuana products (Dave et al. (2023); Hollingsworth et al. (2022); Sabia and Nguyen (2018); Hasin et al. (2017)). In addition to access, there has also been growing potency in marijuana-related products (e.g., delta-9 tetrahydrocannabinol) (Firth et al., 2020; Goodman et al., 2020). One concern with this drug's increasing access and potency is the regulation lag relative to state legalization. Regulation has become particularly difficult given the myriad of available forms of cannabis and marijuana products. Although there is growing consensus surrounding marijuana legalization (Van Green, 2022), less is known about the mental health effects, if any, and appropriate monitoring.¹⁰ Understanding the health effects of this increasingly used drug is vital given the prevalence with which it is used for self-medication Leung et al. (2022); Sarvet et al. (2018).

There is no consensus on the mental health effects of marijuana use. Earlier randomized control trials suggest that cannabinoids can improve sleep quality and reduce the detrimental effects of posttraumatic stress disorder (National Academies of Sciences et al., 2017). There is also some evidence that at low doses, synthetic cannabinoid injections can serve as an antidepressant in some animals (Bambico et al., 2007; Jiang et al., 2005). Some studies also find minimal therapeutic benefits from marijuana (Bergamaschi et al., 2011; Danielsson et al., 2016). There are also recent studies suggesting that cannabis use can lead to an increased prevalence of psychosis and depression (Marconi et al., 2016; Schoeler et al., 2016, 2018).

As it pertains to marijuana laws, many studies have and continue to employ quasi-experimental approaches to leverage the variation in legislation across states. Some studies find that MMLs are associated with decreased suicides (Anderson et al., 2014; Bartos et al., 2019; Grucza et al., 2015; Rich et al., 2022). Some studies find a weak relationship between state marijuana laws and mental health or suicide after accounting for confounding factors (Anderson et al., 2014; Anderson &

Rees, 2021; Leung, 2019). Conversely, recent studies find an ad-verse effect of RMLs on mental health, particularly for younger individuals (Borbely et al., 2022; Sturman, 2022). Wang et al. (2022) finds that increasing the number of dispensaries in an RML state leads to increases in psychosis-related ED visits. Similarly, Wang et al. (2021) finds increases in ED visits for cycli-cal vomiting resulting from a growing presence of marijuana dispensaries.

Overall, marijuana-related products have been found to provide some mental health benefits in smaller-scale controlled studies. However, recent evidence suggests that the growing potency and increased access to marijuana-related products may require additional oversight or research examining appropriate use.

A2 | Figures

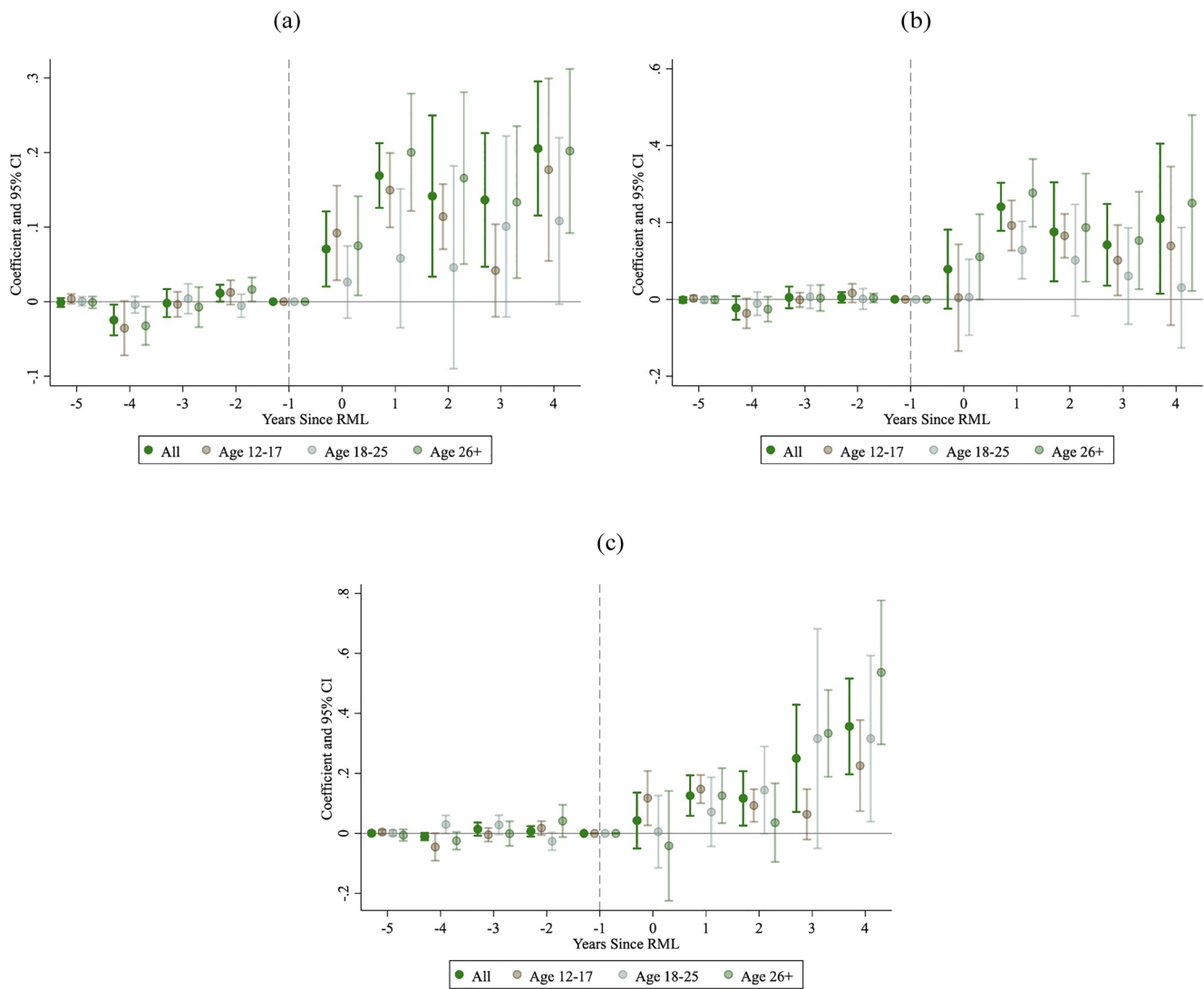


FIGURE A1 Recreational marijuana laws (RMLs) Reported Use. (a) Past Use in Past 365 Days (b) Past Use in Past 30 Days (c) First Use in Past 365 Days. These figures plot the estimates from an event-study regression of reported marijuana use in National Survey on Drug Use and Health (NSDUH) on indicators with years to and years since a RML was passed using the 2SDID proposed by Gardner (2022). *Outcome Data Source:* NSDUH. [Colour figure can be viewed at wileyonlinelibrary.com]

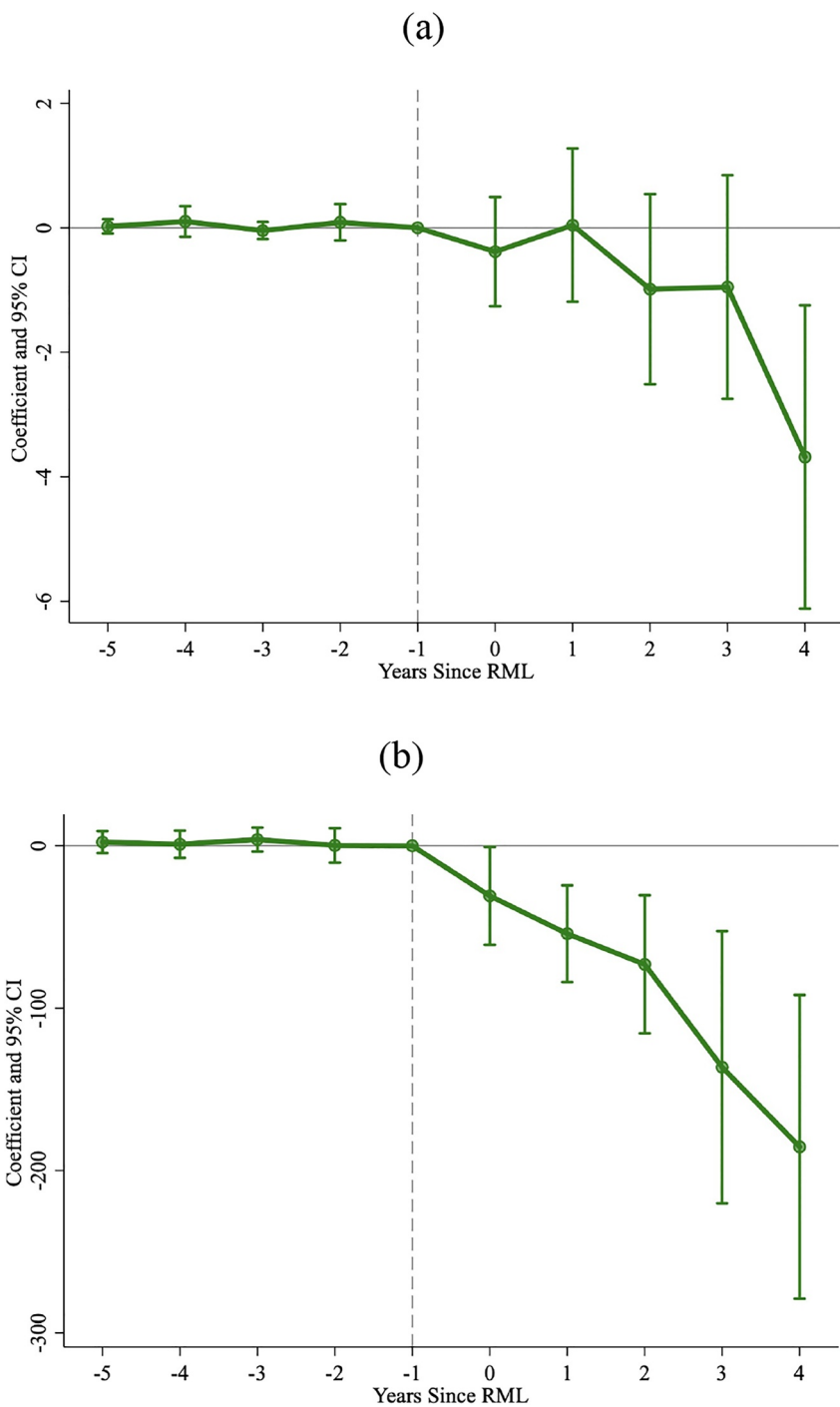


FIGURE A2 Event-Study of Recreational marijuana laws (RMLs) and Mental Health Treatment Admissions, by Type of Facility (a) Psychiatric Hospital. (b) Community. These figures plot the estimates from an event-study regression of mental health treatment admissions on indicators with years to and years since a RML was passed. See equation (2) and the 2SDID proposed by Gardner (2022). Panels (a) and (b) restrict the analysis to psychiatric hospital and community mental health admissions, respectively. *Outcome Data Source:* SAMHSA's Uniform Reporting System (URS). [Colour figure can be viewed at wileyonlinelibrary.com]

FIGURE A3 Recreational marijuana laws (RMLs) and Serious Mental Illness Treatment Admissions. This figure uses Equation (1) and the 2SDID procedure from Gardner (2022) to plot the estimates from an event-study regression of mental health treatment admissions for a serious mental illness on indicators with years to and years since a RML was passed. *Outcome Data Source:* SAMHSA's Uniform Reporting System (URS). [Colour figure can be viewed at wileyonlinelibrary.com]

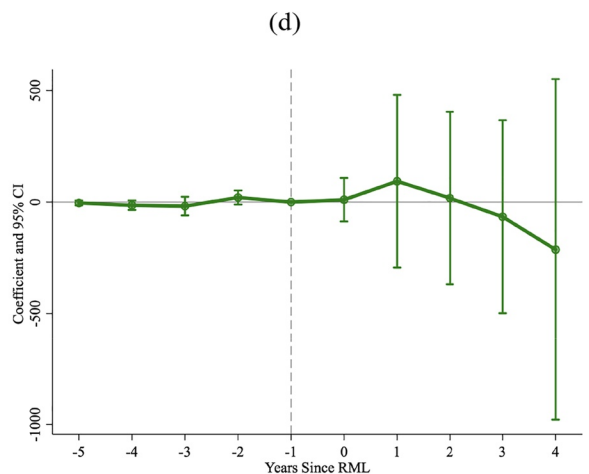
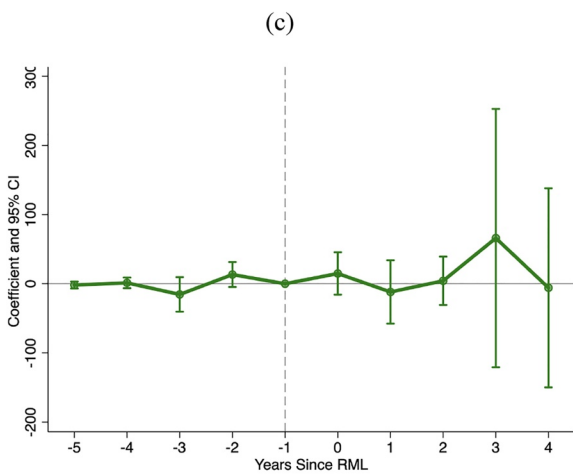
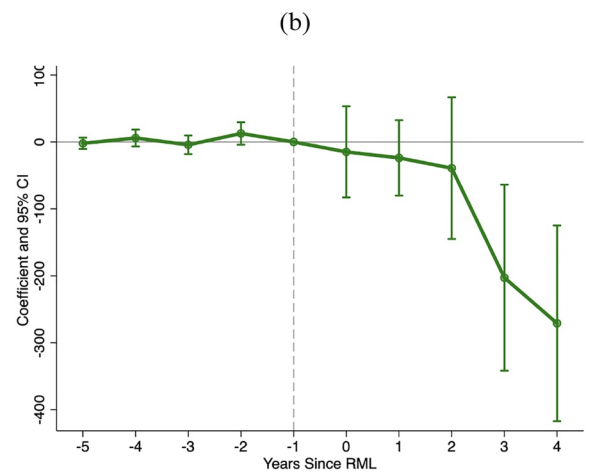
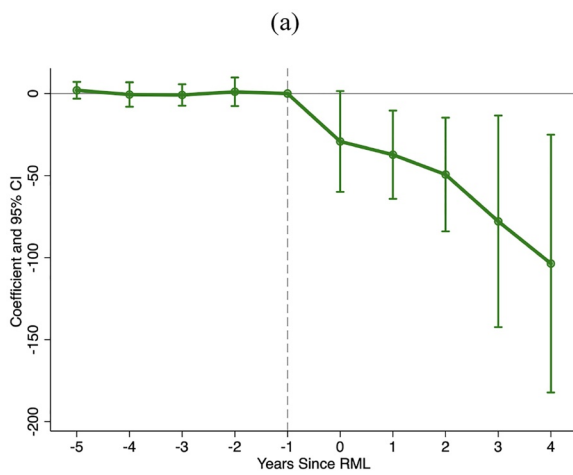
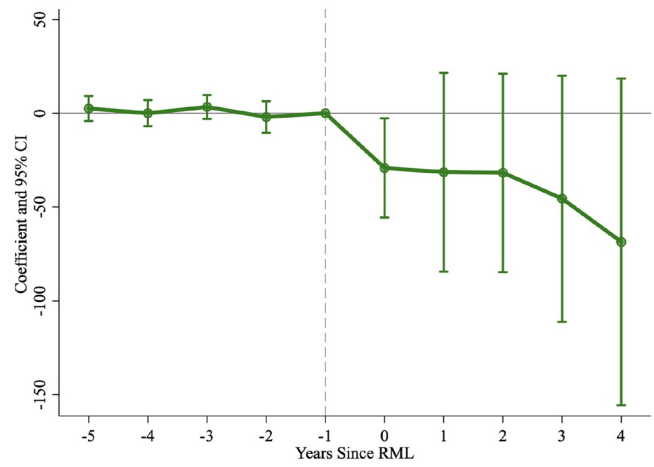


FIGURE A4 Mental Health Treatment Admissions by Race. (a) White (b) Black (c) Hispanic (d) Other Race. These figures plot the estimates from an event-study regression of mental health treatment admissions on indicators with years to and years since a recreational marijuana law (RML) was passed. See equation (2) and the 2SDID proposed by Gardner (2022). Panels (a)-(d) restrict the analysis to respective racial/ethnic groups. *Outcome Data Source:* SAMHSA's Uniform Reporting System (URS). [Colour figure can be viewed at wileyonlinelibrary.com]

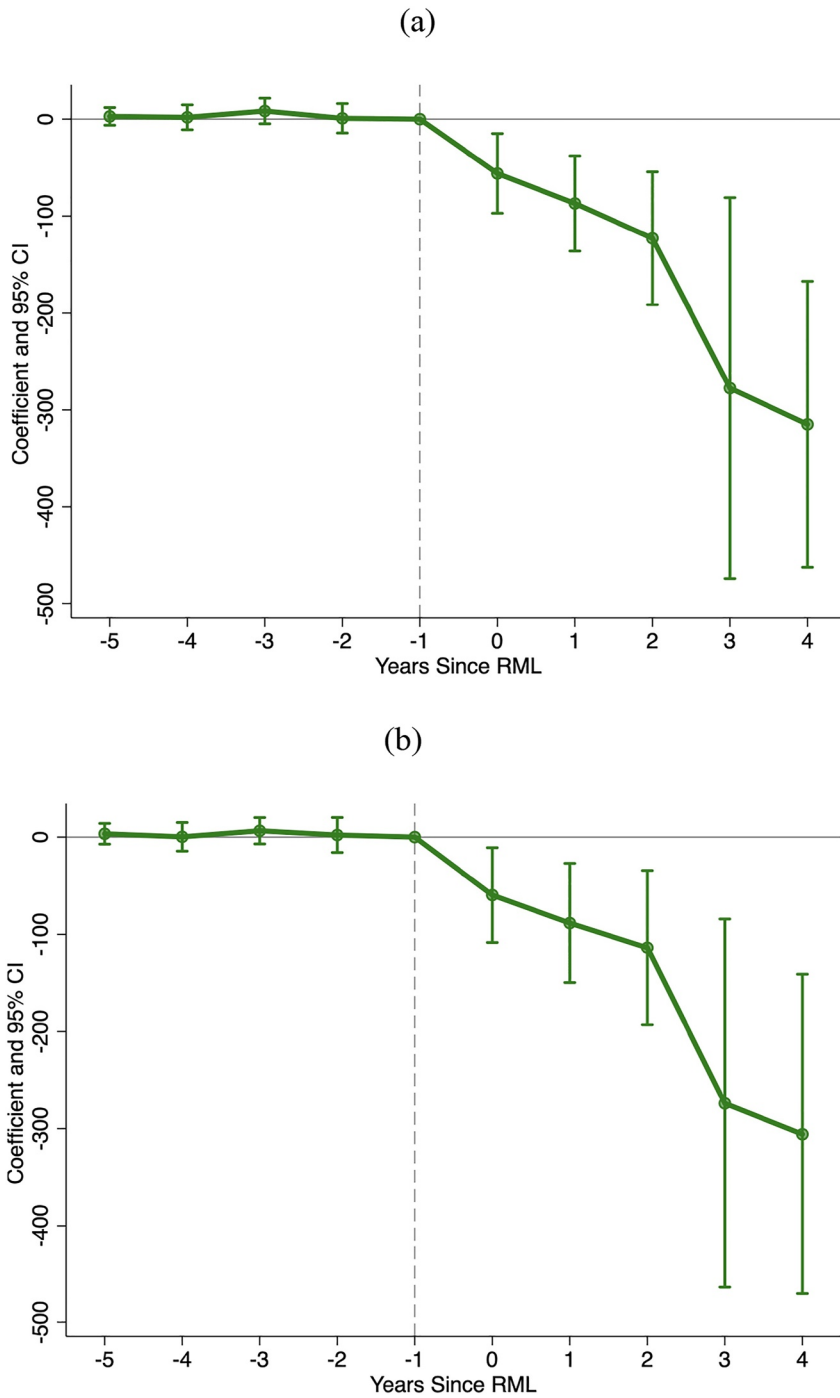


FIGURE A5 Event-Study Recreational marijuana laws (RMLs) and Mental Health Treatment Admissions, Gender (a) Male, (b) Female. These figures plot the estimates from an event-study regression of mental health treatment admissions on indicators with years to and years since a RML was passed. See Equation (2) and the 2SDID proposed by Gardner (2022). Panels (a) and (b) restrict the analysis to male and female admissions, respectively. *Outcome Data Source:* SAMHSA's Uniform Reporting System (URS). [Colour figure can be viewed at wileyonlinelibrary.com]

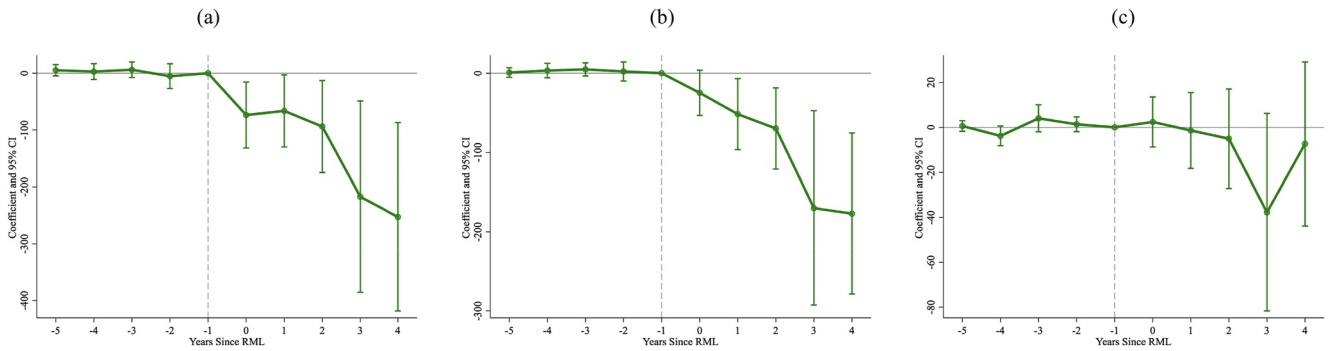


FIGURE A6 Recreational marijuana laws (RMLs) and Mental Health Treatment Admissions by Age Groups. (a) Age 13–20 (b) Age 21–64 (c) Age 65+. These figures plot the estimates from an event-study regression of mental health treatment admissions on indicators with years to and years since a RML was passed using equation (2) and the 2SDID proposed by Gardner (2022). Panels (a), (b), and (c) restrict the analysis by age group, respectively. *Outcome Data Source:* SAMHSA's Uniform Reporting System (URS). [Colour figure can be viewed at wileyonlinelibrary.com]

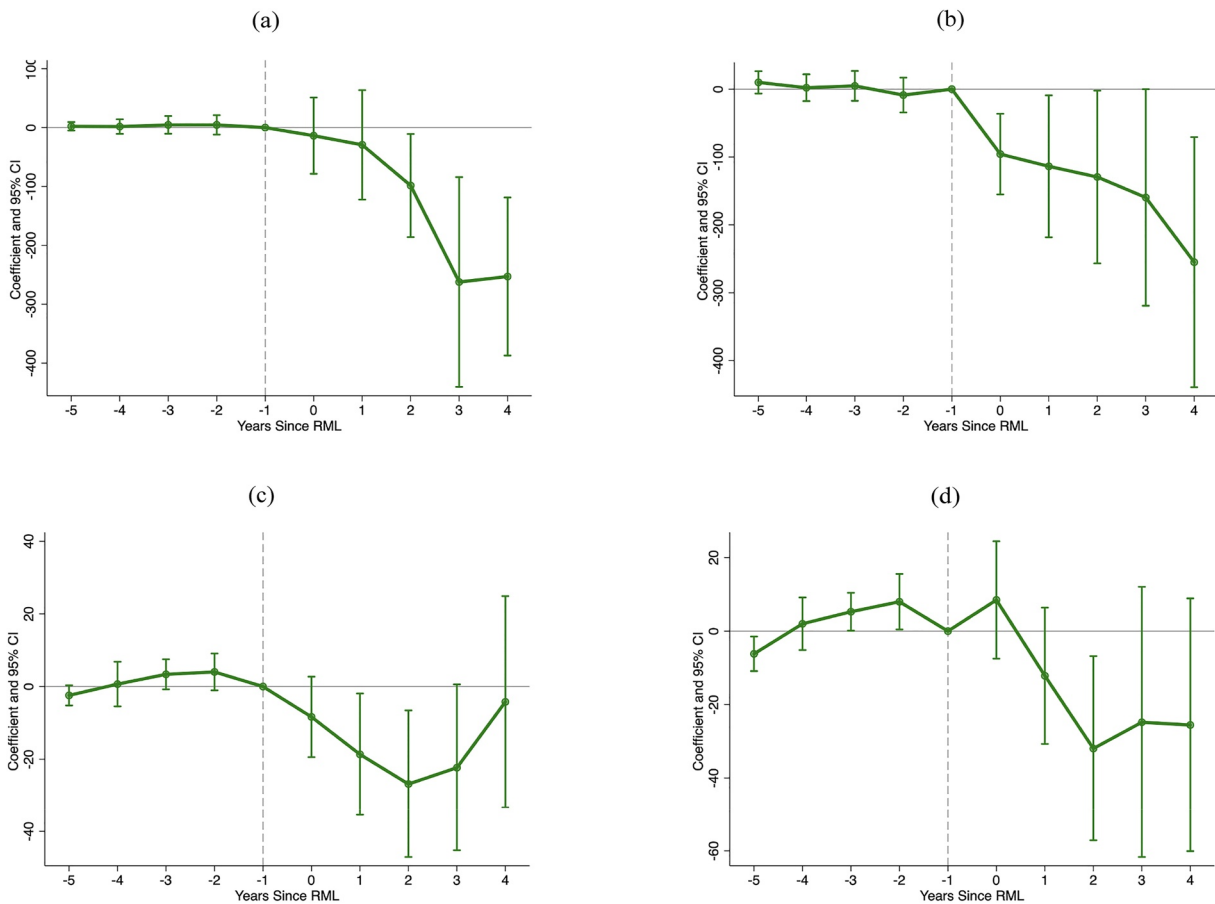


FIGURE A7 Recreational marijuana laws (RMLs) and Mental Health Treatment Admissions, Medicaid. (a) Medicaid, Population Weights (b) Medicaid, Unweighted. (c) Non-Medicaid, Population Weights (d) Non-Medicaid, Unweighted. These figures plot the estimates from an event-study regression of mental health treatment admissions on indicators with years to and years since a RML was passed using equation (2) and the 2SDID proposed by Gardner (2022). Panels (a) and (b) restrict the analysis to Medicaid-funded and non-Medicaid-funded admissions, respectively. *Outcome Data Source:* SAMHSA's Uniform Reporting System (URS). [Colour figure can be viewed at wileyonlinelibrary.com]

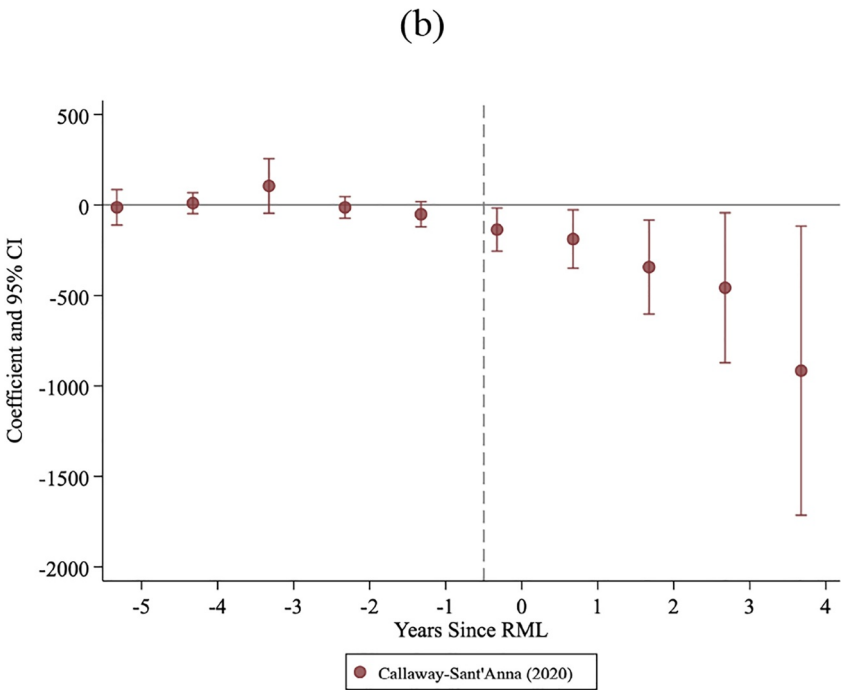
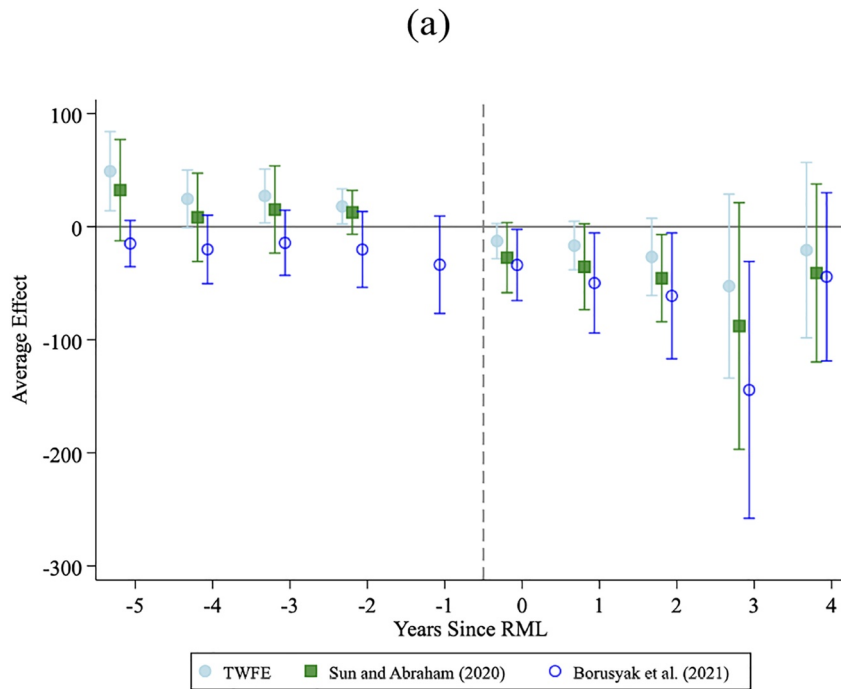
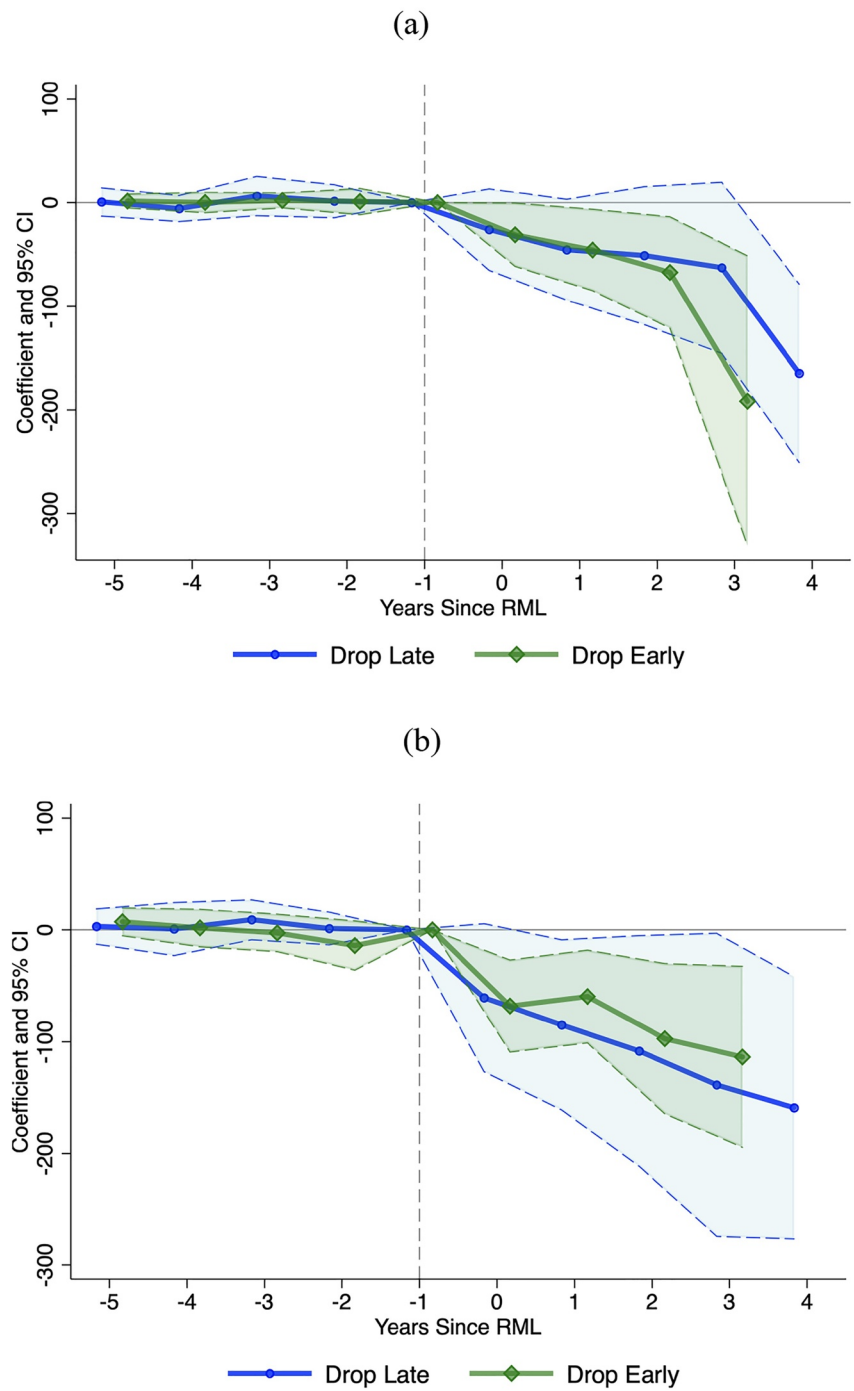


FIGURE A8 Alternative Estimators. This figure plots the event-study estimates using different estimators of the effect of Recreational marijuana laws (RMLs) on mental health treatment admissions. Each specification excludes all time-varying controls except for an indicator for whether a state has an medical marijuana law (MML). The Callaway and Sant'Anna (2021) estimates include region indicators in place of region-by-year fixed effects for convergence. *Outcome Data Source:* SAMHSA's Uniform Reporting System (URS). [Colour figure can be viewed at wileyonlinelibrary.com]

FIGURE A9 Event-Study
 Recreational marijuana laws (RMLs) and
 Mental Health Treatment Admissions,
 Early versus Late Adopters (a) Population
 weights, (b) Unweighted. These figures plot
 the estimates from an event-study regression
 of mental health treatment admissions on
 indicators with years to and years since an
 RML was passed. See Equation (2) and the
 2SDID proposed by Gardner (2022). Panel
 (a) weights by state population and panel
 (b) estimates are unweighted. The circle
 indicators are estimated after dropping states
 that passed an RML after 2015. The diamond
 indicators are estimated after dropping states
 that passed an RML before 2016. In both
 cases, the control group consist of states
 that never implemented an RML. *Outcome
 Data Source:* SAMHSA's Uniform Reporting
 System (URS). [Colour figure can be viewed
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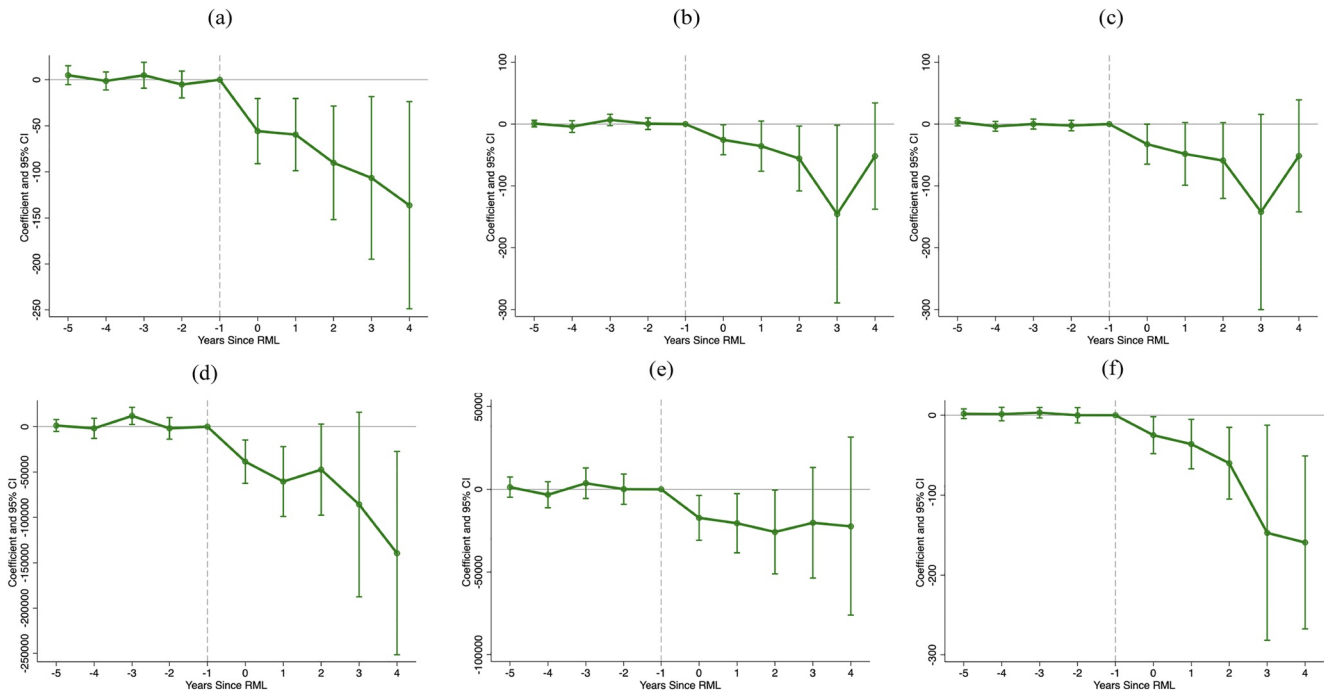


FIGURE A10 Additional Specifications, (a) Unweighted (b) No Population Controls (c) No Controls (d) Levels, Population Weights (e) Levels, Unweighted (f) Balanced Panel. These figures plot the estimates from an event-study regression of mental health treatment admissions on indicators with years to and years since a recreational marijuana law (RML) was passed. See equation (2) and the 2SDID procedure from Gardner (2022). Panel (a) plots the unweighted estimates, panel (b) excludes population controls, panel (c) excludes all time-varying controls, panel (d) uses the level of total admissions as the outcome and weights by state population, panel (e) uses the level of total admissions as the outcome and does not weight by state population, panel (f) restricts the analysis to states with observed treatment admissions for every year in the sample. *Outcome Data Source:* SAMHSA's Uniform Reporting System (URS). [Colour figure can be viewed at wileyonlinelibrary.com]

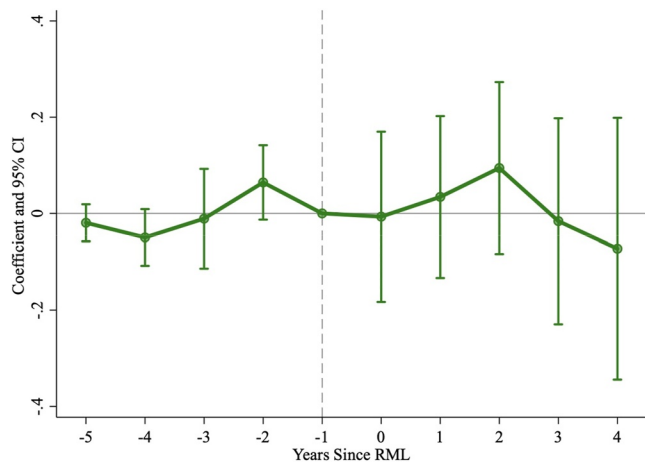


FIGURE A11 Recreational marijuana laws (RMLs) and Self-Reported Mental Health. This figure uses Equation (1) and the 2SDID procedure from Gardner (2022) to plot the estimates from an event-study regression of self-reported mental health on indicators with years to and years since a RML was passed. Self-reported mental health is defined as the number of poor mental health days within the last 30 days. *Outcome Data Source:* Behavioral Risk Factor Surveillance System (BRFSS). [Colour figure can be viewed at wileyonlinelibrary.com]

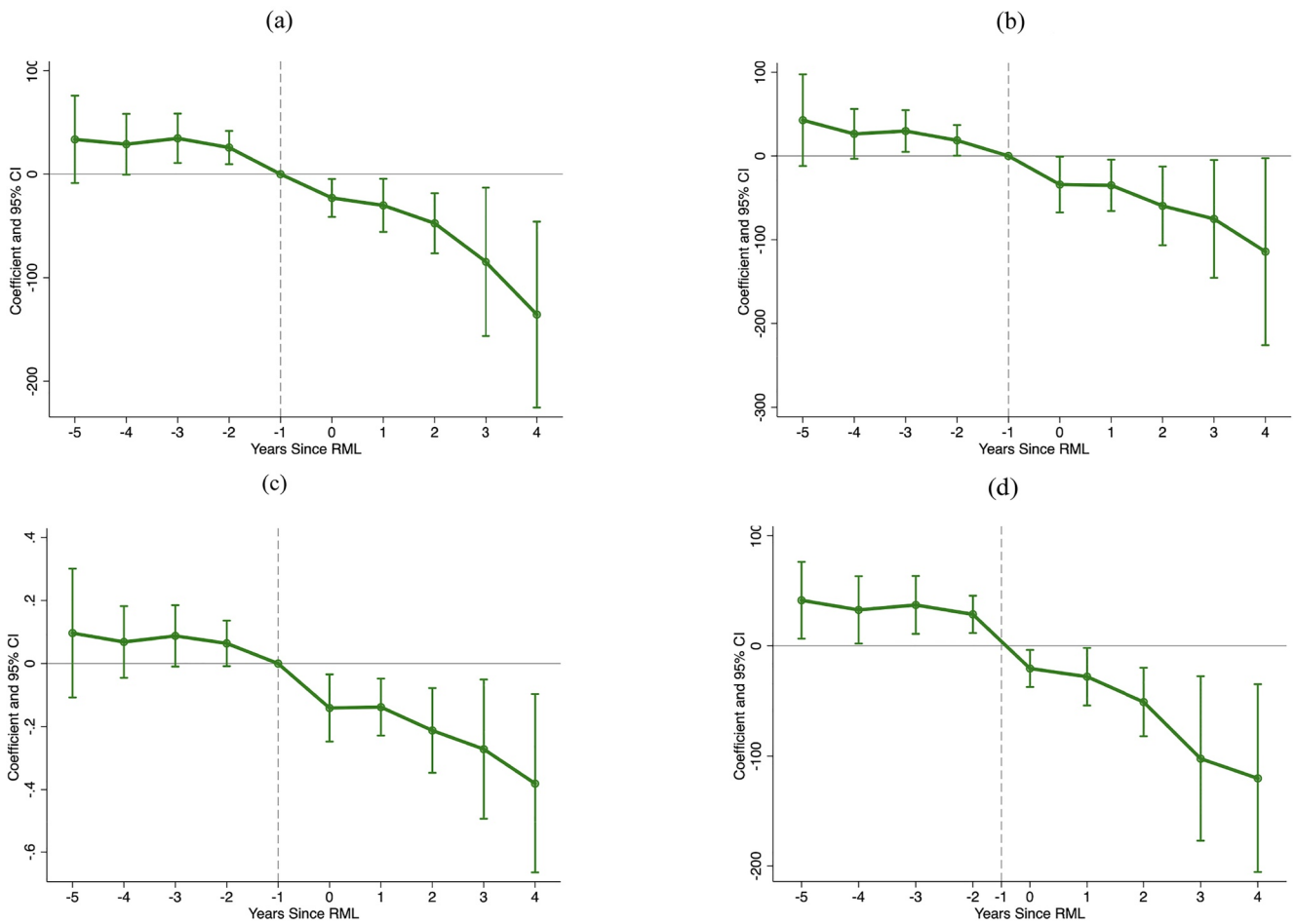


FIGURE A12 Two-way fixed effect (TWFE) Specifications. (a) TWFE, Population Weights (b) TWFE, Unweighted (c) Poisson (d) Wild Cluster. These figures plot the estimates from a canonical TWFE event-study regression of mental health treatment admissions on indicators with years to and years since a recreational marijuana law (RML) was passed. See Equation (2). Panel (a) plots the TWFE estimates weighted by population, panel (b) estimates are unweighted, panel (c) uses a poisson estimator, and panel (d) adjusts standard errors using Wild cluster bootstrap. *Outcome Data Source:* SAMHSA's Uniform Reporting System (URS). [Colour figure can be viewed at wileyonlinelibrary.com]

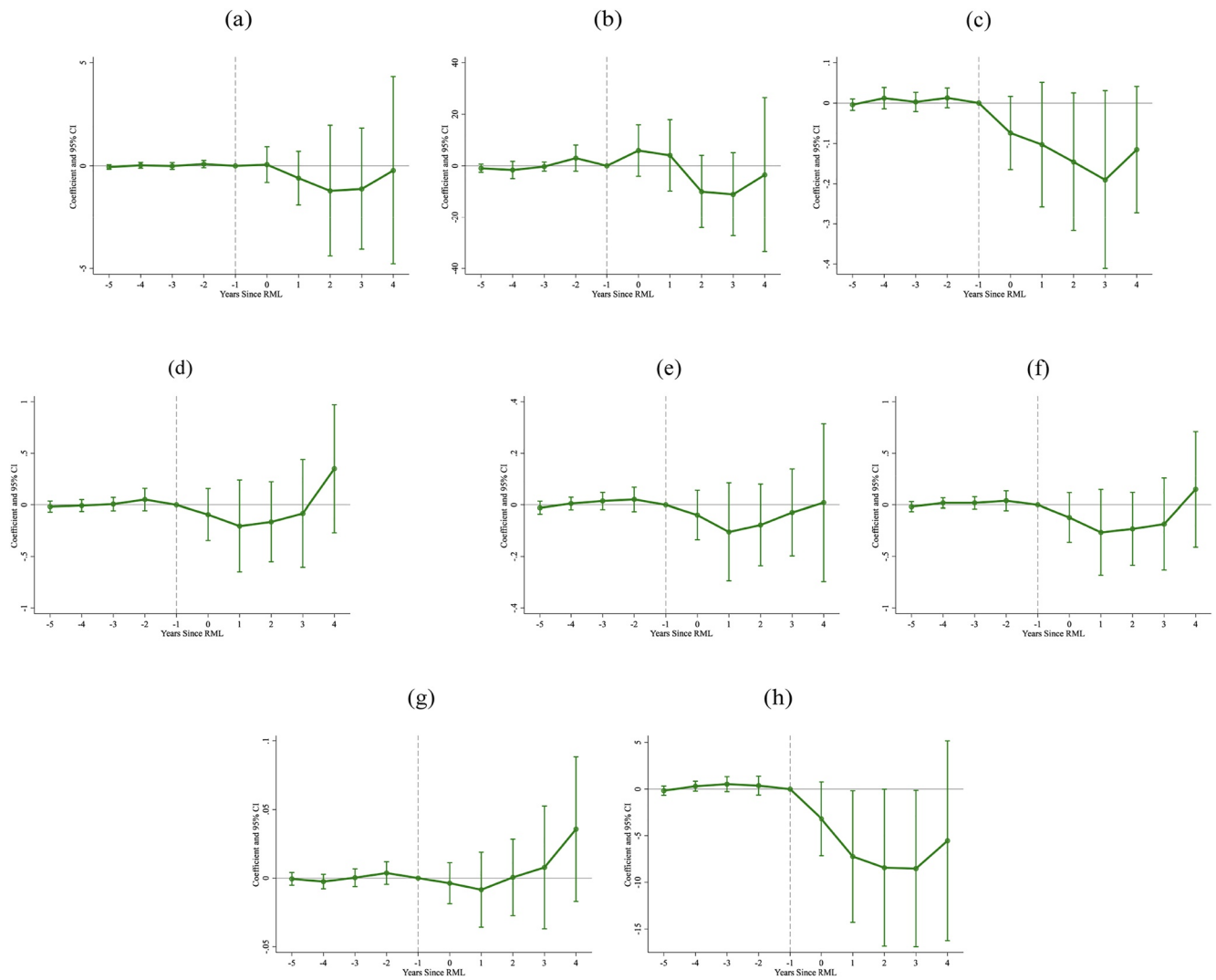


FIGURE A13 Recreational marijuana laws (RMLs) and Substance Use Treatment Admissions, Mental Disorders. (a) Cannabis Abuse (b) Co-Occurring Mental and SUD (c) Anxiety (d) Depression (e) Schizophrenia (f) Bipolar (g) ADHD (h) Other Mental. These figures plot the estimates from an event-study regression of substance use treatment facility admissions for mental health disorders on indicators with years to and years since a RML was passed. See equation (2) and the 2SDID proposed by Gardner (2022). Panels (a)-(h) restrict the analysis by the Diagnostic and Statistical Manual of Mental Disorders (DSM) classification. *Outcome Data Source:* Treatment Episodes Data Set-Admissions. [Colour figure can be viewed at wileyonlinelibrary.com]

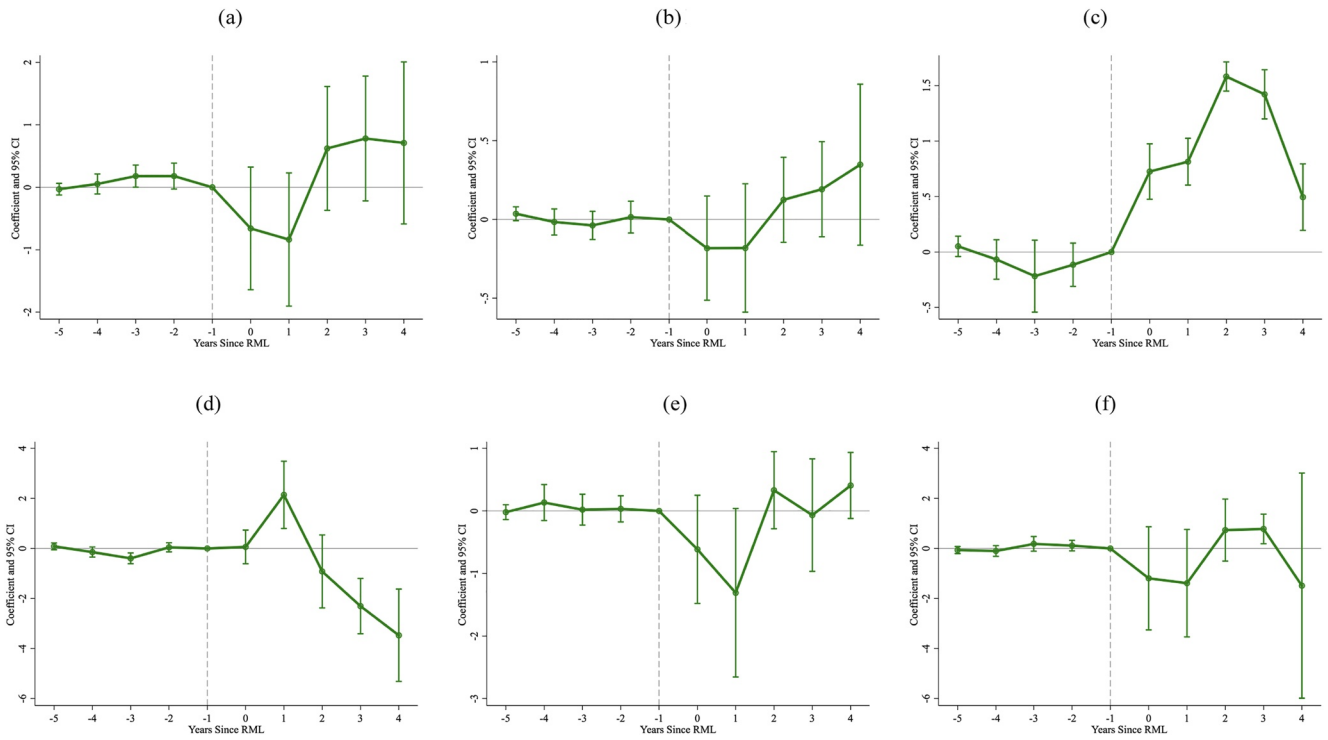


FIGURE A14 Community Mental Health Agency Revenue. (a) Total (b) Block Grants (c) Other SAMHSA (d) Other Federal (Non-Samhsa) (e) State (f) Medicaid. These figures plot the estimates from an event-study regression of logged mental health treatment facility revenue on indicators with years to and years since a recreational marijuana law (RML) was passed. See Equation (2) and the 2SDID proposed by Gardner (2022). Panels (a)–(d) restrict the analysis by revenue source. *Outcome Data Source:* SAMHSA’s Uniform Reporting System (URS). [Colour figure can be viewed at wileyonlinelibrary.com]