Have Recreational Marijuana Laws Undermined Public Health Progress on Adult Tobacco Use?

Presenter

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Acknowledgment & Disclosure Statement

- **This is a joint work with:**

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- **No financial disclosures or conflicts of interest to report**

- **Preliminary results**

Agenda

- **Context and Background**
  - **Recreational marijuana legalization & public health / costs. vs. benefits**
  - **Prior studies**

- **Research questions**

- **Data & Methods**

- **Results**

- **Implication for public health**

Recreational Marijuana Laws (RMLs)

- Legalize the possession, sale & consumption of marijuana for recreational purposes

- Consumer gains access to MJ legally through retail dispensaries (most states)

- Consumer allowed to grow MJ for personal use (most states)

- Unlike most medical marijuana laws (MMLs), RMLs do not require a doctor's recommendation and do not require registration

Map of RMLs

RML Enactments
- Never Adopters
- 2012
- 2015
- 2016
- 2017
- 2018
- 2020
- 2021
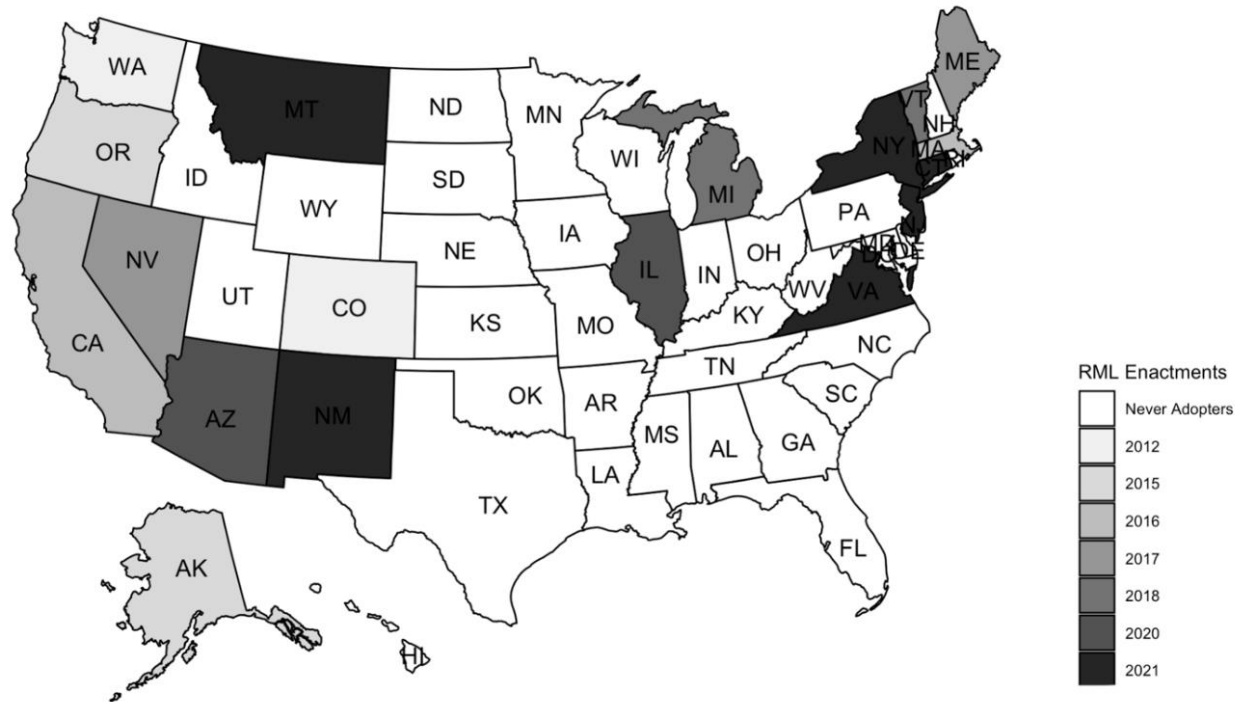
- **CO & WA first states to pass RMLs (11/2012)**

- **To date – 18 states + Washington D.C. have legalized MJ**

- **Support for MJ legalization has doubled (68% in 2020 vs. 34% in 2001)**

Background

- **Proponents**
  - **Light-to-moderate MJ use generates few adverse health effects** (NASEM 2017)

  - **Potential substitution away from alcohol & opioids to MJ**

  - **Costs of enforcing marijuana prohibition run hundreds of billions per year**
    - **Labor market penalties** (Mueller-Smith and Schnepel 2021; Agan et al. 2021)
    - **Violence used by cartels to maintain market power**

  - **Reduce racial disparities in how the prohibition on marijuana is enforced**

Background

- ## Opponents
  - RMLs could increase heavy/frequent marijuana use - leading to more frequent chronic bronchitis episodes, impaired driving, adverse vascular health (NASEM 2017; Volkow et al. 2014)

  - "Gateway effect": addiction to harder drugs such as cocaine, meth, heroin, & fentanyl

  - Spillovers to minors through negative, long-lasting effects on cognitive development (NIDA 2020; Volkow et al. 2014)

  - **RMLs may normalize smoking and lead to higher tobacco use / co-use of MJ and tobacco**

Will RMLs enhance social welfare?

External costs of legalization must be weighed against

- **(i) the utility gains from consumption**
- **(ii) the cost savings from reduced incarceration, any reductions in drug cartel-induced violence, and reduced labor market penalties associated with criminal records to judge the efficacy of legalization from a social welfare perspective**

What are some of the main external costs of legalization?

- **Addiction to Harder Drugs via "Gateway Effects" (Internalities)**
  - ◦ Could lead to cocaine, heroin, methamphetamine, opioid addiction
  - ◦ Rational addiction vs time-inconsistent preferences
  - ◦ For youth, decision-making over consuming addictive substances may not be rational due to underdevelopment of the prefrontal cortex (Casey et al. 2008; Arain et al. 2013)
- **Crime (Externalities)**

- **Spillovers into tobacco use behaviors**

Research Question

- **Assess any broader spillover impact of state RMLs on tobacco use behaviors**

- **Focus on Adults**

  - First-stage effects on MJ use
  - Spillovers into various forms of tobacco use
  - Different margins of use
  - Dynamic consumption responses post-adoption
  - Dynamic transitions across consumption margins

Prior Studies

- **Tobacco use and MJ use co-occur** (McClure et al. 2018; Goodwin et al. 2018; Driezen et al. 2022; Agrawal et al. 2008)
  - **MJ users more likely to initiate cigarette use**
  - **Higher MJ use follows tobacco use**

- **Natural experiments: exogenous variation in tobacco use**
  - **Excise cigarette taxes** (Farrely et al. 2001; Anderson et al. 2020)
  - **E-cig minimum legal purchase age** (Pesko et al 2016; Dave et al. 2019)
  - **Tobacco-21** (Hansen et al. 2020)

- **Medical Marijuana Laws (MMLs)**
  (Anderson et al. 2020; Choi et al. 2019; Andreyeva & Ukert 2019; Veligati et al. 2020)

- **Recreational Marijuana Laws (MMLs)**
  - **Alley et al. (2020) – college students**
  - **Miller & Seo (2018) – tobacco sales in WA**
  - **Veligati et al. (2020) – total cigarette sales**
  - **Vuolo et al. (2022) – short-term effects in 2 states through 2015**

Data

- **National Survey of Drug Use & Health (NSDUH): 2002-2019**
  - MJ use and tobacco use / cigarette use
  - N ≈ 867

- **Behavioral Risk Factor Surveillance System (BRFSS): 2000-2019**
  - Cigarette & e-cigarette use
  - Use & quit margins
  - N ≈ 7.4 million

- **Current Population Surveys – Tobacco Use Supplements (CPS-TUS): 2000-2019**
  - Cigarette, e-cigarette & other forms of tobacco use (smokeless, pipes, cigars…)
  - Extensive & intensive margins
  - N ≈ 1.13 million

- **Population Assessment of Tobacco & Health (PATH): 2013-2019**
  - MJ use and various forms of tobacco use
  - Longitudinal
  - N ≈ 157,000

Methodology
Generalized TWFE Difference-in-Differences

$$Y_{(i)st} = \beta_0 + \beta_1 RML_{st} + \beta_2 MML_{st} + X_{(i)st}\alpha + \tau_t + \delta_s \; [+\delta_s * t] + \varepsilon_{(i)st}$$

Outcome for state *s* in year *t*

Indicators for whether RML & MML is enacted

Socio-demographics
Other MJ policies
Economic/Political controls
Crime policies
Substance use policies
Social welfare policies

Period Fixed Effects

State Fixed Effects

State Linear Trends

State-clustered Standard Errors

Modeling Extensions & Checks

- Separately incorporate allowances in the state for recreational sales / retail access

- Event-study analyses to assess parallel trends & policy dynamics

- Synthetic control DD

- Callaway-Sant'Anna estimator (Callaway & Sant'Anna 2021)
  - Use never-adopters as counterfactuals (results are similar using not-yet-adopters)

- Longitudinal analyses with person fixed effects (PATH)

- Discrete time hazard models (PATH)

$$Prob(S_{ist} = 1 \mid t - 1 < T < t)$$

$$= \delta_0 + \delta_1 RML_{st} + \delta_2 MML_{st} + X_{ist}\kappa + \alpha_s + \theta_t + \mu_i + \varepsilon_{ist}$$
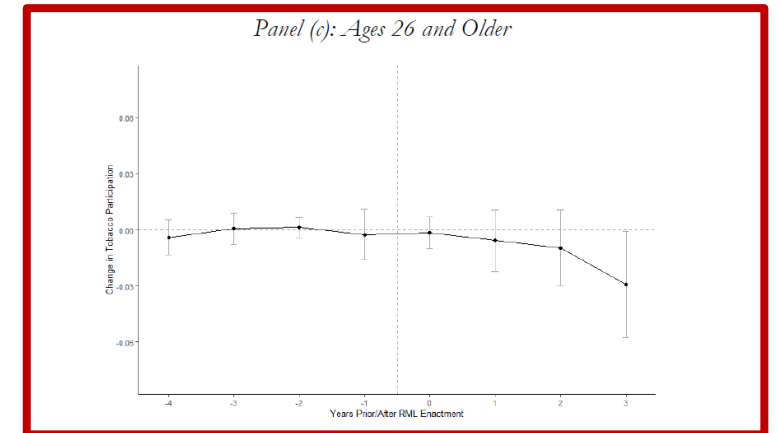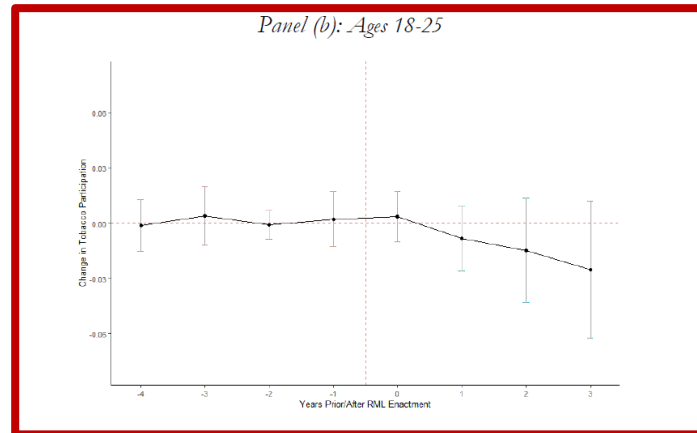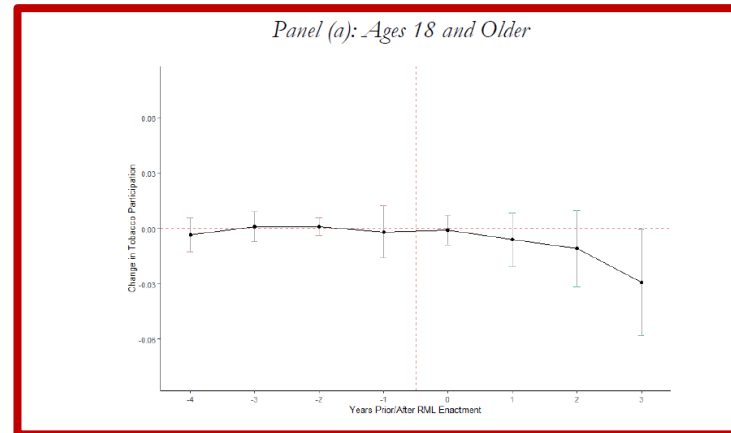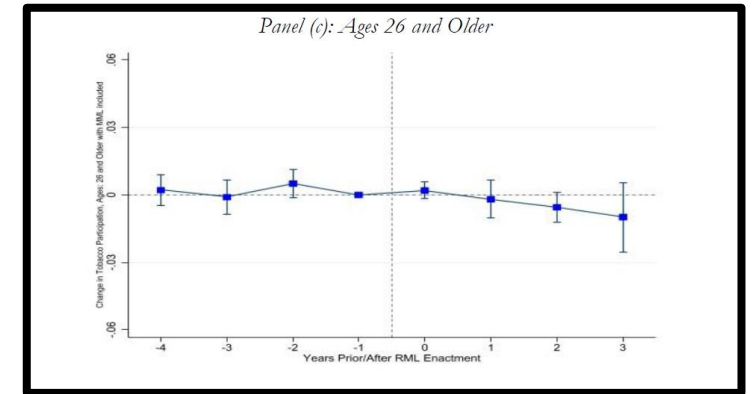
RMLs Increased MJ Use among Adults & Young Adults?
Yes, by 3-5 percentage points (40-50%) (NSDUH)

	Two-Way Fixed Effects (TWFE)					Callaway-Sant'Anna (CS)
	(1)	(2)	(3)	(4)	(5)	(6)
Panel I: Overall RML Effect						
RML	0.0368***	0.0346***	0.0429***	0.0414***	0.0205***	0.0310**
	(0.00719)	(0.00765)	(0.00498)	(0.00462)	(0.00705)	(0.0040)
Pre-Treatment Mean DV	0.0745	0.0745	0.0745	0.0745	0.0745	0.0745
Panel II: Lagged RML Effects						
Year of RML Enactment	0.0104***	0.0102***	0.0146***	0.0159***	0.0113***	0.0140***
	(0.00331)	(0.00329)	(0.00277)	(0.00309)	(0.00334)	(0.0033)
1 Year After RML	0.0151**	0.0149**	0.0227***	0.0245***	0.0159**	0.0245**
	(0.00618)	(0.00637)	(0.00576)	(0.00562)	(0.00599)	(0.0072)
2 Year After RML	0.0161**	0.0161**	0.0253***	0.0278***	0.0168**	0.0244**
	(0.00607)	(0.00654)	(0.00796)	(0.00824)	(0.00812)	(0.0083)
3 Years+ After RML	0.0377***	0.0393***	0.0383***	0.0376***	0.0185***	0.0259**
	(0.00244)	(0.00234)	(0.00323)	(0.00279)	(0.00364)	(0.0087)
State FE, Year FE & MML?	Yes	Yes	Yes	Yes	Yes	Yes
Socioeconomic controls?	No	Yes	Yes	Yes	Yes	No
Tobacco control policies?	No	No	Yes	Yes	Yes	No
Social welfare policies?	No	No	No	Yes	Yes	No
State Linear Time Trends?	No	No	No	No	Yes	No
N	867	867	867	867	867	867

Positive Spillovers into Tobacco / Cigarette Use?
No (NSDUH)

Panel (a): Ages 18 and Older

Panel (b): Ages 18-25

Panel (c): Ages 26 and Older

Panel (a): Ages 18 and Older

Panel (b): Ages 18-25

Panel (c): Ages 26 and Older
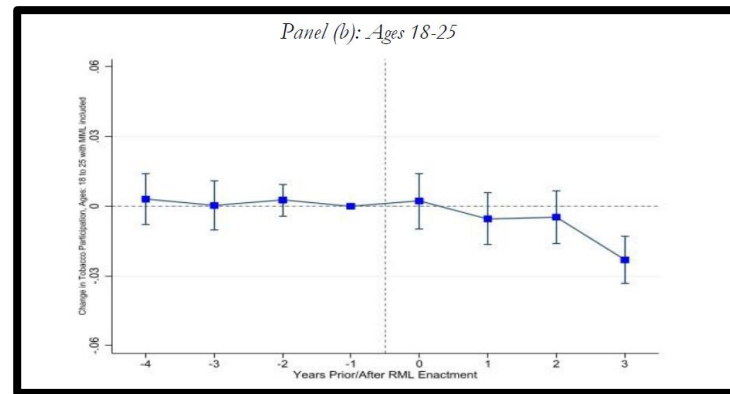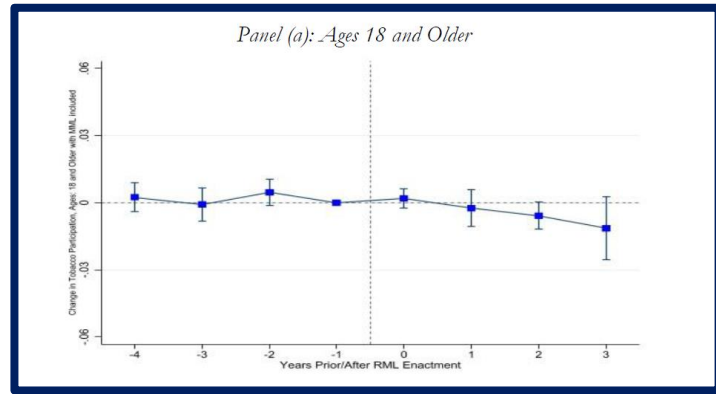
Positive Spillovers into Tobacco / Cigarette Use?
Decreased by 0.5 ~ 1.5 pct. points

	Two-Way Fixed Effects (TWFE)					Callaway-Sant'Anna (CS)
	(1)	(2)	(3)	(4)	(5)	(6)
Panel I: Overall RML Effect						
RML	-0.00674**	-0.00343	-0.00340	-0.00484	-0.0100	-0.0131
	(0.00263)	(0.00361)	(0.00414)	(0.00462)	(0.00843)	(0.0089)
Pre-Treatment Mean DV	0.2826	0.2826	0.2826	0.2826	0.2826	0.2826
Panel II: Lagged RML Effects						
Year of RML Enactment	0.00145	0.00162	0.00243	0.00217	0.000318	-0.0008
	(0.00190)	(0.00202)	(0.00158)	(0.00196)	(0.00376)	(0.0034)
1 Year After RML	-0.00120	-0.000157	0.00278	0.00341	-0.00591	-0.0061
	(0.00321)	(0.00379)	(0.00327)	(0.00381)	(0.00619)	(0.0064)
2 Year After RML	-0.00719***	-0.00640*	-0.00292	-0.00179	-0.0162**	-0.0107
	(0.00265)	(0.00373)	(0.00347)	(0.00464)	(0.00751)	(0.0102)
3 Years+ After RML	-0.0118*	-0.0145**	-0.0141**	-0.0138*	-0.0353***	-0.0291*
	(0.00665)	(0.00702)	(0.00685)	(0.00804)	(0.00974)	(0.0118)
State FE, Year FE & MML?	Yes	Yes	Yes	Yes	Yes	Yes
Socioeconomic controls?	No	Yes	Yes	Yes	Yes	No
Tobacco control policies?	No	No	Yes	Yes	Yes	No
Social welfare policies?	No	No	No	Yes	Yes	No
State Linear Time Trends?	No	No	No	No	Yes	No
N	867	867	867	867	867	867

Effects are generally larger when retail sales open up

	(1)	(2)	(3)	(4)	(5)
Panel I: Marijuana Use					
RML With Sales Allowed	0.0409***	0.0393***	0.0461***	0.0444***	0.0237***
	(0.00849)	(0.00897)	(0.00539)	(0.00463)	(0.00759)
RML Without Sales Allowed	0.0276***	0.0238***	0.0341***	0.0327***	0.0156***
	(0.00432)	(0.00427)	(0.00531)	(0.00502)	(0.00552)
Panel II: Tobacco Use					
RML With Sales Allowed	-0.0106***	-0.00750*	-0.00676	-0.00786	-0.0197**
	(0.00263)	(0.00397)	(0.00450)	(0.00519)	(0.00916)
RML Without Sales Allowed	0.00193	0.00584	0.00584	0.00373	0.00453
	(0.00532)	(0.00446)	(0.00451)	(0.00539)	(0.00842)

Results similar for the BRFSS
No evidence of any positive spillovers

Panel (a): Any Cigarette Use
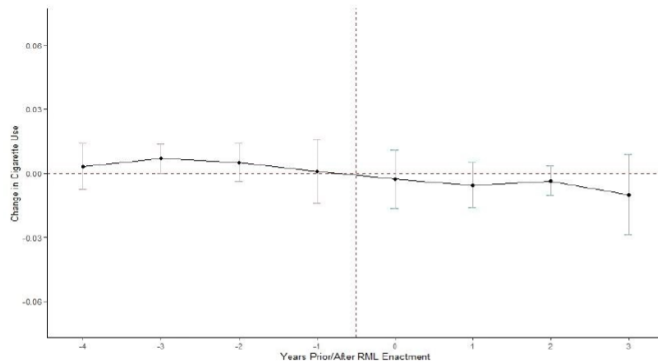
Panel (b): Everyday Smoking
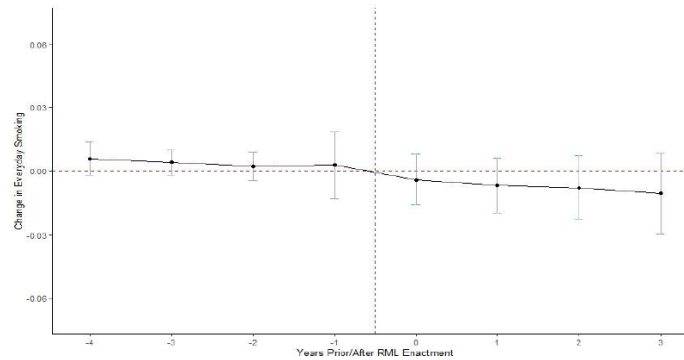
Panel (c): Quit
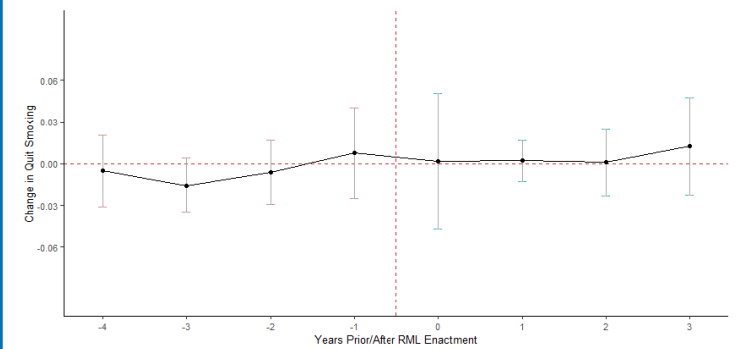
Any increase in E-cigarette use?
No evidence (BRFSS) – but…

	Ages 18 and Older		Ages 18-to-20		Ages 21 and Older	
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel I: Overall RML Effect					
RML	-0.0265***	-0.0450***	-0.107***	-0.132**	-0.0174*	-0.0343*
	(0.00804)	(0.0130)	(0.0295)	(0.0644)	(0.00933)	(0.0199)
Pre-Treatment Mean DV	0.0342	0.0342	0.1369	0.1369	0.0319	0.0319
	Panel II: Lagged RML Effects					
Year of RML Enactment	-0.000489	0.00599	-0.0632	-0.0733	0.00285	0.00932
	(0.0144)	(0.0198)	(0.0933)	(0.143)	(0.0235)	(0.0272)
1 Year After RML	-0.0244*	-0.0331	-0.134	-0.150	-0.0154	-0.0269
	(0.0136)	(0.0215)	(0.0883)	(0.172)	(0.0197)	(0.0241)
State FE, Year-Month FE & MML?	Yes	Yes	Yes	Yes	Yes	Yes
Individual and State Controls?	Yes	Yes	Yes	Yes	Yes	Yes
State Linear Time Trends?	No	Yes	No	Yes	No	Yes
N	187114	187114	11018	11018	176096	176096

Heterogeneity?
Too imprecise (BRFSS)

Panel (a): Cigarette Use
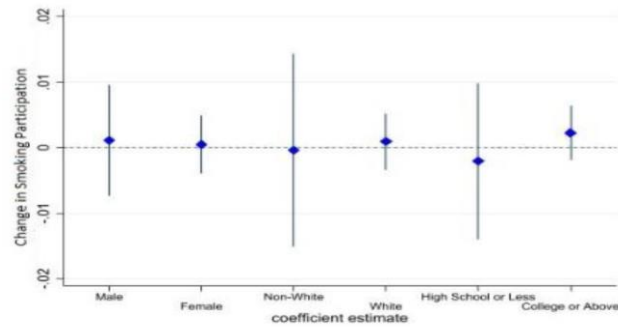
Panel (b): Everyday Smoking

Panel (c): E-Cigarette Use
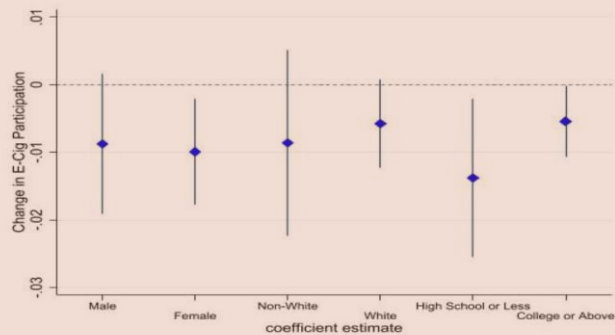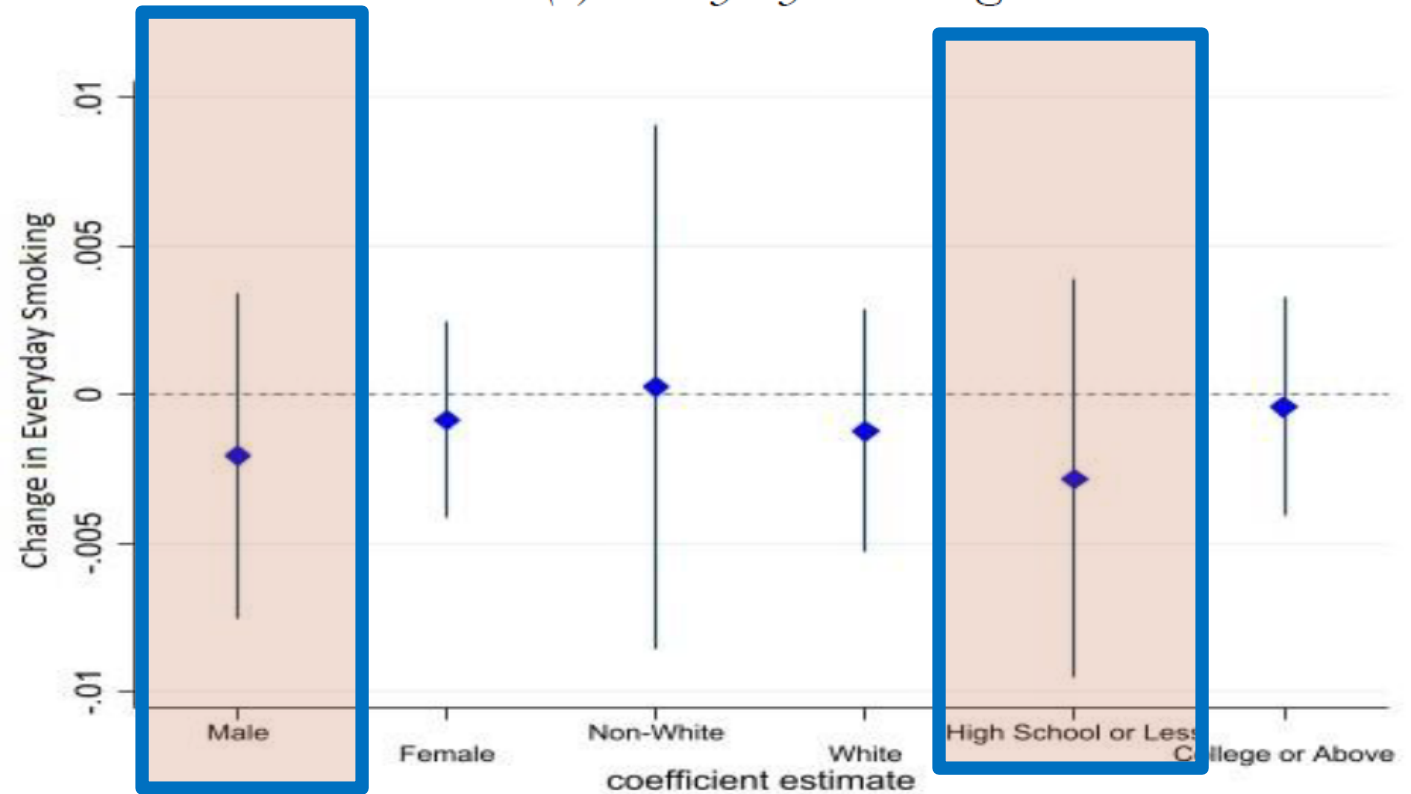
Results similar for the CPS-TUS
No evidence of any positive spillovers
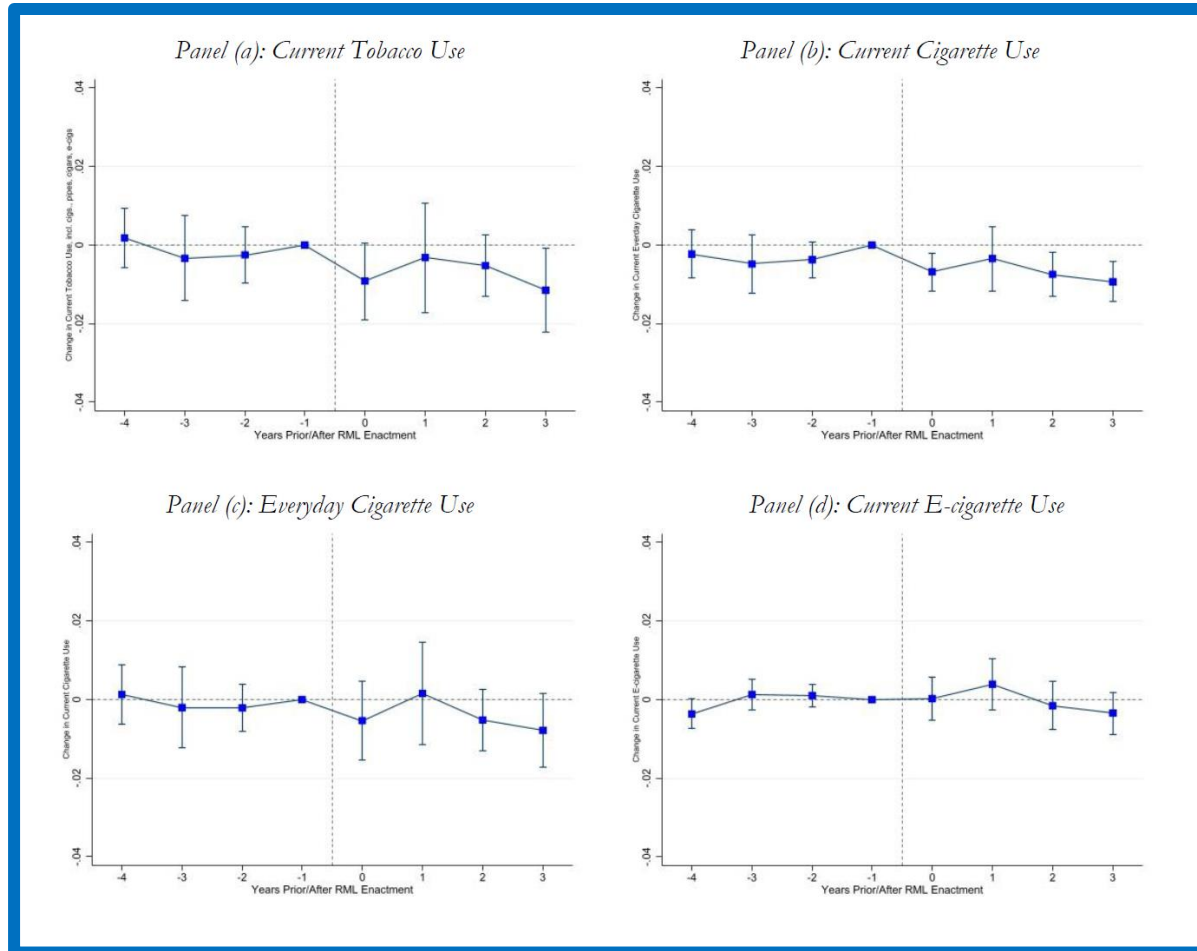
Longitudinal Analyses – PATH
RMLs increase MJ use (8-22%)

	Past 12-month Marijuana Use	Past 30-day Marijuana Use	Past 30-day Blunt Use	Number of days of Blunt Use in Past 30 days	Past 2-day Vaped Marijuana Use	Ever Vaped Marijuana Use
	(1)	(2)	(3)	(4)	(5)	(6)
Panel I: Ages 18 and Older						
RML	0.020***	0.019***	0.001	0.031	0.008***	0.019***
	(0.005)	(0.004)	(0.002)	(0.048)	(0.003)	(0.005)
N	156,804	156,671	101,489	83,414	87,457	87,754
Pre-Treatment Mean DV	0.253	0.183	0.062	0.716	0.038	0.170
Panel II: Ages 21 and Older						
RML	0.020***	0.018***	0.002	0.041	0.008***	0.017***
	(0.005)	(0.005)	(0.002)	(0.053)	(0.003)	(0.005)
N	132,002	131,898	85,106	68,697	71,226	71,464
Pre-Treatment Mean DV	0.234	0.172	0.053	0.654	0.036	0.165
Years	2013-2019	2013-2019	2014-2019	2015-2019	2015-2019	2015-2019

Longitudinal Analyses – PATH
No increase in tobacco/cig use

	Prior-Year Tobacco Use	Prior-Month Tobacco Use	Prior-Month Cigarette Use	Prior-Month Daily Cigarette Use	Prior-Month Number of Cigarettes	Prior-Month ENDS Use	Prior Month Daily ENDS Use	Prior-Month Cigar Use	Prior Month Combustible Tobacco Use
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel I: Ages 18 and Older									
RML	-0.003	0.003	0.005	0.000	9.186	-0.006	-0.001	-0.004	0.001
	(0.008)	(0.006)	(0.005)	(0.003)	(10.029)	(0.004)	(0.003)	(0.004)	(0.007)
N	156,888	156,898	156,866	156,898	156,434	156,732	156,898	156,765	156,898
Pre-Treatment Mean DV	0.562	0.496	0.377	0.252	136.753	0.134	0.033	0.130	0.439
Panel II: Ages 21 and Older									
RML	-0.001	0.004	0.006	-0.000	9.988	-0.006	-0.001	-0.003	0.002
	(0.008)	(0.007)	(0.006)	(0.003)	(10.631)	(0.004)	(0.003)	(0.004)	(0.007)
N	132,070	132,077	132,047	132,077	131,651	131,930	132,077	131,954	132,077
Pre-Treatment Mean DV	0.575	0.514	0.406	0.283	154.400	0.123	0.032	0.125	0.461
Years	2013-2019	2013-2019	2013-2019	2013-2019	2013-2019	2013-2019	2013-2019	2013-2019	2013-2019

Longitudinal Analyses – PATH
No increase in tobacco/cig use
Some Decrease in ENDS Use (10 – 15%)

	Prior-Month Marijuana Use	Prior-Month Cigarette Use	Prior-Month ENDS Use	Prior-Month Cigar Use	Prior-Month Combustible Tobacco Use
	(1)	(2)	(3)	(4)	(5)
Panel I: Ages 18 and Older					
Year of RML Enactment	0.016***	0.004	-0.005	-0.005	-0.001
	(0.004)	(0.005)	(0.004)	(0.004)	(0.007)
1 Year After RML	0.011	0.010	-0.013**	0.003	0.006
	(0.008)	(0.008)	(0.006)	(0.008)	(0.011)
2 Year After RML	0.028***	0.009	-0.015**	0.005	0.003
	(0.006)	(0.007)	(0.006)	(0.006)	(0.009)
3 Years+ After RML	0.015	0.004	-0.016**	0.009	0.002
	(0.009)	(0.008)	(0.007)	(0.008)	(0.010)
N	156,671	156,866	156,732	156,765	156,898
Pre-Treatment Mean DV	0.183	0.377	0.134	0.130	0.439
Panel II: Ages 21 and Older					
Year of RML Enactment	0.015***	0.005	-0.005	-0.004	0.000
	(0.005)	(0.006)	(0.004)	(0.004)	(0.007)
1 Year After RML	0.008	0.012	-0.012*	0.002	0.007
	(0.009)	(0.008)	(0.006)	(0.009)	(0.012)
2 Year After RML	0.026***	0.010	-0.015**	0.004	0.003
	(0.007)	(0.008)	(0.006)	(0.007)	(0.010)
3 Years+ After RML	0.011	0.005	-0.016**	0.007	0.002
	(0.010)	(0.008)	(0.007)	(0.008)	(0.011)
N	131,898	132,047	131,930	131,954	132,077
Pre-Treatment Mean DV	0.172	0.406	0.123	0.125	0.461

RMLS & Consumption Margins– PATH
Discrete-time Hazard Estimates

	Initiation of Cigarettes Among Non-Users (Survival)	Cessation of Cigarettes Among Users (Survival)	Initiation of Cigars Among Non-Users (Survival)	Cessation of Cigars Among Users (Survival)	Initiation of ENDS Among Non-Users (Survival)	Cessation of ENDS Among Users (Survival)	Initiation of Marijuana Among Non-Users (Survival)	Cessation of Marijuana Among Users (Survival)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel I: Ages 18 and Older								
RML	0.002	-0.008	-0.002	0.057	-0.002	0.007	0.013***	-0.019
	(0.005)	(0.012)	(0.002)	(0.041)	(0.003)	(0.049)	(0.004)	(0.020)
N	82,455	53,162	118,258	14,661	118,174	13,399	116,108	18,214
Pre-Treatment Mean DV	0.038	0.081	0.039	0.263	0.048	0.300	0.049	0.153
Panel II: Ages 21 and Older								
RML	0.004	-0.011	-0.002	0.040	-0.002	0.012	0.013***	-0.025
	(0.005)	(0.013)	(0.002)	(0.045)	(0.003)	(0.053)	(0.004)	(0.021)
N	65,747	48,980	100,682	11,832	100,452	10,676	99,467	14,411
Pre-Treatment Mean DV	0.032	0.076	0.036	0.254	0.042	0.306	0.043	0.146
Years	2013-2019	2013-2019	2013-2019	2013-2019	2013-2019	2013-2019	2013-2019	2013-2019

RMLS & Dual Use– PATH
Increase in dual use but…

	Dual Marijuana and Tobacco Use	Initiation of Marijuana among Baseline Tobacco Users	Initiation of Tobacco and Marijuana among Baseline Non-users	Dual Marijuana and ENDS Use
	(1)	(2)	(3)	(4)
Panel I: Ages 18 and Older				
RML	0.013***	0.032***	0.002	0.003
	(0.003)	(0.012)	(0.002)	(0.002)
N	156,707	52,427	64,787	156,805
Pre-Treatment Mean DV	0.141	0.067	0.018	0.048
Panel II: Ages 21 and Older				
RML	0.012***	0.030**	0.002	0.003
	(0.004)	(0.012)	(0.002)	(0.002)
N	131,927	47,993	51,672	132,009
Pre-Treatment Mean DV	0.133	0.061	0.013	0.040
Years	2013-2019	2013-2019	2013-2019	2013-2019

Summary & Discussion

- First comprehensive analysis of the broader/spillover effects of RMLs on tobacco use outcomes

  - Significant increases in MJ use among adults and young adults
    - Including initiation margin

  - No evidence of any positive spillovers into cigarette use / ENDS use / other tobacco use over an average post-policy window of 3-4 years

  - While auxiliary synthetic control estimates for early adopters confirm similar patterns & suggest no evidence of medium-run positive spillovers into tobacco use, understanding the long-run effects of RMLs (particularly during the COVID-19 era) will be important for future scholars

- Results complement Sabia et al. (2021)
  - No evidence of spillovers into harder drugs

Cost-Benefit Calculus?

- These effects figure into the cost-benefit calculus of the social welfare of RMLs

  - 1.0 ~ 1.5 pct. pts. longer term decline in smoking
  - $1,995 added health care costs per smoker-year (Xu et al. 2015)
  - Healthcare cost savings of $10.2 billion / year

- Balanced against…
  - Public health costs / benefits of legalization & increased MJ use
  - Any adverse effects for youth

Thank You
Comments / Questions welcome

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