Exploring U.S. Cannabis Markets: Developing a Dataset to Estimate Illicit and Total Cannabis Consumption by State

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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 medicinal or recreational cannabis has been legalized. Because data on illegal production and sales do not exist, the quantity of illegal cannabis consumed can only be estimated with a high degree of uncertainty. We rely on publicly available data to develop a panel dataset of total cannabis consumption for 2002–2019 by state. We then combine state tax data with our consumption estimates to determine the sizes of the illegal and legal cannabis markets in California.

BACKGROUND

- In November, 2016, California voters passed Proposition 64 to legalize cultivation, possession, and sale of recreational cannabis.
- In January, 2018, California dispensaries began selling recreational cannabis.
- Cannabis is subject to cultivations taxes, excise taxes, state retail taxes, and additional local taxes that vary by jurisdiction.
- Compared to Colorado, Oregon, and Washington—states that legalized cannabis earlier—taxes are higher and participation in the legal market is lower in California.

OBJECTIVES

- We follow the approach of Kilmer et al. (2013) and utilize National Survey on Drug Use and Health (NSDUH) data to estimate states' cannabis consumption from 2002–2019.
- With our panel of cannabis consumption estimates, we use an econometric approach to predict states' per capita cannabis consumption in 2020 and 2021.
- Using California tax revenue data, we estimate the total volume of legal cannabis cultivated in California in terms of flower-equivalents.
- We then adjust our estimates and predictions of California cannabis consumption for visitor demand and out-of-state cannabis purchases by Californians to estimate the share of legal cultivation in total California cannabis demand.

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 (Orens et al, 2017), differentiated by user type, are combined with 2-year estimates of frequency of use and past month and year use, by state, for 2002-2019 (SAMHSA, 2022) to calculate cannabis consumption per capita.
- These estimates are adjusted for underreporting. Per capita consumption estimates for California are shown in Table 1.

Table 1. Estimated Total CA Cannabis Consumption

Year	Lower bound per capita consumption	Mean per capita consumption	Upper bound per capita consumption
2002–03	10.0	13.0	16.1
2004–05	11.7	14.9	18.4
2006–07	11.6	14.7	18.1
2008–09	12.9	16.5	20.4
2010–11	17.5	22.2	27.2
2012–13	19.4	24.4	29.7
2014–15	20.8	26.3	32.1
2016–17	23.5	29.7	36.2
2018–19	28.1	35.6	43.4

PREDICTING CANNABIS CONSUMPTION

- 2-year estimates of cannabis consumption are converted to annual estimates by treating them as the midpoint of the survey years, assuming a constant rate of change between estimates.
- Using this panel dataset for 50 states and DC from 2002-2019, we test numerous econometric specifications to obtain predicted values of cannabis consumption per capita.
- The dependent variable is grams of cannabis consumed per capita (population age 18+).
- Right-hand side variables include demographic characteristics, indicator variables for medical and recreational legalization and if retail stores are legally open, and various tax rate variables.
- Model selection is determined using mean per capita consumption, then the model is estimated again using lower and upper bound consumption estimates.
- The preferred model based on AIC includes a lagged grams per capita variable. Estimated versus fitted values for per capita consumption in California are shown in Figure 1.

Table 2. Estimated California legal cannabis cultivation

Year	Dry-weight flower (ounces, millions)	Dry-weight trim (ounces, millions)	Total dry-weight, flower-equivalents (ounces, millions)
2019	5.74	10.28	6.76
2020	10.41	8.60	11.27
2021	11.48	11.60	12.64

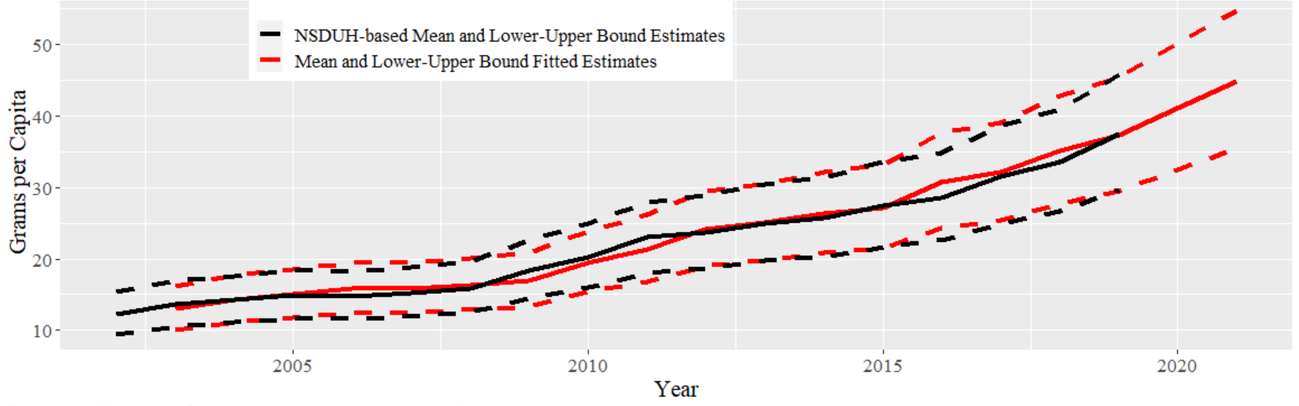

Figure 1: Estimated and fitted per capita cannabis consumption in California, 2002-2021

ESTIMATING LEGAL SHARE OF CANNABIS CONSUMPTION

- Annual California cannabis cultivation volumes are estimated based on reported tax revenues from flower and trim.
- Assuming trim has one-tenth the THC content of flower, we estimate the total cultivation volume in flower-equivalents. These cultivation estimates are in Table 2.
- 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.
- We add estimated cannabis consumed by visitors to California to our estimates of demand for cannabis within California, following the methodology of Orens et al (2017).
- Similarly, we subtract estimated cannabis consumed by Californians on out-of-state trips.
- Data on California tourism are from Visit California (2022).
- Legal cannabis as a share of cannabis consumed in California for 2019 through 2021 is shown in Table 3.
- We estimate that as of 2021, legal cannabis only accounts for 20-30% of cannabis consumed in California.

Table 3. Legal cannabis as a share of cannabis consumed in California, adjusting for visitor and out-of-state consumption

Year	Legal share (using lower bound consumption)	Legal share (using mean consumption)	Legal share (using upper bound consumption)
2019	0.22	0.15	0.14
2020	0.30	0.23	0.19
2021	0.30	0.24	0.20

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