# Marijuana Liberalization and Public Finance: A Capital Market Perspective on A Public Health Policy

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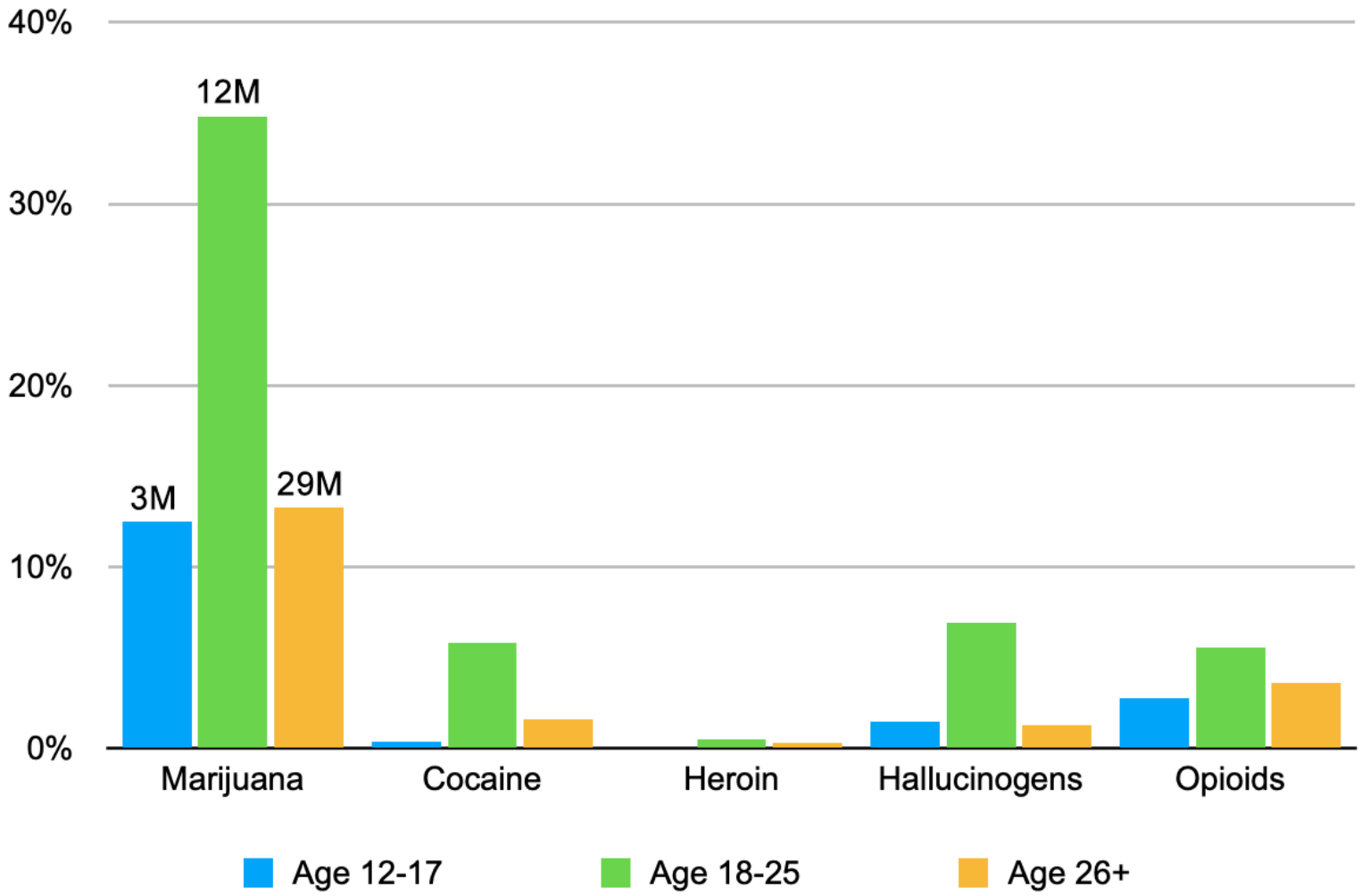
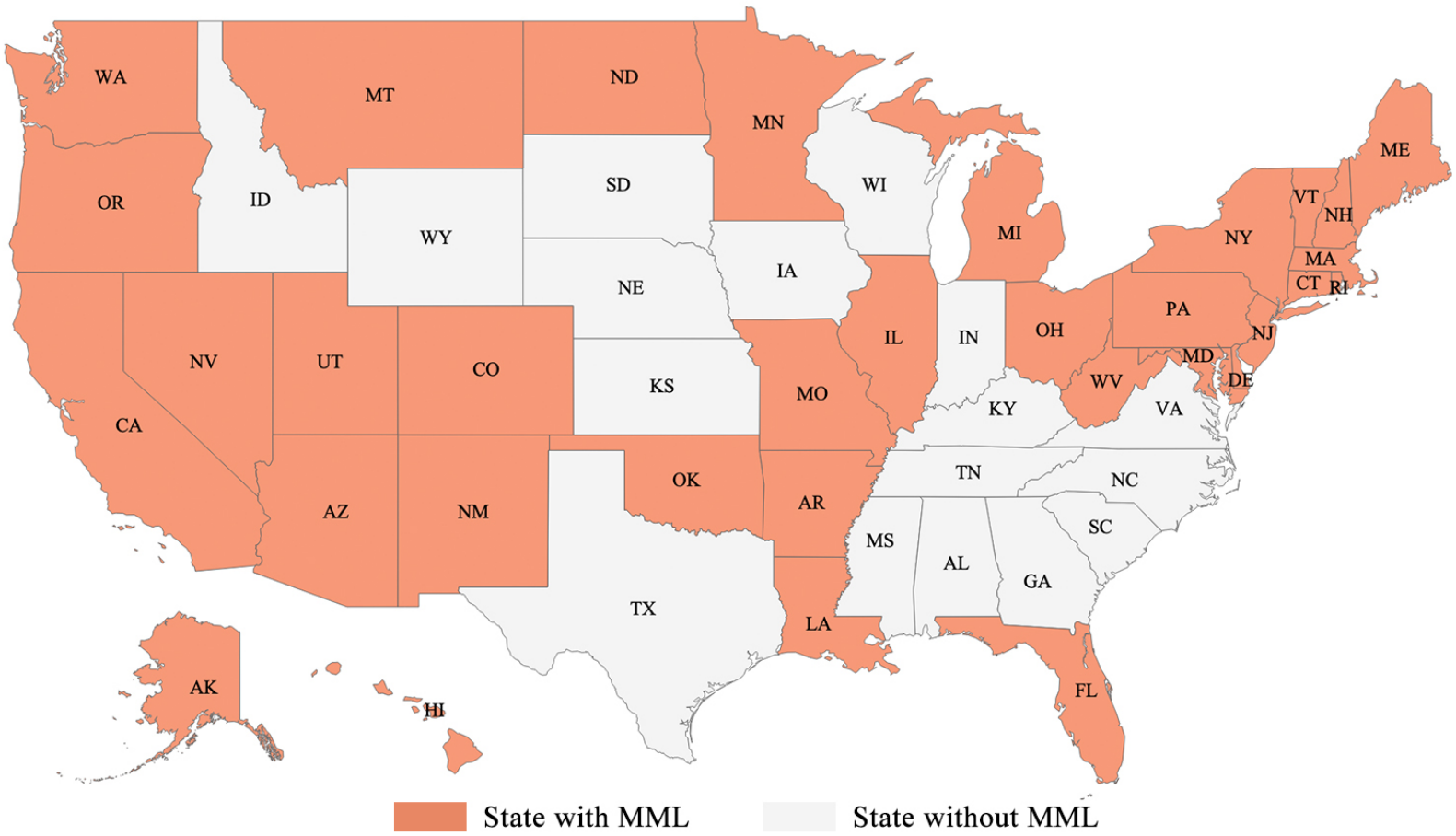
# Percentages of Yearly Drug Users by Age Group



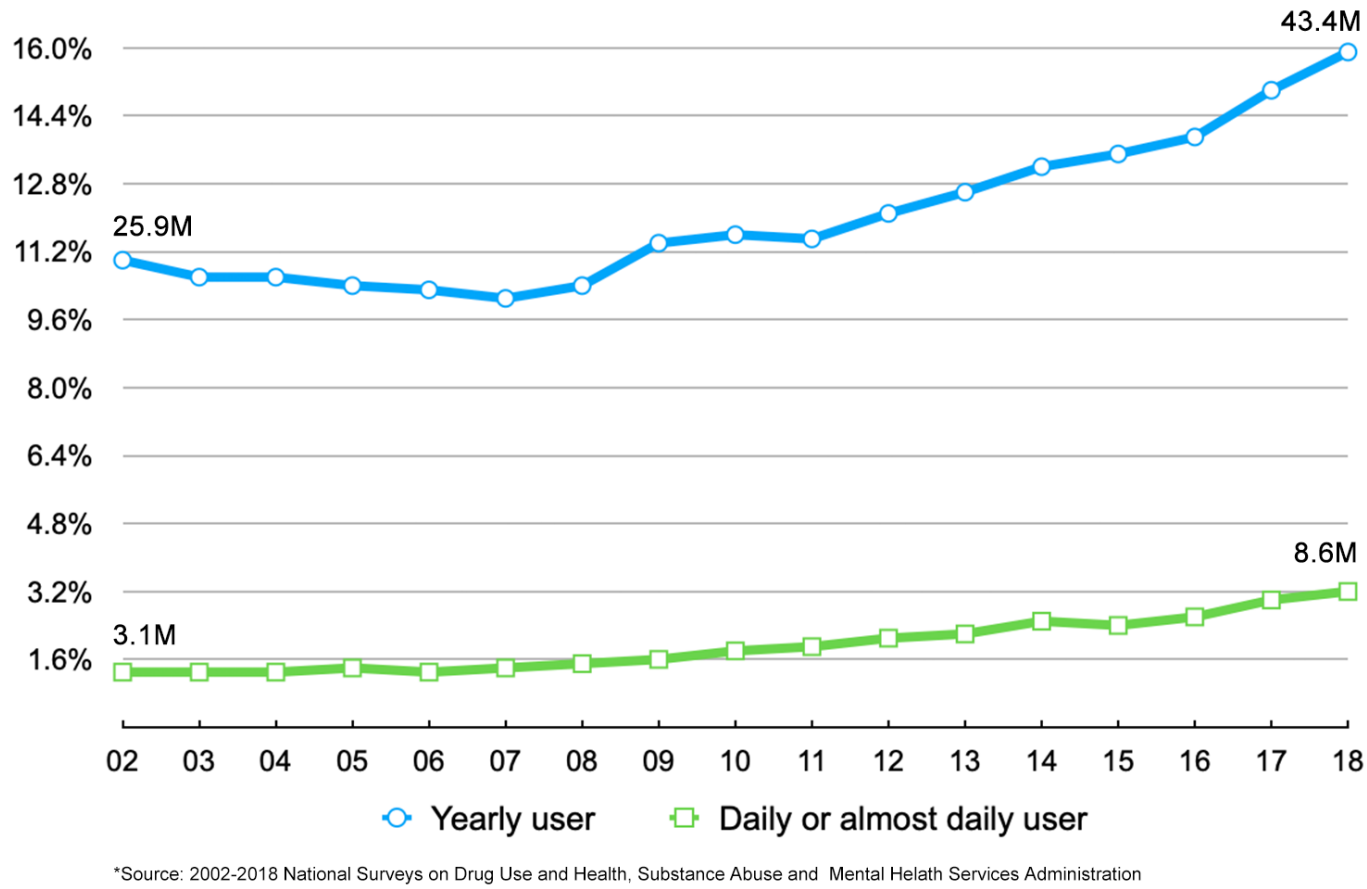

*Source: the 2018 National Survey on Drug Use and Health, Substance Abuse and Mental Helath Services Administration

# Medical Marijuana Laws




33 states legalized medical marijuana between 1996 and 2018

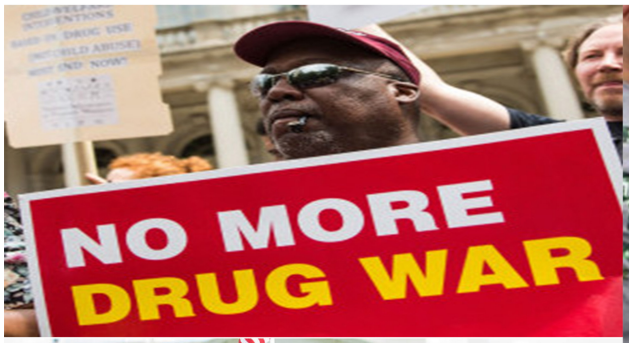
# Percentages of Marijuana Users from 2002 to 2018




**Increased medical and illicit marijuana use after MML**, supported by both substance use theory (Becker and Murphy 1988; Grossman 2005) and empirical evidence (Cerda et al. 2012; Wen et al. 2015; Hasin et al. 2017)

# Contentious Debates

## Pros



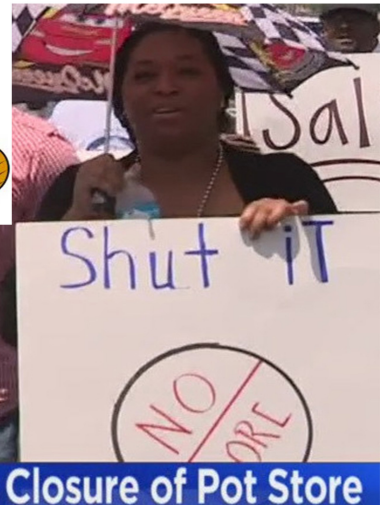





## Cons



A gateway drug



# Motivation and Research Question

- Motivation
  - Contentious debates among legislators, voters, social activists, researchers, and popular press
  - Limited discussion on capital market consequences and public finance implications
- Research question
  - Do medical marijuana laws affect municipal borrowing costs?

# Impacts of MML on Borrowing Costs

- MML $\Rightarrow$ State governments' credit risks $\Rightarrow$ Borrowing costs
- **Positive impacts**
  - Satisfy patients' needs and potentially improve their health
  - Collect sales tax (0–10%), and application/license fees
  - Cultivate a new industry, create jobs, and attract residents
- **Negative impacts**
  - Social consequences: potentially more crimes, car accidents and school drop-outs, increasing safety, health and public welfare expenditures
  - Health consequences: long-term use disorder, cognitive impairment, and diminished life achievement (e.g., Volkow et al. 2014), reducing labor productivity and thus tax base
- Bondholders condition their decisions on **aggregated economic benefits and costs** related to issuers' financial health

# Research Design

$$y_{ijt} = \alpha + \beta MML_{jt} + \gamma' X_{it} + \delta' Z_{jt} + \eta_j + \mu_t + \varepsilon_{ijt}$$

- $y_{ijt}$, **treasury-adjusted offering spreads** for bond $i$ issued by state $j$ in year month $t$
- $MML_{jt}$, an indicator that equals one for bonds issued after state $j$'s passage of MML, and zero otherwise
- $X_{it}$, bond $i$'s contractual terms and credit ratings
- $Z_{jt}$, state $j$'s economic conditions in year month $t$
- $\eta_j$, **state fixed effects**
- $\mu_t$, **year-month fixed effects**
- Standard errors double clustered by issue and year-month

# Main Results

| Panel A: Effect of MML on Offering Spreads | | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | Off. Spread | Off. Spread | Off. Spread | Off. Spread |
| MML | 0.11*** | 0.10*** | 0.09*** | 0.07*** |
| | (5.02) | (5.31) | (4.75) | (4.01) |
| Contractual Controls | No | Yes | Yes | Yes |
| Economic Controls | No | No | Yes | Yes |
| Rating FE | No | No | No | Yes |
| State, YM FE | Yes | Yes | Yes | Yes |
| Observations | 113,723 | 113,723 | 113,723 | 113,723 |
| Adjusted $R^2$ | 0.70 | 0.82 | 0.84 | 0.84 |

Table 3

# Parallel Trends

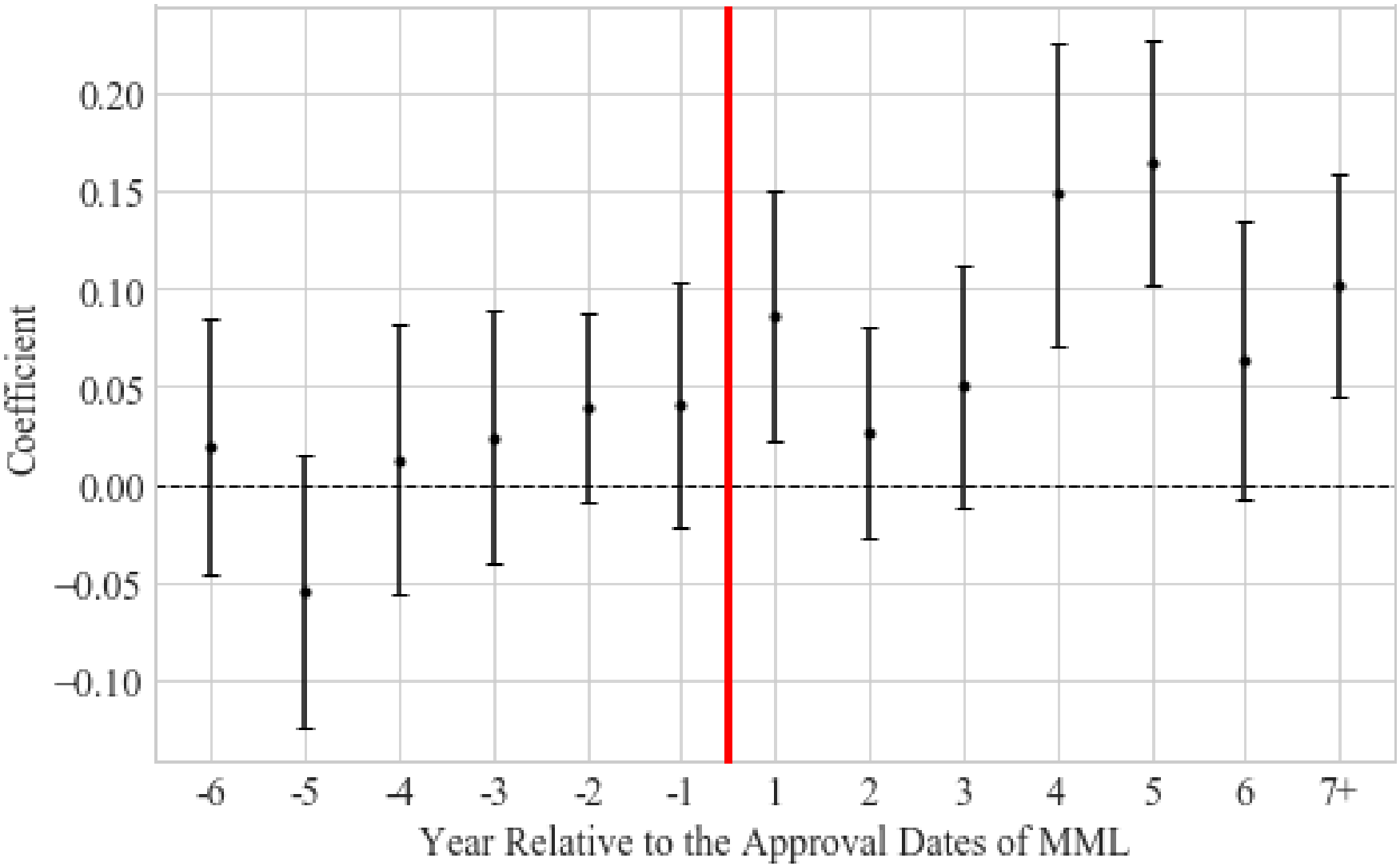



Figure 4

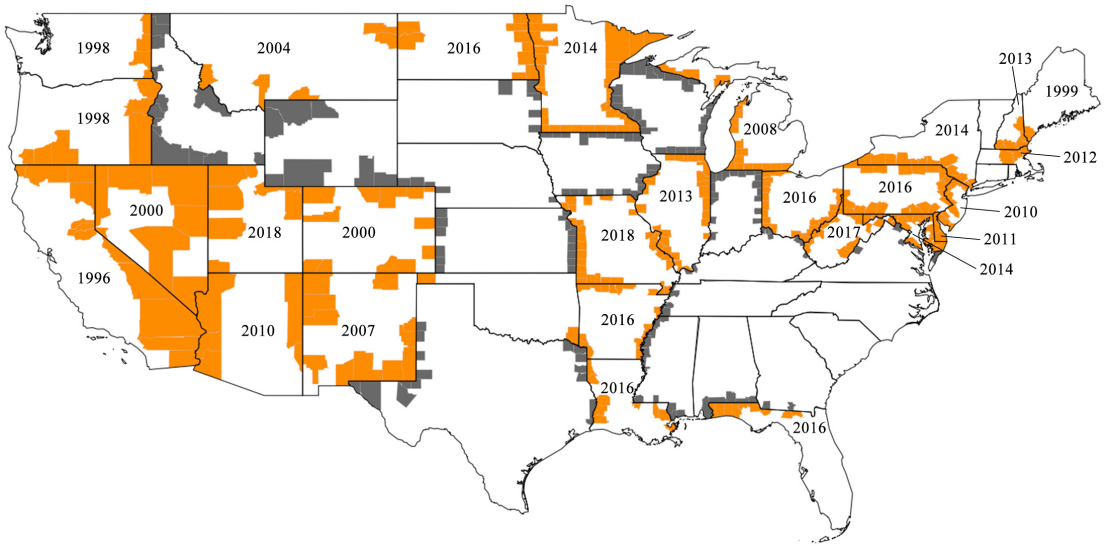
# Main Results: Two-Stage Regressions

| Panel B: Effect of MML on Offering Spreads through Marijuana Use | | |
|---|---|---|
| | (1) | (2) |
| | Marijuana Use | Off. Spread |
| MML | 1.23*** | |
| | (8.80) | |
| Predicted Marijuana Use | | 0.07** |
| | | (2.45) |
| Contractual Controls | Yes | Yes |
| Economic Controls | Yes | Yes |
| Rating FE | Yes | Yes |
| State, YM FE | Yes | Yes |
| Obs. | 43,240 | 43,240 |
| Adj. $R^2$ | 0.92 | 0.79 |

Table 3

# Two Additional Identification Strategies

- Policy discontinuity in **neighboring counties across state borders** (similar in social, economic and demographic conditions)




- Random passage / failure for states with **ballot outcomes around 50%** (similar in political environments and voting preference)
  - Arizona (50.10%) and Arkansas (48.56%)

# Mechanism: Cross-Sectional Tests

- **Increased marijuana use:** stronger effects for states with
  - Higher corruption (likely low enforcement quality)
  - More vulnerable population (younger, more African American and higher urbanization rates)
  - Better marijuana cultivation environment (more optimal temperature)
- **Higher credit risks:** stronger effects for
  - General obligation bonds
  - Low-rating bonds
  - Long-term bonds
- **Increased marijuana use $\Longrightarrow$ Higher credit risks**
  - Negative social and health consequences of marijuana use, e.g., crimes, drug abuse, school drop-outs, diminished productivity (Volkow et al. 2014)

# Mechanism: States' Expenditures and Programs

**Panel A: States' Expenditures and Financial Strength**

| | MML Related Expenditures | | | | MML Unrelated Expenditures | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| | Police | Correction | Health | Public Welfare | Highway | Natural Resource | Parks & Recreation | Deficit |
| MML | 9.040** | 9.210* | 22.84 | 169.1*** | 7.770 | -0.7900 | -2.120 | 237.54** |
| | (2.48) | (1.87) | (1.48) | (3.55) | (0.45) | (-0.15) | (-1.35) | (2.18) |
| Controls, State & Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Obs. | 1,300 | 1,300 | 1,300 | 1,300 | 1,300 | 1,300 | 1,300 | 1,300 |
| Adj. $R^2$ | 0.87 | 0.89 | 0.74 | 0.92 | 0.86 | 0.91 | 0.77 | 0.91 |

**Panel B: Social Welfare Programs**

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Public Housing | Energy Subsidy | Food Stamp | High-School Graduation | College Degree | Drug-Induced Death |
| MML | 1.29** | 0.30* | 0.37 | -2.38** | -1.09*** | 2.72*** |
| | (2.61) | (1.69) | (1.42) | (-2.64) | (-2.88) | (2.85) |
| Controls, State & Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Obs. | 1,479 | 1,479 | 1,479 | 1,450 | 1,479 | 1,020 |
| Adj. $R^2$ | 0.47 | 0.71 | 0.79 | 0.83 | 0.93 | 0.80 |

# Robustness and Alternative Explanations

- Robustness
  - Alternative measures: raw offering yields, tax-adjusted offering spreads, secondary yields and gross spread
  - Sample selection: excluding any one specific region (west/midwest/northeast/south)
- Alternative Explanations
  - Other confounding factors:
    Higher increase after **states' first opening of dispensary stores**
  - Increased political uncertainty (Pastor and Veronesi 2013):
    Higher increase after Cole's memorandum to **de-prioritize federal marijuana enforcement**
  - Investors' avoidance of sin securities (Hong and Kacperczyk 2009):
    Higher increase when **marijuana is more publicly accepted**

# Conclusion

- First evidence on the capital market consequence of marijuana liberalization
  - **7 bps increase** in MML state bond spreads ($7.35M interest cost)
  - Stronger for states with higher corruption, more vulnerable demographics, and better cultivation environment
  - Evidence consistent with states incurring **more safety, health and public welfare expenditures** as MML induces more marijuana use, driving up credit risks
- Contributions
  - **Evaluation of MML policies**
  - Impacts of public health issues on finance
  - Determinants of municipal borrowing costs

Increased Marijuana Use after MML

Identification Strategy I: Bordering Counties

Identification Strategy II: Discontinuity in Ballot Outcomes

Cross-Sectional Tests: State Contextual Factors

Cross-Sectional Tests: Bond Contractual Features

State Contextual Cuts

Robustness

Alternative Explanations

# Increased Marijuana Use after MML

Suggested by both substance use theory (Becker and Murphy 1988; Grossman 2005) and empirical evidence (Cerda et al. 2012; Wen et al. 2015; Hasin et al. 2017)

| | (1) Yearly User | (2) Daily User | (3) Perceived Harm | (4) Perceived Legal Risk | (5) Perceived Availability | (6) Yearly User |
|---|---|---|---|---|---|---|
| MML | 0.95** | 0.70*** | -1.03*** | -2.69*** | 2.54*** | 0.36 |
| | (2.42) | (5.17) | (-3.29) | (-3.17) | (3.63) | (1.23) |
| Perceived Harm | | | | | | -0.31*** |
| | | | | | | (-6.63) |
| Perceived Legal Risk | | | | | | -0.05*** |
| | | | | | | (-3.45) |
| Perceived Availability | | | | | | 0.14*** |
| | | | | | | (5.30) |
| Economic Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| State & Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Obs. | 645 | 516 | 516 | 516 | 516 | 516 |
| Adj. $R^2$ | 0.88 | 0.77 | 0.92 | 0.83 | 0.76 | 0.90 |

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# Robustness

- Alternative measures
  - Raw offering yields
  - Tax-adjusted offering spreads (Schwert 2017)
  - Secondary yields: aggregated by month and facility
  - Gross spread: underwriter fees

| | (1) Raw Off. Yield | (2) Tax-Adjusted Off. Spread | (3) Trading Spread | (4) Trading Spread | (5) Gross Spread |
|---|---|---|---|---|---|
| MML | 0.06*** | 0.09*** | 0.14*** | 0.11*** | 0.04** |
| Rating, state, YM FE | Yes | Yes | Yes | No | Yes |
| Facility, YM FE | No | No | No | Yes | No |
| Observations | 113,723 | 113,723 | 1,097,097 | 1,097,097 | 37,043 |
| Adjusted $R^2$ | 0.92 | 0.76 | 0.52 | 0.74 | 0.52 |

- Sample selection
  - Excluding any one specific region (west/midwest/northeast/south)

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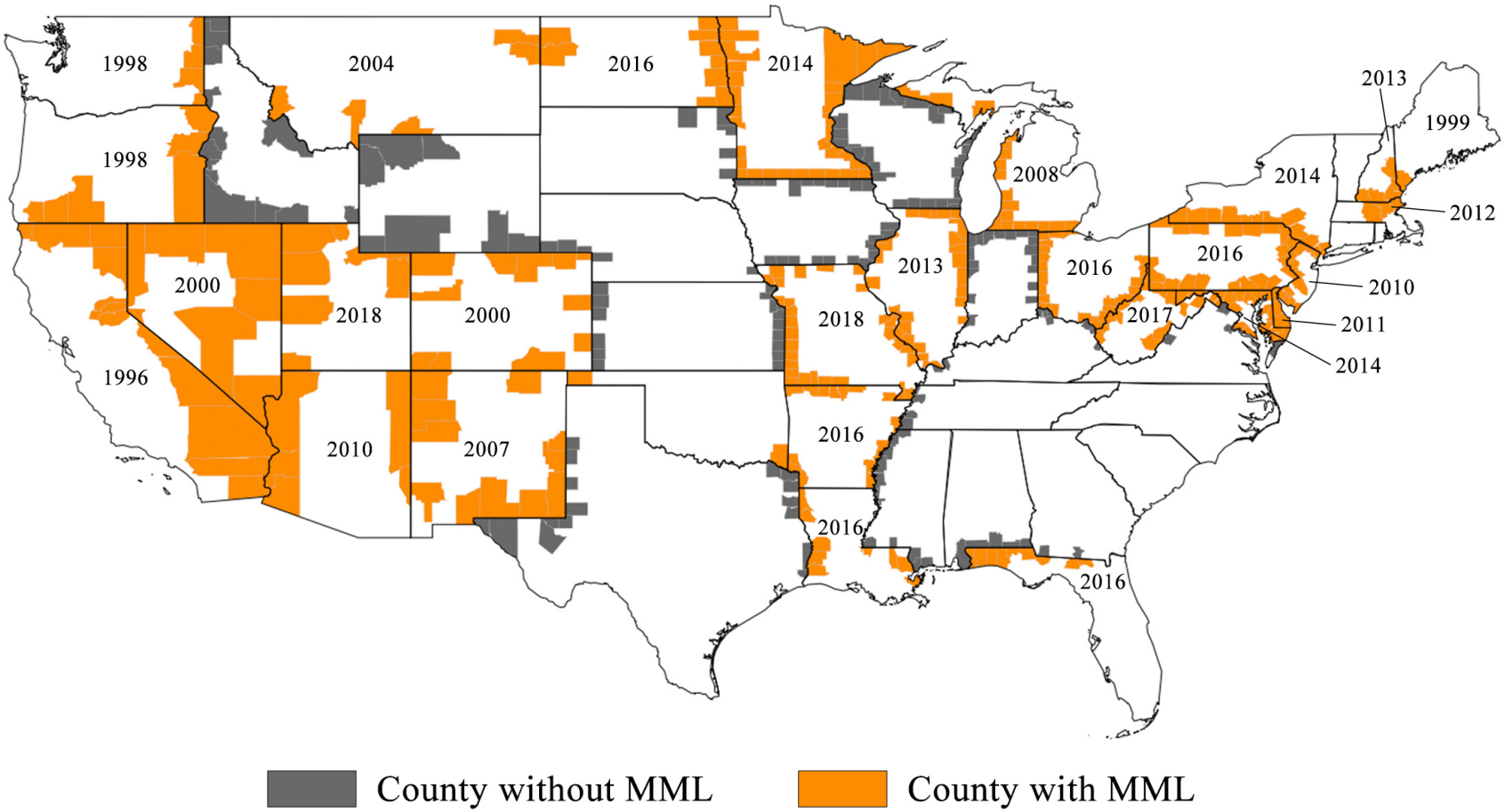
# Identification Strategy I: Bordering Counties Sample I

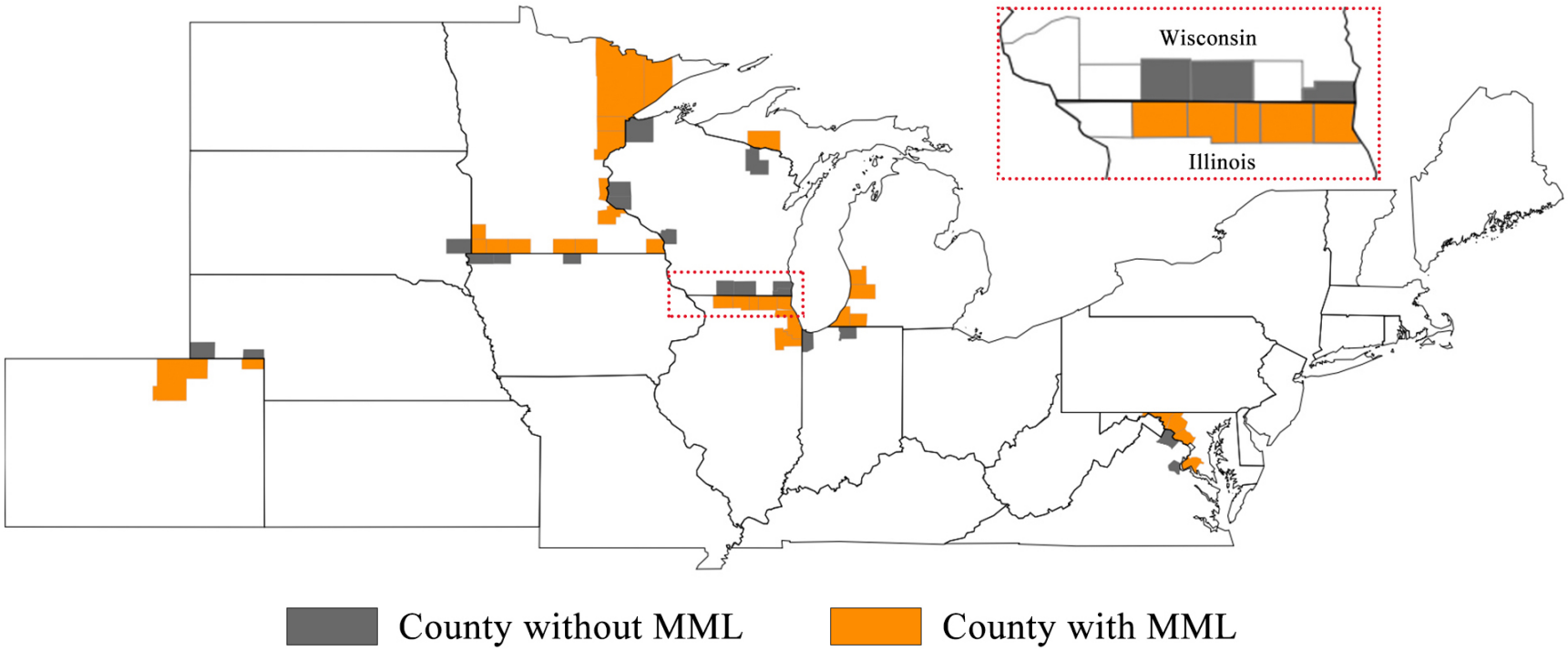
- Paired sample: 495 county pairs
  - Pairs with at least some difference in MML status in our sample period
  - Both counties have at least one bond issuance




Panel A Figure 5 Back

# Identification Strategy I: Bordering Counties Sample II

- Strict DID sample: 30 county pairs
  - One passed MML and the other didn't
  - Bond issuances in both the pre and post four-year windows




Panel B Figure 5

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# Bordering Counties - Results

| | (1) Off. Spread | (2) Off. Spread |
|---|---|---|
| MML | 0.06** | 0.21*** |
| | (2.48) | (3.06) |
| Contractual controls | Yes | Yes |
| Economic controls | Yes | Yes |
| Rating, County, YM FE | Yes | Yes |
| Observations | 146,005 | 6,344 |
| Adjusted $R^2$ | 0.86 | 0.84 |

Table 4

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# Discontinuity in Ballot Outcomes

- Arizona: Prop. 203 (2010), Approved (50.10% yes votes)
- Arkansas: Issue 6 (2012), Defeated (48.56% yes votes)

| | (1) Trading Spread | (2) Trading Spread |
|---|---|---|
| MML | 0.36*** | 0.25*** |
| | (3.22) | (2.65) |
| Controls | Yes | Yes |
| Rating FE | Yes | NA |
| State FE | Yes | NA |
| Facility FE | No | Yes |
| YM FE | Yes | Yes |
| Observations | 6,587 | 6,577 |
| Adjusted $R^2$ | 0.67 | 0.78 |

Table 5

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# Cross-Sectional Tests: State Contextual Factors

- Law enforcement quality (monitoring)
  Proxied by state perceived corruption index from Saiz and Simonsohn (2013)

- Population more susceptible to marijuana use (demand)
  Higher marijuana use among young adults, African Americans and adults with less education (Hasin et al. 2015)

- Natural conditions for marijuana cultivation (supply)
  Ideal temperature of growing marijuana falls into the narrow range of 75 to 86 degrees (Green 2010)

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# Cross-Sectional Tests: State Contextual Factors

| Indicator = | Corrupt | Young | African American | Low College | Optimal Growing |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| | Off. Spread | Off. Spread | Off. Spread | Off. Spread | Off. Spread |
| MML | 0.01 | 0.05*** | 0.04** | 0.07*** | 0.05*** |
| | (0.66) | (2.64) | (2.40) | (3.42) | (2.63) |
| MML x Indicator | 0.12*** | 0.05* | 0.05* | 0.01 | 0.06* |
| | (4.70) | (1.76) | (1.83) | (0.45) | (1.69) |
| Indicator | - | -0.01 | -0.10** | -0.05** | - |
| | | (-0.45) | (-2.47) | (-1.99) | |
| Controls | Yes | Yes | Yes | Yes | Yes |
| Rating, state, YM FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 111,188 | 113,723 | 113,723 | 113,723 | 113,546 |
| Adjusted $R^2$ | 0.84 | 0.84 | 0.84 | 0.84 | 0.84 |

Panel A Table 6

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# Cross-Sectional Tests: Bond Contractual Features

- Long-term vs. short-term bonds
  Marijuana use associated with more severe long-term health and social issues (Volkow et al. 2014)

- General obligation (GO) vs. revenue bonds (RV)
  GO bonds' repayment more tightly tied to governments taxing powers

- Low-rating vs. high-rating bonds
  Low-rating bonds' yield more sensitive to deteriorating governments' credit quality

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# Cross-Sectional Tests: Bond Contractual Features

| Indicator = | Long Term | GO | Below AA |
|---|---|---|---|
| | (1) | (2) | (3) |
| | Off. Spread | Off. Spread | Off. Spread |
| MML | 0.02 | 0.00 | 0.05*** |
| | (0.91) | (0.17) | (3.12) |
| MML x Indicator | 0.11*** | 0.10*** | 0.07** |
| | (6.90) | (4.06) | (2.40) |
| Indicator | 0.08*** | -0.13*** | - |
| | (9.40) | (-8.69) | |
| Controls | Yes | Yes | Yes |
| Rating, state, YM FE | Yes | Yes | Yes |
| Observations | 113,723 | 113,723 | 97,113 |
| Adjusted $R^2$ | 0.84 | 0.84 | 0.87 |

Panel B Table 6

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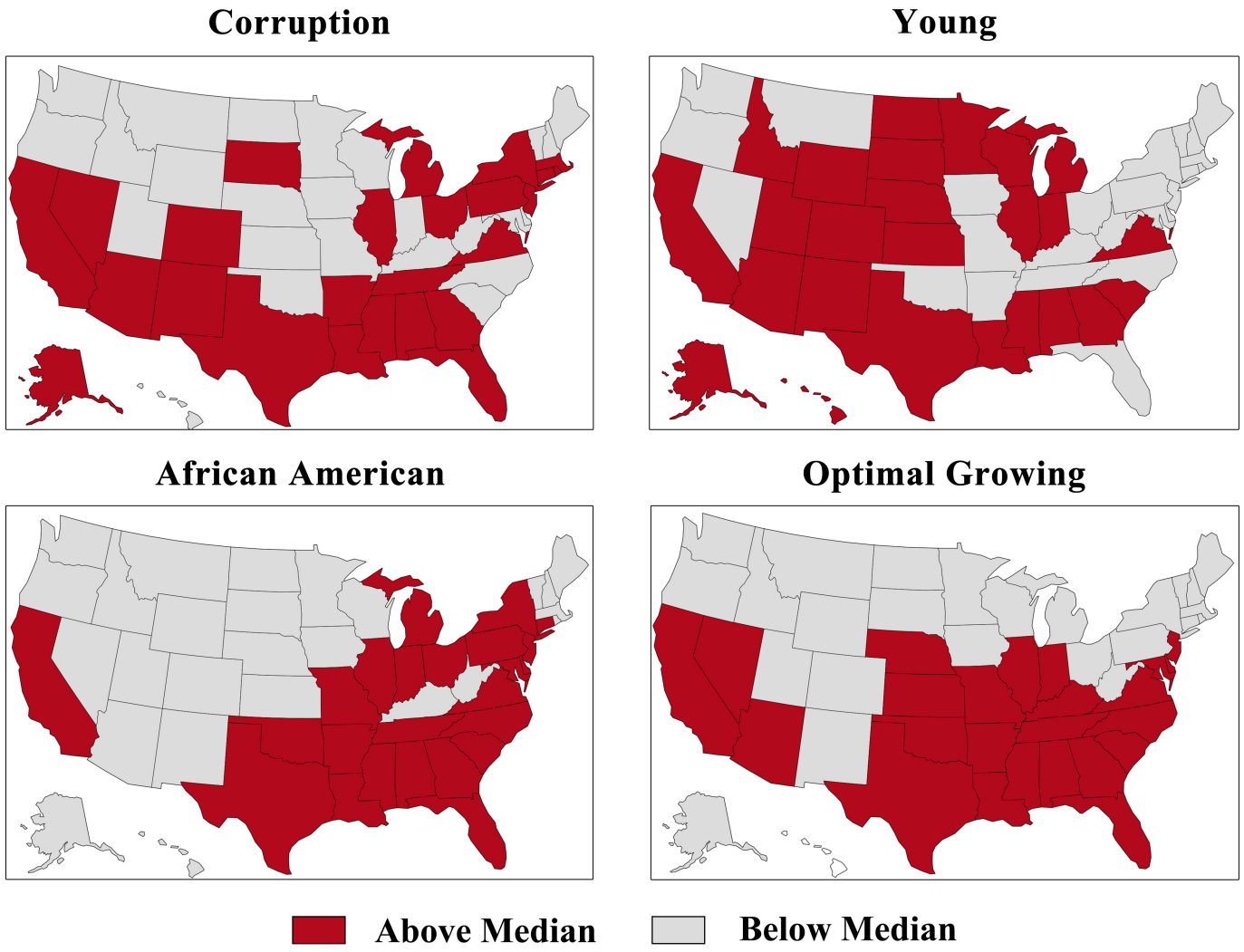
# State Contextual Cuts

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# Cross-Sectional Cuts - Correlation Table

| | Corrupt | Young | African American | Optimal Growing |
|---|---|---|---|---|
| Corrupt | - | | | |
| Young | 0.12 | - | | |
| African American | **0.40** | -0.10 | - | |
| Optimal Growing | 0.14 | 0.08 | **0.60** | - |

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# Alternative Explanations Back

- Other confounding factors
- Increased political uncertainty (Pastor and Veronesi 2013) resulting from legal conflict between state legalization and federal ban
- Investors' avoidance of sin securities (Hong and Kacperczyk 2009)

| | (1) | (2) | (3) |
|---|---|---|---|
| | Off. Spread | Off. Spread | Off. Spread |
| MML | 0.05*** | 0.06*** | -0.03 |
| | (2.91) | (2.94) | (-0.53) |
| MML×Dispensary Opening | 0.05** | | |
| | (2.14) | | |
| MML×Cole Memo | | 0.05* | |
| | | (1.70) | |
| MML×Acceptance Rate | | | 0.24** |
| | | | (2.08) |
| Controls, Rating, State & YM FE | Yes | Yes | Yes |
| Obs. | 113,723 | 113,723 | 113,723 |
| Adj. $R^2$ | 0.84 | 0.84 | 0.84 |