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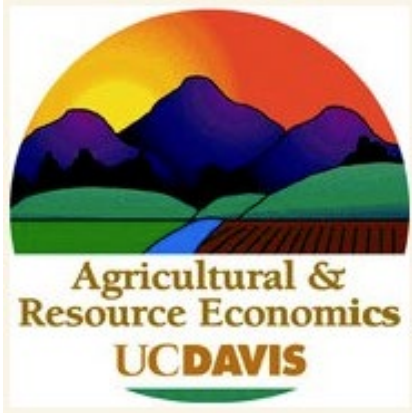
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U.S. Cannabis Markets: Estimating Cannabis Consumption by State and the Legal Share of Cannabis in California

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Exploring U.S. Cannabis Markets: Estimating Cannabis Consumption by State and the Legal Share of Cannabis in California

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ABSTRACT. U.S. federal law prohibits use, possession, sale, and distribution of cannabis. So it is not surprising that the illicit market dominates cannabis sales nationally. The illegal market also accounts for the majority of sales in some states where medical or adult-use cannabis is legal. Because data on illegal production and sales do not exist, states’ cannabis consumption can only be estimated with a high degree of uncertainty. In order to estimate the efficacy of policy to shift demand from the illegal cannabis market to the legal market, accurate estimates of cannabis consumption are required. The National Survey on Drug Use and Health (NSDUH) is the most commonly used data source to estimate cannabis consumption. However, respondents to this federally administered survey are likely to underreport cannabis consumption, in part because of fear of criminal penalty. We identify the effect of adult-use legalization on underreporting to develop more accurate estimates of states’ cannabis consumption. In turn, we combine these consumption estimates with cultivation data to determine the legal market share of cannabis in California.

BACKGROUND

- In November, 2016, California voters passed Proposition 64 to legalize cultivation, possession, and sale of adult-use cannabis.
- In January, 2018, California dispensaries began selling adult-use cannabis.
- As of 2021, 18 states and D.C. have legal adult-use cannabis (21 as of 2023), but only 11 have legally operating adult-use dispensaries.
- NSDUH is the most commonly used source to estimate cannabis consumption, but the survey is subject to underreporting error.^{2,5,6,7,9} Stigma and fear of repercussions are primary factor influencing underreporting. Therefore, we expect underreporting to decline following adult-use legalization. This hypothesis is supported by interdisciplinary studies that find increased social acceptance and decreased perceived risk, but mixed effects on consumption.^{1,3,4,8,10}

RESEARCH QUESTIONS

- Does adult-use legalization increase reported cannabis consumption?
- Does access to legal cannabis increase reported consumption?
- What is the share of legal cannabis in California?

ESTIMATING CANNABIS CONSUMPTION

- Consumers are defined as heavy or light users depending on their monthly frequency of use.
- Estimates of cannabis consumption per use-day differentiated by user type^{5,9} are combined with 2-year estimates of frequency of use and past month and year use, by state, for 2002-2020¹¹ to calculate cannabis consumption per capita. Estimates are adjusted for underreporting.
- Per capita consumption for California, 2016-2021, are shown in Table 1. These estimates reflect an *ex post* adjustment for the effect of adult-use legalization on underreporting.

Table 1. Cannabis consumption in California

| Year | Lower bound per capita consumption | Mean per capita consumption | Upper bound per capita consumption |
|-------|------------------------------------|-----------------------------|------------------------------------|
| 2016 | 23.4 | 29.6 | 36.0 |
| 2017 | 23.7 | 30.0 | 36.6 |
| 2018 | 26.0 | 32.9 | 40.2 |
| 2019 | 28.5 | 36.2 | 44.2 |
| 2020 | 29.4 | 37.3 | 45.6 |
| 2021* | 30.5 | 38.8 | 47.8 |

*: 2021 per capita consumption is predicted using regression model.

- Figure 1 depicts box-and-whiskers plots of states’ per capita cannabis consumption from 2012 (year in which the first states legalized adult-use cannabis) through 2020. Boxes correspond to quartiles, whiskers to 95% confidence intervals, and x’s to means.

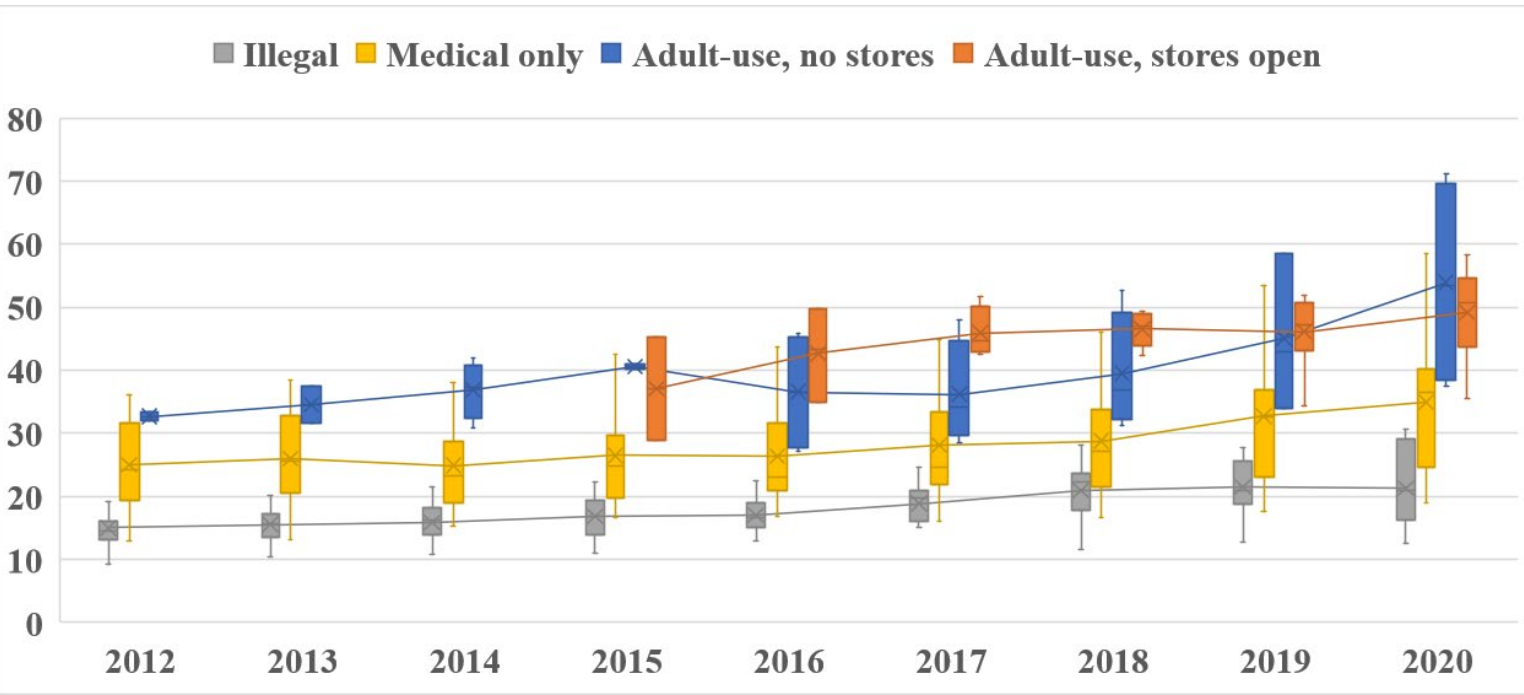


Figure 1. States’ per capita consumption, by legal status

ESTIMATING EFFECTS OF LEGALIZATION, 2021 CONSUMPTION

- With our panel of cannabis consumption estimates, we use a log-log fixed-effect OLS model to estimate effects of legalization on reported consumption.
- The dependent variable is grams of cannabis consumed per capita (population age 12+).
- Right-hand side variables include lagged consumption, demographic characteristics, indicator variables for medical and adult-use legalization and if retail stores are legally open, and various tax rate variables.
- We treat adult-use legalization—prior to stores opening—as a shock to reported cannabis consumption; and the effect of cannabis availability in stores as a shock to actual consumption.
- Adult-use legalization increases reported consumption by 4.2%, and the result is robust to specification. The effect of availability in stores is not statistically significant across specifications.
- We apply a downward adjustment of 4.2% to consumption estimates in states with adult-use legalization to correct for a change in underreporting.
- Using our revised consumption estimates, we estimate our fixed-effect model again to predict a distribution of states’ per capita cannabis consumption in 2021.
- Figure 2 depicts the distribution of 2020 (estimated) and 2021 (predicted) per capita consumption in California.

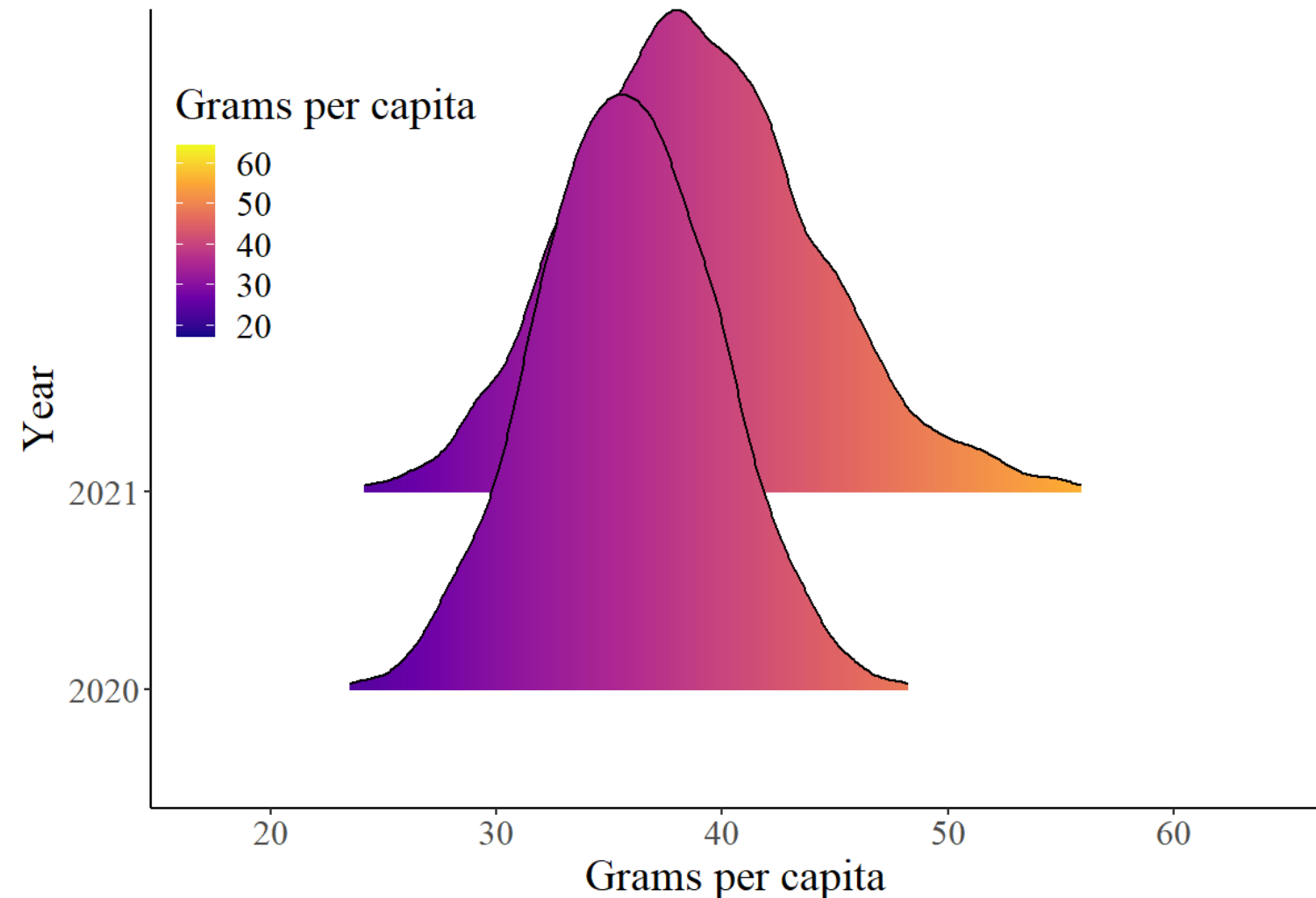


Figure 2. Distribution of 2020 and 2021 CA per capita consumption

ESTIMATING LEGAL SHARE OF CANNABIS CONSUMPTION

- Using California tax revenue data, we estimate the total volume of legal cannabis cultivated in California in terms of flower-equivalents.
- Annual California cannabis cultivation volumes are estimated based on reported tax revenues from flower and trim.
- Cultivation represents the legal supply of cannabis in California.
- We assume the volumes of untaxed cannabis leaking into the legal market and taxed cannabis leaving for other illegal markets are negligible.
- Adjustments are made for net tourism demand in California.
- Legal cannabis as a share of cannabis consumed in California for 2019 through 2021 is shown in Table 2

Table 2. Legal cultivation as a share of cannabis demand in California, adjusted for a change in underreporting

| Year | Legal share (5% lower bound consumption) | Legal share (mean consumption) | Legal share (95% upper bound consumption) |
|------|--|--------------------------------|---|
| 2019 | 0.27 | 0.22 | 0.18 |
| 2020 | 0.39 | 0.32 | 0.25 |
| 2021 | 0.44 | 0.35 | 0.28 |

- Despite adult-use stores open since Jan 2018, illegal market still accounts for the majority of cannabis demand in California.

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