

CHAPTER 13. CANNABIS IN CALIFORNIA

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ABSTRACT

In November 2016, two decades after legalizing medicinal cannabis, California voted to legalize, tax, and regulate “adult-use” (recreational) cannabis. Subsequent legislation unified adult-use and medicinal cannabis taxation and regulation under a single structure. Implementation of the new licensed cannabis system was introduced in stages from January 1, 2018, to early 2019. However, as of 2020, lack of publicly available data still make it difficult to understand the emerging licensed market. Media reports suggest that these are difficult times for licensed cannabis businesses. At the same time, a vibrant unlicensed market continues to exist. We discuss the reasons why unlicensed cannabis markets can continue to thrive even after licensed systems have been implemented. We assess the situation for the industry in 2020, from cultivation through retail. We estimate that less than one-third of in-state retail sales are currently in the legal, regulated, and taxed segment. Finally, we assess briefly the impact of COVID-19 (Coronavirus) on the cannabis industry.

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With the passage of Proposition 64 in 2018, which legalized recreational cannabis, California set up a system of state licensing, regulation, and taxation. However, cannabis sale, purchase, and possession remain prohibited under federal law.

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INTRODUCTION

Cannabis production, processing, sale, purchase, and possession by California residents with a doctor's recommendation was first allowed under the Compassionate Use Act of 1996, a voter initiative that allowed California residents with doctor's recommendations to purchase and possess cannabis without being subject to criminal penalties. Two decades later, in November 2016, Proposition 64 (another voter initiative) decriminalized cannabis purchase and possession by all adults 21 and over, without medical recommendations or California residency requirements. Proposition 64 also set up a system of state licensing, regulation, and taxation to be governed by several state agencies starting in 2018. Cannabis sale, purchase, and possession remain prohibited under federal law, with potentially severe penalties. This status of cannabis under federal law continues to mean that cannabis is not a normal farm product in the context of interstate trade, finance, and banking.

This chapter deals with two broad questions. First, what is the economic situation of the cannabis industry in California from farm cultivation through processing, marketing, and retailing? Second, what is the likely evolution of the industry in the future?

For our examination of the wholesale and retail markets, we draw on our research developed at the University of California Agricultural Issues Center (AIC) (Sumner et al., 2018, 2019, 2020; Goldstein, Saposhnik, and Sumner, 2020; Goldstein and Sumner, 2019; Goldstein, Sumner, and Fafard, 2019; Valdes-Donoso et al., 2019, 2020). For the discussion of cultivation and manufacturing, we draw on reports prepared to inform the California regulatory process (MacEwan et al., 2017; Eschker et al., 2018).

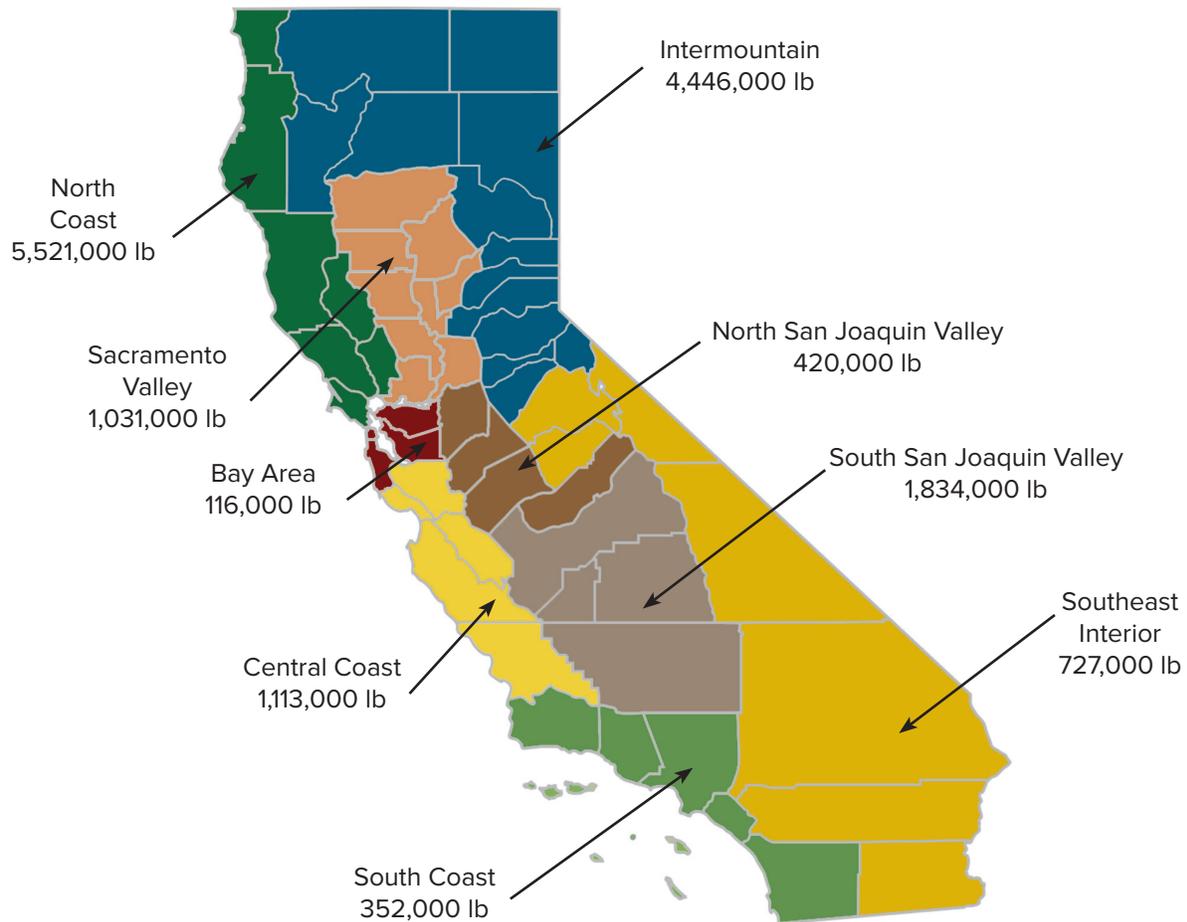
In broad terms, the dimensions of cannabis in California are as follows. Production is about 16 million pounds of raw dried flower. We do not think this number has changed substantially since before adult-use legalization and the implementation of state cannabis taxes, regulations, and licensing at the beginning of 2018. We estimate 2019 consumption in California, by weight, at about 2.8 million pounds, about 2.3 million pounds of which were illegal (unlicensed) and about 540,000 pounds of which were legal (licensed). This represents a modest shift from the legal retail market to the illegal

retail market since 2017, when we estimated total consumption at 2.8 million pounds, with the illegal (unlicensed) cannabis market at 2.1 million pounds and the legal (licensed) cannabis market at 700,000 pounds. We estimate that in 2019, as in 2017, about 80 percent of total cannabis production by weight was illegally exported to destinations outside the state. We stress that the estimates of total production and illegal shipments out of California are based on very limited and indirect data sources.

A variety of factors have contributed to the small size of the licensed market relative to the unlicensed market. First of all, for several reasons, unlicensed prices are relatively low. Licensed cannabis is more expensive to produce on the farm in part because licensed producers must pay taxes and satisfy a long list of regulations and standards. These include payroll and income taxes, and environmental, labor, transport and other rules.

The second factor keeping the licensed cannabis market relatively small is that licensed cannabis businesses throughout the supply and retail chain must also comply with a set of cannabis-specific regulations and taxes. Cannabis manufacturing, distributing, and retail regulations, introduced in 2018, added compliance costs and capital barriers to licensed cannabis but not to unlicensed cannabis. Compliance costs include license fees, locally and state-compliant renovations, the installation and maintenance of special security apparatus, taxes at two or three levels, compliance with track-and-trace software systems, labeling and child-proof packaging requirements, waste disposal rules, and legal and business consultants necessary to comply with these and other new regulations.

The third major barrier for would-be licensed cannabis businesses has been the difficulty of getting local approval for their plans. As of early 2020, more than 70 percent of local jurisdictions in California have prohibited all or most cannabis businesses. These local prohibitions were enabled under the so-called "local control" provisions of Proposition 64, which made state licensing contingent on local licensing. Many investors and industry observers were surprised by how many local jurisdictions chose to forgo local cannabis taxes and enact prohibitions. Because of local control, in

Figure 13.1. Estimated California Cannabis Production by Region, 2017

Source: Adapted from MacEwan et al., 2017

many parts of the state, pre-existing businesses that were legally operating in the medicinal segment in 2017 never had any path to becoming legal under the new state system. Delivery from licensed cannabis retailers is allowed throughout the state, but this has not compensated for lack of storefront licenses across many regions in California.

Barriers to entry, including the costs of running any legal business in California, cannabis-specific start-up compliance costs, and local control, have all restricted the supply of licensed businesses and subjected licensed businesses to higher costs (of becoming and staying licensed, complying with regulations, and paying taxes). These effects may help account for the fact that only a minority of farm cultivators appear to have become compliant as of late 2019 (by some accounts, less than 10 percent of the growers in Humboldt County have entered the licensed system).

The remainder of this chapter discusses in greater detail the structure and economics of the current California cannabis industry, using the latest data available as of early 2020, including the full-year 2019 cannabis tax collections announced by the California Department of Tax and Fee Administration (CDTFA) on March 6, 2020. We divide the remainder of the chapter into brief reviews of California cannabis cultivation, manufacturing, and retail followed by a more general discussion about the economics of California cannabis.

CANNABIS CULTIVATION IN CALIFORNIA

We estimate that between one-quarter and one-third of domestic cannabis consumed, by weight, is currently being sold through licensed channels in California. As discussed, the wholesale and farm prices (defined below) of cannabis differ by growing method, potency, other product characteristics, and regulation status. As of March 2020, according to Cannabis Benchmarks (2020), which surveys a selected and not necessarily unbiased set of wholesale transactions each week, the wholesale price of medicinal cannabis averaged about \$1,200 per pound, with lower prices for cannabis grown outdoors (about \$850 per pound), and higher prices for cannabis grown indoors (about \$1,800 per pound). Prices for cannabis grown in greenhouses was similar to the volume-weighted market average of \$1,200 per pound.

Because most cannabis grown in California is illegal, estimates of the quantity of cannabis production in California must be assembled from a variety of sources. MacEwan et al. (2018) used information from satellite imagery, law enforcement reports, local interviews, and many other sources to estimate 2017 production by region. Figure 13.1 displays their estimates. The data are displayed in what we term “dried cannabis flower equivalent” units, which includes estimates of a small contribution from leaves and trimmings (sold at much lower prices—as low as one-tenth of dried flowers or less).

Of the 15.6 million pounds of production in 2017, MacEwan et al. (2018) estimated that about 11 million pounds came from Northern California, where cannabis has long been grown in mountains and valleys, often in remote areas. Another 3 million pounds came from the San Joaquin Valley and the mountain and desert interior counties. That left about 1.5 million pounds in the coastal regions from San Diego up to San Francisco, where the bulk of the California population resides and where most California cannabis consumption occurs.

Table 13.1 shows the estimated distribution of production in each region by the share of production method—outdoor, indoor, and greenhouse. The final column in Table 13.1 shows the share of California production in each region based on the production quantities reported in Figure 13.1. More than 70 percent of California production comes from Northern California. These regions, like most others, have the majority of production outdoors, but the 51 percent grown outdoors in the North Coast region is below the statewide average of 58 percent grown outdoors. The share grown in greenhouses ranges from 54 percent in the South San Joaquin Valley and 43 percent in the North Coast region, to only 8 percent in the Southeast Interior and 9 percent in the North San Joaquin Valley. Finally, only 9 percent of California cannabis is grown indoors with the highest shares in the more urban regions of the Bay Area and the South Coast.

Table 13.1. Share of Production Measured in Pounds by Method by Region, 2016–17

	Outdoor	Indoor	Mixed Light	Total Share
	Percent			
Intermountain	63	9	27	29
North Coast	51	6	43	35
Sacramento Valley	77	8	15	6.6
Bay Area	26	61	13	0.7
North San Joaquin	74	17	9	2.7
Central Coast	74	6	20	7.2
South San Joaquin	43	3	54	12
Southeast Interior	83	8	8	4.7
South Coast	48	30	22	2.4
Statewide	58	9	33	100

Source: Adapted from MacEwan et al., 2017

Notes: Figures may not add exactly due to rounding; Mixed Light includes greenhouse.

These production estimates from 2017 include the roughly 80 percent of cannabis that is shipped outside California, similar to many other California commodities. There are two major differences for cannabis. First, evidence suggests that relatively little cannabis is exported from the U.S. (with Canada as the potential exception). Second, unlike other farm products, cannabis is illegal to ship to other U.S. states.

The other difference is that much of the production remaining in California is also being sold outside the regulated and taxed legal market. Although cannabis is legal to buy and possess (buying cannabis from unlicensed sellers is not a crime), selling cannabis outside the licensed, taxed, and regulated system is subject to criminal penalties.

Compared with other agricultural products, cannabis canopy area per farm is small (a fraction of an acre on average for all methods). Canopy is the designated area that will contain mature plants, and is measured in square feet. Cannabis output per square foot varies significantly by cultivation method: outdoor, indoor, and greenhouse (mixed light). Given wholesale prices, however, cannabis farms are not small as measured by total revenue.

Outdoor production typically has one harvest per year and, for the surveyed farms, yields an average of only 0.019 pounds, or 0.3 ounces, of dried flowers per square foot of canopy area. Indoor operations average only about 60 percent of the area of outdoor operations, but produce several harvests per year and, in this sample, yield almost 10 times as much cannabis per square foot as outdoor production. Greenhouse production is much closer to indoor in terms of square feet per operation, and averages about 0.105 pounds of cannabis per square foot. Indoor cultivation is much more intense and has very high annual yields of dried flowers per square foot compared to the outdoor operations in this sample. The canopy area per operation is about 60 percent of the outdoor canopy, thus the indoor cultivators averaged about six times as much cannabis as the average outdoor cultivator. The average greenhouse cultivator produced about 3.6 times as much as the outdoor cultivator in this sample.

The prices in 2016–17 were much higher per pound for indoor and greenhouse cannabis. Before legal adult-use cannabis retail sales began in California in 2018, revenue per farm averaged about \$411,000 for outdoor cultivators, compared to \$3,687,000 for indoor and \$1,646,000 for greenhouse

cultivators. Reported direct expenses are only about half of revenue indicating very high returns to management and risk.

In April 2018, farm prices were reported to be between \$800–\$900 per pound for outdoor-grown cannabis and between \$1,500–\$1,600 per pound for indoor-grown cannabis, with greenhouse-grown again in the middle (Cannabis Benchmarks, 2018). Two years later, in March 2020, these farm prices had remained remarkably stable, averaging about \$850 for outdoor cannabis, \$1,800 for indoor cannabis, and about \$1,200 for greenhouse-grown cannabis. These are reported as prices that apply to sales within the legal and licensed market channel.

Note that we distinguish “farm prices” as discussed above (i.e., the price for the raw material of one pound of dried cannabis flower) from what we call “wholesale prices” above (which, imputed from CDTFE, based on about \$1.3 million in 2019 wholesale sales and 540,000 pounds, would suggest an average wholesale price about \$2,400 per pound).

The wholesaling stage in the supply chain (which is sometimes integrated by firms that are licensed to conduct cultivation, manufacturing, or retail operations) adds value by being responsible for labeling, packaging, and distribution to retailers. Wholesalers are also responsible for arranging for and paying for mandatory testing that must be conducted by an independent entity. For operations that are vertically integrated (except for testing), prices at each stage cannot be cleanly separated.

Taxes and regulations that were implemented in 2018 and revised in 2020 affect the cannabis cultivation industry both directly and through market relationships. In January 2020, state cultivation taxes were raised to \$154 per pound of dried flower. The state requires a track-and-trace system starting at the farm, as well as surveillance to implement the system and provide security. The California Department of Food and Agriculture (CDFA) is responsible for licensing cannabis growers and issuing several license types based on cultivation method, farm size, and whether the cannabis is to enter the medicinal or adult-use segment. The cannabis itself may be identical in these license categories.

License fees per square foot rise with the area of canopy and are higher for greenhouse and indoor methods to reflect higher production and prices per square foot of canopy. Producers may obtain several licenses.

We estimate that state regulations add about \$50 per pound to cultivation costs, not including cultivation taxes. Local governments, mainly counties and cities, also implement taxes and regulations on cultivators. These vary by medicinal versus adult-use cannabis and by cultivation method—outdoor, indoor, or greenhouse. Although local taxes and regulations are still in flux and much harder to gauge, local taxes were estimated to add approximately \$130 per pound to the costs of supplying cannabis from the farm (MacEwan et al., 2018). One complication is that growers tend to avoid high-tax, high-regulation areas. Some taxes are on a per-square-foot basis and thus favor growing systems with high-yields of cannabis per square foot. The overall tax rate per pound thus depends in part on how production methods evolve and where production concentrates across jurisdictions.

The evolution of a licensed, taxed, and regulated cultivation industry will favor those firms adept at attracting relatively sophisticated management and adequate capital to meet the new regulatory setting. This new setting includes not only cannabis-specific taxes and regulations, but an array of labor, health and safety, environmental, and other regulations and taxes about which many incumbent cannabis growers have not been knowledgeable or compliant. We expect many growers who were well suited to the long-standing unlicensed and unregulated system to be less suited to the new system than many new entrants. Many of these incumbents may therefore choose to remain unlicensed. Since the size of illegal market is likely to remain large relative to the regulated market, these producers can remain in the cannabis business without attempting to navigate a system in which they may have little comparative advantage.

In general, the prospect of becoming licensed is less appealing to outdoor cannabis producers than to greenhouse or indoor cannabis producers. The first disadvantage to outdoor producers is that pesticide restrictions on cannabis have been at a more restrictive level than the restrictions on any other agricultural product in California (Valdes-Donoso, Goldstein, and Sumner, 2018). It is more difficult for outdoor growers than it is for indoor growers to comply with zero-tolerance standards in areas where there are already residual nonzero amounts of pesticides in the air from neighboring farms.

The second disadvantage is that there is a fixed cost per square foot associated with building state-compliant premises, and cannabis grown indoors or in greenhouses can yield four or five times more cannabis per square foot by inducing multiple harvests per year.

Third, there is a tax disadvantage for outdoor producers. Many local jurisdictions also tax cannabis per square foot, and the state cultivation tax is a tax by weight (rather than by value). Thus lower-yield cannabis cultivation per square foot and cheaper cannabis, both of which are associated with outdoor-grown cannabis, face high taxes per dollar of revenue versus indoor-grown or greenhouse-grown cannabis. California government officials have publicly discussed changing the structure of taxation in ways that may shift this balance to some extent (Schroyer, 2020).

In spite of these challenges, outdoor-grown cannabis has kept the plurality of the California market by volume, perhaps because of its foothold on the low-priced end of the retail market. The relative shares of outdoor-grown, indoor-grown, and greenhouse-grown cannabis fluctuate throughout the year, with outdoor-grown cannabis taking a larger share in the months following the fall harvest. But even four or six months after the last outdoor harvest, in March 2020, about 40 percent of wholesale transactions observed by Cannabis Benchmarks were for outdoor-grown cannabis. Indoor-grown cannabis was about 30 percent of wholesale transactions, and greenhouse-grown cannabis was about 30 percent of wholesale transactions. (It is not clear how representative Cannabis Benchmarks' measures are, but they are the only widely cited source for this information.)

Why does outdoor-grown cannabis still maintain a plurality of the licensed market? Probably the resilience of outdoor-grown is because of its foothold in the low-price segment of the market, where dried cannabis flower can sell at or below \$5 per gram (less than half the statewide average retail price). Electricity is relatively expensive in California, and outdoor-grown cannabis, which uses natural light, saves on this major input into greenhouse-grown and indoor-grown cannabis production. Some large outdoor farms have opened in sunny and sparsely populated areas of the state with advantageous climates and local laws and tax structures that impose fewer costs on growers, such as Kings County and Coachella Valley. Outdoor growers also tend to sell in the largest batch sizes per transaction, thus reducing testing costs per unit.

CANNABIS MANUFACTURING AND RETAIL IN CALIFORNIA

Most retail cannabis is sold as dried flowers for smoking, but a significant minority of the retail market is manufactured cannabis products derived from cannabis flowers, leaves, and trim. Manufactured products are made using cannabis materials that are extracted using a variety of methods, including pressurized solvent-based extraction, distillation, pressing, tumbling, and dry sifting. The retail products using these concentrated extractions are roughly divided into three product categories:

- (1) Concentrates, e.g., Butane Hash Oil (BHO) and CO₂ oil, typically sold at retail as vape pens, cartridges, or rosin. Oil typically has 60–75 percent THC content by volume.
- (2) Edibles, e.g., cannabis-infused foods and beverages generally manufactured using cannabis concentrates.
- (3) Topicals, e.g., creams, lotions, oils, or balms manufactured using cannabis concentrates as ingredients.

Eschker et al. (2018) estimated that manufactured products, including concentrates, edibles, and topicals, comprised about 30 percent of California’s legal medicinal cannabis segment (by revenue) in 2017, and had a similar share of the licensed and regulated market that includes adult-use cannabis. Using the AIC estimate of a legal retail market of about \$2.5 billion in 2019 (the same as the \$2.5 billion medicinal market in 2017), this would translate to a retail value of about \$750 million for the manufactured products segment in 2019.

Eschker et al. (2018) estimated an average ratio of wholesale to retail prices for manufactured products of 0.4 during 2017 (lower than the 0.5 ratio we impute from CDTFE tax data). That ratio implies that retail sales value of \$750 million means a wholesale revenue of about \$300 million for manufactured products in the medicinal cannabis market.

Sales volumes within manufactured cannabis products in the medicinal segment is about 75 percent concentrates, 22 percent edibles, and 3 percent topicals. Manufactured products in the unlicensed segment are almost all concentrates (in the form of vape pens and cartridges).

In 2018, the California Department of Public Health (CDPH) began regulating manufactured cannabis products. Separate license types are required for extracts using nonvolatile solvents and extracts using volatile solvents. CDPH also

enforces rules covering food safety, the security of licensed manufacturing premises, compliance with the track-and-trace system, packaging and labeling, and other areas of regulatory oversight. Eschker et al. (2018) estimate costs of the licenses plus state regulations. In general, the licensed share of manufactured products seems to be higher than the licensed share of dried flower products, but reliable data on quantities by product type are not available.

The price of retail cannabis varies widely by region and location, regulation status, and product characteristics. One distinct difference between retailers is whether or not they are licensed. Most retailers that advertise public listings—72 percent, in data we collected for July 2019 (Goldstein, Saposhnik, and Sumner, 2019)—were unlicensed. The highest proportions of unlicensed retailers were in Southern California (83 percent of all retailers) and the Los Angeles area (78 percent). The lowest proportions of unlicensed retailers were in eastern California, including Sacramento (43 percent), and the greater Bay Area, including Napa and Sonoma (44 percent). Note these data do not include sales from retailers that do not advertise publicly, which may apply to a significant share of the market among some segment of buyers and some locations.

As of mid-2019, in a sample of more than 200,000 retail prices for cannabis flower in California, we observed that licensed storefront retailers listed prices that were 25 percent higher than prices of unlicensed retailers for dried flower, and licensed delivery-only retailers listed prices that were 7 percent higher than those of unlicensed delivery-only retailers.

We observed average retail prices, before sales tax, of about \$11.50 per gram (\$5,200 per pound) at licensed storefront retailers, \$9.20 per gram (\$4,200 per pound) at unlicensed storefronts, \$11.80 per gram (\$5,400 per pound) at licensed delivery-only retailers, and \$11.00 per gram (\$5,000 per pound) at unlicensed delivery-only retailers (Goldstein, Saposhnik, and Sumner, 2019). Both of these retail averages are higher than the 2017 price of cannabis in the medicinal retail market, which was about \$8 per gram. For most retailers, these prices include the state and local excise taxes. But, based on a limited survey, there remains some variation across retailers in whether or not these excise taxes are included in the listed prices.

CANNABIS TAXES AND MARKET SIZE IN CALIFORNIA

Since MAUCSRA was implemented in January 2018, the California Department of Tax and Fee Administration (CDTFA) has published quarterly information about cannabis tax collections. In Table 13.2, we show all tax collections reported by CDTFA in the first two years of California's regulated cannabis system.

These data show a rapid jump in tax collections as more farms and firms became licensed in 2018. Total state tax collections, as shown in Table 13.2, increased from \$347 million to \$620 million in 2019. Growth in tax collections continued in 2019, but at a much slower pace.

In Table 13.2, California's revenue from its taxes on cannabis is separated into the three levels of state taxation. The left most column shows the cultivation taxes collected from farms based on weight produced, which in 2018 and 2019 were fixed at \$9.25 per ounce, or \$148 per pound. The second column, moving right, shows the excise taxes collected from distributors, which in 2019 were 24 percent of the wholesale price. The third column shows the state

sales taxes collected from retailers, which we estimate at an average of 8.3 percent (including a 7.25 percent base sales and a 1.05 percent average county tax that may or may not be incorporated into CDTFA's reported sales tax figures). Note that Table 13.2 does not report any cannabis-specific tax collections from local governments.

In the remainder of this section, we estimate some basic market characteristics for cannabis in California based on CDTFA's reported tax numbers shown in Table 13.2. The retail market size, as measured by total (aggregate) retail revenue, can be estimated directly from CDTFA's sales tax collections, or indirectly through CDTFA's excise tax collections. Excise tax collections also give a window onto the wholesale market size, as measured by total (aggregate) wholesale revenue.

Cultivation taxes are on a per-pound basis. CDTFA reports its total cultivation tax collections each quarter. These reports can be used, along with some simple arithmetic, to approximate the size of the licensed market in California in

Table 13.2. California Cannabis Taxes Collected from Licensed Activities, 2018–2019

2018	Cultivation Tax Collections	Excise Tax Collections	Sales Tax Collections	Total Tax Collections	Annual Growth
	\$ Thousands				
Qtr 1	1,600	32,000	27,300	60,900	
Qtr 2	4,500	43,500	26,200	74,200	
Qtr 3	12,600	53,300	34,900	100,800	
Qtr 4	17,200	55,600	39,100	111,900	
Total	35,900	184,400	127,500	347,800	
2019					Percent
	\$ Thousands				
Qtr 1	17,100	3,100	40,600	120,800	98
Qtr 2	22,900	75,800	58,200	156,900	111
Qtr 3	22,700	84,400	63,000	170,100	69
Qtr 4	23,600	84,400	64,700	172,700	54
Total	86,300	307,700	226,500	620,500	78

Source: Based on quarterly tax reports by CDTFA (2018–2020), including later revisions
 Note: Does not include local municipal cannabis taxes.

Table 13.3. Size of California’s Licensed Cannabis Market Estimated from Tax Collections, 2018–2019

Year	Total Weight (lb), Estimated Based on Cultivation Taxes	Total Wholesale Revenues, Estimated Based on Excise Taxes	Total Retail Revenues, Estimated Based on Excise Taxes ¹	Total Retail Revenues, Estimated Based on Sales Taxes ²
2018	Pounds		\$ Millions	
Qtr 1	10,811	133	293	329
Qtr 2	30,405	181	399	316
Qtr 3	85,135	222	489	420
Qtr 4	116,216	232	510	471
Total	242,568	768	1,690	1,536
2019	Pounds		\$ Millions	
Qtr 1	115,541	263	578	489
Qtr 2	154,730	316	695	701
Qtr 3	153,378	352	774	759
Qtr 4	159,459	352	774	780
Total	583,108	1,282	2,820	2,729

Source: Based on quarterly tax reports by CDTFA (2018–2020), including later revisions

Notes: Does not include local municipal cannabis taxes.

¹ Assumes an actual retail markup of 120 percent. This is meant to apply to the 2018–2019 markets only. Note that in our simulation model, we assume a lower markup (85 percent) so that our results can be more generally relevant to future markets, where we think the average markup will fall over time from the effects of technology, efficiency, and competition.

² Assumes that CDTFA reported tax collections include both state and county taxes, thus an average sales tax rate of 8.3 percent.

each quarter since California’s regulated cannabis market began. In our simple model, the implied quantities are just CDTFA’s reported tax revenue (\$86.3 million for all of 2019) divided by the tax rate (\$148 per pound at the farm in 2019), which generates an estimate of $\$86,300,000 / \$148 = 583,000$ pounds cultivated in 2019.

As shown in Table 13.3, from 2018 to 2019, the total weight of licensed cannabis cultivated in California more than doubled, from about 243,000 pounds to about 583,000 pounds. Note that these and other calculations discussed above and shown in Table 13.3 do not incorporate complications from accounting for leaves and trim, which have a low tax rate and farm price and, as discussed above, are used in manufactured products.

Next, we use CDTFA’s excise and sales tax collections to estimate total wholesale and retail revenues in California. Excise taxes provide a direct window onto licensed wholesale revenues and an indirect window onto licensed retail revenues. In 2018 and 2019, California’s cannabis excise tax rate was 24 percent of wholesale revenue. We

estimate total wholesale revenues by dividing total CDTFA excise tax collections (\$307.7 million for all of 2019) by 0.24 (24 percent) to get our estimate of \$1.3 billion total wholesale revenues in California in 2019. This estimate is shown and broken down by quarter in the second (“total wholesale revenues”) column of Table 13.3.

Officially, the state arrived at 24 percent by assessing a 15 percent tax on the product of the wholesale price times an assumed “markup” multiple of 1.6. But this is simply equivalent to a 24 percent tax on wholesale price. In 2020, although the published excise tax rate of 15 percent remained constant, the effective excise tax increased to 27 percent because the assumed markup multiple increased to 1.8. (This excise tax increase is discussed below and modeled as Simulation Scenario 1.)

Retail revenue can also be estimated, indirectly, from CDTFA’s excise tax collections by assuming an average wholesale-to-retail markup and multiplying total wholesale revenues by the average markup. (Here, we mean the *actual* average markup in the California

marketplace, not to be confused with CTDDFA's assumed markup multiple that is used in calculating excise taxes.) We assume a wholesale-to-retail markup of 120 percent, based on our own price data and our previous findings on the overall cannabis market in California (Goldstein et al., 2019; Sumner et al., 2018). By multiplying our estimate of total wholesale revenues, as above (\$307.7 million / 24% = \$1.3 billion) by 2.2 (100% + 120% markup = 220%), we get our estimate of \$2.8 billion in total retail revenues. Total retail revenue estimates based on excise taxes are broken down by quarter for 2018 and 2019 in the third column of Table 13.3.

California assesses a fixed state sales tax on all retailers, including cannabis retailers, plus an additional local sales tax that varies by county. In 2019, state sales tax was set at 7.25 percent and county sales tax averaged 1.05 percent, for a statewide average sales tax rate of about 8.3 percent (Sumner et al., 2018). Dividing total sales tax collections from cannabis purchases (\$226.5 million in 2019) by 8.3 percent (our assumed sales tax rate) generates a California cannabis retail market size estimate of about \$2.7 billion of total retail revenues in 2019—similar to the \$2.8 billion estimate we arrived at via excise tax collections, assuming a 120 percent markup. Total retail revenue estimates based on sales taxes are broken down by quarter for 2018 and 2019 in the fourth column of Table 13.3.

Retail revenue increased by almost 80 percent year-over-year from 2018 to 2019. However, retail revenue did not grow substantially between quarters 3 and 4 of 2019. Despite the track-and-trace system, some cannabis that did not pay the cultivation tax may leak into the licensed retail market. If that is the case, then our estimate of quantity sold at the licensed retailers is an underestimate.

The fact that 583,000 pounds of cannabis were legally produced on California farms in 2019 does not mean that 583,000 pounds of cannabis were legally sold by California retailers in 2019. Cannabis, like many other agricultural products, must be processed, tested, packaged, labeled, distributed, received, priced, and listed before being sold at retail. There is a time lag between production and retail sale and the quantity produced in a year does not directly line up with the quantity sold in the same year. Cannabis comes in many forms whose shelf life and consumer popularity vary considerably.

California's cannabis industry is new and expanding rapidly making a given year's quantity grown or manufactured a relatively poor estimate of the same year's quantity sold at retail. Data are not yet available (e.g., from California's track-and-trace system) about the length of the average retail cycle in the cannabis industry from "seed-to-sale." We handle the above uncertainties by making



About 700,000 pounds of cannabis were sold legally in California through medicinal cannabis retailers in 2017, and about 600,000 pounds of cannabis were sold legally in California through licensed cannabis retailers in 2019. However, about 2.1 million pounds were sold through the illegal market in 2017, and about 2.4 million pounds were sold through the unlicensed market in 2019.

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Table 13.4. Estimates of the California Cannabis Market Size, Prices, and Quantities

Assumption	Assuming Retail Sale in Same Month of Production¹	Assuming Retail Sale 3 Months after Production²	Assuming Retail Sale 6 Months after Production³
2019 Market Size Estimates Based on CDTFA Reported Sales Tax Collections			
7.25% Average Sales Tax ⁴	583,000 lbs x \$5,400/lb = \$3.1B Retail Revenue	540,000 lbs x \$5,800/lb = \$3.1B Retail Revenue	472,000 lbs x \$6,600/lb = \$3.1B Retail Revenue
8.3% Average Sales Tax ⁵	583,000 lbs x \$4,700/lb = \$2.7B Retail Revenue	540,000 lbs x \$5,100/lb = \$2.7B Retail Revenue	472,000 lbs x \$5,800/lb = \$2.7B Retail Revenue
2019 Market Size Estimates Based on CDTFA Reported Excise Tax Collections			
80% Actual Wholesale-to-Retail Markup	583,000 lbs x \$4,000/lb = \$2.3B Retail Revenue	540,000 lbs x \$4,300/lb = \$2.3B Retail Revenue	472,000 lbs x \$4,900/lb = \$2.3B Retail Revenue
120% Actual Wholesale-to-Retail Markup	583,000 lbs x \$4,800/lb = \$2.8B Retail Revenue	540,000 lbs x \$5,200/lb = \$2.8B Retail Revenue	472,000 lbs x \$6,000/lb = \$2.8B Retail Revenue
Averages of 200,000 California Online Retail Flower Prices We Collected in July 2019			
Statewide Averages	Average Storefront Price: \$5,200/lb Average Delivery Price: \$5,400/lb		
Our Estimated Range for 2019 Licensed Market	520,000–560,000 lbs x \$5,000–\$5,400/lb = \$2.6B–\$3B Retail Revenue		
Source: Estimated based on CDTFA reported sales tax, excise tax, and cultivation tax collection			
Notes: Our estimates of cannabis quantity from CDTFA reported cultivation tax collections assume that all cannabis is dried flower taxed at \$9.25/ounce in 2019. We do not account for lower-potency trim that is taxed at a lower level.			
¹ 583,000 lb = estimated pounds of cannabis on which cultivation taxes were collected by CDTFA in 2019 Q1–Q4.			
² 540,000 lb = estimated pounds of cannabis on which cultivation taxes were collected by CDTFA in 2018 Q4 + 2019 Q1–Q3.			
³ 472,000 lb = estimated pounds of cannabis on which cultivation taxes were collected by CDTFA in 2018 Q3–4 + 2019 Q1–Q2.			
⁴ 7.25 percent is the base state sales tax rate that is kept by the state. CDTFA is not clear in its reported sales tax revenue from cannabis whether or not the revenue includes additional county sales taxes that are collected by the state in addition to the 7.25 percent sales tax and then remitted back to local jurisdictions. Therefore we vary the sales tax rate assumption (including versus not including additional county tax) in the first two rows of this table.			
⁵ 8.3 percent is our estimate of the average sales tax rate including county taxes averaging 1.05 percent statewide in addition to the 7.25 percent base state sales tax.			

market estimates, shown in Table 13.4, using three different assumptions about the average time from farm to retail sale: less than one month, three months, and six months.

In Table 13.4, the left most column of numbers, an unlikely boundary case, assumes that cannabis is sold at retail in the same month that it is produced and taxed at the farm. In this scenario, the 2019 estimate of 583,000 licensed pounds produced would correspond to 583,000 licensed pounds sold. However, the assumption of less than a one-month lag time between farm and retail sale is likely to overestimate the number of pounds actually sold at retail in 2019 (or in any given span of quarters within the data set of eight CDTFA reports since Q1 2018).

In the second column of Table 13.4, we assume—more reasonably, we think—that the average time from farm taxation to retail sale is three months (one quarter). Thus we assume that the volume of cannabis sold in 2019 quarters 1 through 4 would be best approximated by the volume of cannabis produced from 2018 quarter 4 through 2019 quarter 3. Using this assumption of retail sale averaging three months after production, there are 540,000 licensed pounds (43,000 fewer than in the initial no-lag scenario). Column 3 uses an even more conservative assumption about quantity by volume: a six-month average time from farm taxation to retail sale, where only 472,000 licensed pounds are sold at retail in 2019.

THE ECONOMIC PAST AND PRESENT OF CALIFORNIA CANNABIS

From 1996 to 2017, the medicinal cannabis segment operated for 21 years with no significant state regulation and a small and highly variable degree of regulation under local jurisdictions. In many municipalities, no cannabis retail storefronts were allowed, but delivery services made cannabis available to customers with medicinal recommendations.

Until 2017, medicinal cannabis buyers, in order to enter a retail store or order from a delivery service, were required to obtain, and renew annually, a medical document (not a prescription) signed by a California physician indicating that cannabis was recommended. In practice, such recommendations could be obtained via a very quick in-person visit. A patient would self-report medical symptoms indicating cannabis, and show that he or she (or his or her parent or legal caretaker) was a California resident aged 18 or over. The typical fee for an in-person appointment was about \$50.

Starting around 2015, some doctors began offering these recommendations via websites with video-chat functionality. No video chat was required—only completion of an online form, proof that the patient was a California resident of legal age, and access to payment by credit card. Fees for online appointments were somewhat lower and permission was available within minutes. It is instructive to note that despite the ease of meeting the medicinal requirements, most cannabis remained outside this California-legal retail segment.

Proposition 64 legalized cannabis consumption. In June 2017, the California State Legislature enacted the Medicinal and Adult Use Cannabis Regulation and Safety Act (MAUCRSA), which specified the framework for taxing and regulating cannabis in California. The first set of regulations went into effect on January 1, 2018. Some MAUCRSA rules, however, were not enforced until later. Mandatory pesticide-testing rules went into effect between July 1, 2018 and January 1, 2019.

There are several specific challenges that complicate economists' contributions to helping policymakers, the public, and market participants understand the economics of the rapidly evolving legal and regulatory environment for cannabis in California. First, there are no official price or quantity data from the State of California or other government sources. Moreover, as documented above, most California

production and use has been and remains outside the legal channels for medical production, processing, sale, and use. Thus, a large industry developed in California that avoided compliance with auxiliary government regulations such as those administered by environmental, labor, public health, or tax authorities.

An important area of current regulation covers implementation of the track-and-trace system, which starts with seeds used in cultivation and continues through retail sales. Security measures require cameras, video archival, record keeping, security guards, secure destruction and disposal, and secure childproof packaging. Even more costly is the requirement that each batch of cannabis (with maximum batch size of 50 pounds) must be tested for a long list of microbial and chemical contaminants as well as for THC levels, moisture, and for some manufactured products, uniformity. The wholesalers are required to hold the cannabis products during testing and are responsible for submitting state excise and cultivation taxes.

Sumner et al. (2018) find that tests themselves are likely to cost more than \$50 per pound. However, the largest cost derives from loss of product that fails the required tests, given zero tolerance for contaminants such as pesticides and microbials and the difficulty for growers to meet the very tight standard. Valdes-Donoso et al. (2019, 2020) estimate costs when a significant percent of product fails a test and must be destroyed as a result. The costs of testing and of lost inventory from failed batches depends on two main inputs: the average batch size and the failure rate. For instance, assuming a 5-pound average batch size and a 7 percent failure rate, the average testing compliance cost would be about \$200 per pound. Given the same failure rate of 7 percent, if the batch size increased to 50 pounds (the legal maximum), then the cost per pound would be cut in half, to about \$100.

Failure rates and batch sizes are rapidly changing. Recent data from the Bureau of Cannabis Control suggests that the failure rate has recently fallen below 5 percent (Valdes-Donoso et al., 2020). Cannabis Benchmarks (2020) reports the current average batch size at only about 4 pounds, but this may represent a biased sample of sellers. Considering the best available evidence, we estimate that in 2020, average testing costs may fall slightly below \$100 per pound.

Estimated Regulatory Costs per lb of Cannabis	2019 Licensed Costs	2020 Licensed Costs	2019 and 2020 Unlicensed Costs
U.S. Dollars per Pound			
Cultivators' Costs of Regulatory Compliance	50	50	0
Manufacturers' Costs of Regulatory Compliance	100	100	0
Testing Costs, Including Cost of Rejected Product	100	100	0
Distribution, Packaging, and Retail Regulatory Compliance	200	200	0
Total Estimated Regulatory Costs in \$ per lb	450	450	0
Estimated Tax Costs per lb			
State Cultivation Taxes	148	154	0
Local Cultivation, Testing, and Manufacturing Taxes	180	180	0
Local Cannabis Retail Taxes	5% of Retail Price ¹ ~ \$230	5% of Retail Price ² ~ \$240	0
State Excise Taxes ¹	24% of Wholesale Price ¹ ~ \$570	27% of Wholesale Price ¹ ~ \$640	0
State Sales Taxes	8.3% of Retail Price ¹ ~ \$450	8.3% of Retail Price ² ~ \$470	0
Total Estimated Tax Costs \$ per lb	1,580	1,680	0
Total Estimated Taxes and Regulatory Costs \$ per lb	\$2,030 per lb	\$2,130 per lb	\$0 per lb
Notes: Tax calculations assume \$5,000 per pound licensed retail price; U.S. dollars per pound of dried flower equivalent cultivated. Estimates rounded to nearest \$5.			
¹ Wholesale price assumed to be ~\$2,375 (based on CDTFA excise tax, and retail price assumed to be ~\$5,200 including state excise taxes (~120 percent retail markup). Excise tax calculated as (15% x 1.6 x wholesale price) for 2019 and (15% x 1.8 x wholesale price) for 2020. Local cannabis retail taxes applied to retail price not including state excise taxes or state sales taxes. State sales taxes imposed on retail price including state excise taxes and local cannabis retail taxes.			
² Retail price for 2020 is adjusted upward to incorporate: (1) an additional \$6 in cultivation tax that (assuming farm price of \$1,200 and constant markup percentage) translates to \$6 x (5200/1200) = \$26 per pound; (2) an additional \$70 in excise tax that (assuming wholesale price of \$2,375 and constant markup percentage) translates to \$70 x (5200/2375) = \$153 per pound; so the total retail price is \$26 + \$153 = \$179, which we round to \$180 and add it to the 2019 retail price of \$5,200 to get a 2020 retail price of \$5,380.			

Table 13.5 provides a summary of taxes, fees, and regulatory costs including those at the cultivation, manufacturing, wholesale and retail stages in 2019 and 2020. The retail taxes for cannabis are added in several steps from both state and local jurisdictions. As discussed above, the cultivation tax is \$148 per pound in 2019 and \$154 per pound in 2020. The state excise tax is 24 percent in 2019 and 27 percent in 2020; and the sales tax remains constant in 2019–2020 at about 8.3 percent.

The sales tax does not apply to medicinal cannabis sales if the buyer has a county-issued medical card in addition

to the required medical recommendation. However, by all accounts, this exemption is rarely used by consumers.

Local cannabis retail taxes vary widely across the state. A survey of local taxes and fees that were implemented, scheduled, or likely in early 2018 indicated an average of 8.2 percent for adult-use cannabis and 7.8 percent for medicinal cannabis (Sumner et al., 2018). We assume that local cannabis retail taxes are applied to retail price not including excise or state sales tax, whereas state sales taxes are applied to retail price including state excise and local cannabis retail taxes. We recognize that retailers tend to avoid high-tax

Table 13.6. Estimated California Retail Cannabis Quantities, Prices, and Revenues, Legal vs. Illegal, 2017 vs. 2019

Market Segment	2017	2019
Legal Market	Medicinal in 2017	Licensed in 2019
Total Weight Sold at Retail (lb)	700,000	540,000
Average Retail Price Without Any Taxes (\$/lb)	3,600	4,300
Average Retail List Price (Incl Cultivation & Excise Taxes but Not Sales & Local Cannabis Retail Taxes) (\$/lb)	3,600	5,200
Average Retail Price After All Taxes (\$/lb)	3,600	5,900
Total Retail Revenue (Incl Cultivation & Excise Taxes but Not Sales and Local Cannabis Retail Taxes) (\$ Billions)	2.5	3.2
Legal's Share of Total Market by Pound (%)	25	20
Legal's Share of Total Market by Revenue, Incl Cultivation & Excise Taxes but Not Sales & Local Cannabis Retail Taxes (%)	33	36
Illegal Market	Non-medicinal in 2017	Unlicensed in 2019
Total Weight (lb)	2,100,000	2,220,000
Average Retail Price (\$/lb)	2,400	2,500
Total Retail Revenue (\$ Billions)	5.0	5.6
Illegal's Share of Total Market by Pound (%)	75	80
Illegal's Share of Total Market by Revenue (%)	67	64
Aggregate Market (Legal + Illegal)		
Total Weight (lb)	2,800,000	2,760,000
Average Retail Price (\$/lb)	2,700	3,200
Total Retail Revenue	\$7.5 billion	\$8.7 billion
Source: AIC simulations and calculations		

places for retail operations; especially given that regulations do not limit delivery operations from delivering across regulatory jurisdictions. We expect that many customers are willing to travel (or order from delivery services) across jurisdictions for a lower price. We thus use 5 percent as a statewide average local cannabis retail tax.

Table 13.6 shows our estimates of the prices and quantities in the legal and illegal (or unlicensed) California retail cannabis market in 2017, before MAUCRSA regulations were implemented; and in 2019, the second complete year under MAUCRSA. We estimate that about 700,000 pounds of

cannabis were sold legally in California through medicinal cannabis retailers in 2017, and that about 600,000 pounds of cannabis were sold legally in California through licensed cannabis retailers in 2019. We estimate that 2.1 million pounds were sold through the illegal market in 2017, and that about 2.4 million pounds were sold through the unlicensed market in 2019.

SIMULATION OF LIKELY EFFECTS OF CHANGES IN TAX RATES AND REGULATIONS

What are the impacts of taxes and regulations on cannabis purchases in the legal (licensed) and illegal (unlicensed) segments? We designed a simulation model to assess how changes in taxes on licensed cannabis producers and distributors affect the two market segments for cannabis in California. Cannabis is assumed to be available in two types: licensed and unlicensed. For simplicity, we assume that the retailer is also the distributor and that there is no intermediate wholesaler or manufacturer in the supply chain.

Licensed cannabis gets taxed at two stages. First, cultivation tax is applied to cannabis produced by licensed cultivators (growers). Cultivation tax is additive and is applied in dollars per pound of dried flower equivalent. We convert this specific tax to an ad valorem equivalent in order to simplify log-transformation of this model. The wedge between wholesale and retail prices includes wholesale-to-retail markup, excise taxes, sales taxes, and local taxes. First, excise tax is applied to wholesale price plus a multiple that the state calls a “markup” (but is distinct from the actual markup as we discuss it elsewhere). Local municipal tax is applied to a cannabis price exclusive of the excise tax. State sales taxes—which include California state tax and county sales tax—are applied to a cannabis price that already includes cultivation, excise, and local municipal taxes.

Our model allows us to calculate changes in quantities and prices for licensed and unlicensed cannabis as a function of exogenous demand shifters and taxes. We parameterize our model using values of initial prices and quantities, markups and taxes, and elasticities. Reliable data and parameter values to calibrate the model and specify the demand and supply equations are difficult to develop for cannabis. Little or no useful econometric estimations for cannabis have been published. Moreover, even basic data on quantities (and, to a lesser degree, prices) is not available from normal sources.

We use our best estimates of key supply and demand parameters for licensed and unlicensed cannabis, and

substitutability between cannabis from the two market channels taken from interviews with industry sources and by analogy with other farm products that share similar characteristics with some aspects of cannabis. That is, we use information from other products and our own experience with the industry to specify the models.

We assume some consumer willingness to pay extra for legal cannabis because of testing, product security, and perhaps convenience or customer service advantages. The notion that safety testing and government assurances of testing and safety can increase willingness to pay is widely incorporated in analysis of demand for other agricultural products (Pouliot and Sumner, 2008; Saitone, Sexton, and Sumner, 2016; and Gray et al., 2005).

The farm supply elasticity of cannabis in each segment is 5.0, which reflects the fact that cannabis requires few specialized resources and will be a very small share of the space available in greenhouses, warehouses, or outdoor plots (Matthews and Sumner, 2017). The demand elasticity for cannabis overall is taken to be quite inelastic. We use -0.2 from Jacobi and Sovinsky (2016), but this parameter is of little importance in the main results. We assume own-price demand elasticities to be -2 for both licensed and unlicensed cannabis, and calculate cross-price elasticities between licensed and unlicensed cannabis. Cross-price elasticity between licensed and unlicensed cannabis is calculated to be 7.57, and between unlicensed and licensed cannabis: 0.40.

Other parameters included in the model are volumes and prices for licensed and unlicensed cannabis, as well as taxes for licensed cannabis, which are discussed at length earlier in this chapter.

Table 13.7. Simulated Impacts of Small Changes in Tax Rates and Regulations

Variables	Simulation Scenarios	
	1 Small Tax Rate Increase (Changes Implemented January 1, 2020)	2 Allowing More Retail Hours of Operation per Day
	Percent Change	
Total Quantity of Cannabis	-0.1	0.4
Quantity of Licensed Cannabis	-2.3	8.4
Quantity of Unlicensed Cannabis	0.4	-1.5
Retail Price of Licensed Cannabis	1.5	1.7
Retail Price of Unlicensed Cannabis	0.1	-0.3
Price Received by Licensed Suppliers	-0.5	1.7
Price Received by Unlicensed Suppliers	0.1	-0.3

Source: AIC simulations and calculations

SCENARIO 1. HIGHER TAXES

On January 1, 2020, the State of California raised its two main cannabis taxes: the cannabis cultivation tax (from \$148 to \$154 per pound of cannabis flower cultivated) and the cannabis excise tax. The markup used to calculate the excise tax rate also increased from 0.6 to 0.8, resulting in an effective excise tax increase from 24 percent of wholesale price to 27 percent of wholesale price (a 12.5 percent increase in the excise tax rate). This is the first simulation scenario we consider. Results are reported in Table 13.7.

In Simulation Scenario 1, the quantity of licensed cannabis is projected to decline by about 2.3 percent, or about 12,000 pounds, while quantity of unlicensed cannabis is projected to increase by about 0.4 percent, or about 9,000 pounds. As a result, total quantity of cannabis will decline slightly by 0.1 percent, or about 3,000 pounds. Therefore, the new tax policy accomplishes a slight reduction in the total amount of cannabis consumed in California, but with a shift of 9,000 pounds from the licensed to the unlicensed market segment.

SCENARIO 2. MORE HOURS OF OPERATION

The state may want to consider implementing regulations that increase the share of licensed cannabis relative to unlicensed cannabis, while causing few changes in costs

to the state. Currently, licensed cannabis retailers have restricted hours of operation from 9 a.m. to 10 p.m.. This regulation makes licensed cannabis less available to consumers who want to shop outside of those hours.

In 2017, we estimated that about 13 percent of the opening hours of medicinal cannabis retailers that existed in the unregulated pre-MAUCRSA market fell outside of legally allowable hours of operation for licensed cannabis retailers under MAUCRSA (Sumner et al., 2018). Between 10 p.m. to 2 a.m., which are busy hours for cannabis delivery in some areas, unlicensed retailers are the only option available to consumers. Some consumers will adjust to the 10 p.m. curfew and buy in advance from licensed retailers, whereas others will not.

In California, we assume that eliminating this restriction on operating hours would increase consumer demand for licensed cannabis by 7 percent, defined as an outward (right) shift in demand. This is the second simulation scenario we consider. Results are reported in Table 13.7.

Under Scenario 2, demand for licensed cannabis is estimated to increase by 8.4 percent, or about 45,000 pounds; the demand for unlicensed cannabis to decrease by 1.5 percent, or about 33,000 pounds, and total demand for cannabis to increase by about 0.4 percent, or 12,000 pounds.

COVID-19

In spring 2020, the spread of COVID-19 (Coronavirus) resulted in the declaration of state and Federal emergencies and several temporary regulations governing retail markets and buying behavior. These included statewide and local “shelter-at-home” orders. Initially, many cannabis retailers reported a bump in revenues as consumers rushed to buy cannabis. Although many licensed storefronts remained open after cannabis was deemed by the state to be an “essential” good, we expect that COVID-19 will result in an overall shift away from storefront retailers and toward delivery-only retailers.

Preliminary data in late March 2020 indicate an increase of 230 percent in cannabis revenues reported by Weedmaps in the first week after Governor Newsom issued his “shelter-in-place” order (*Wall Street Journal*, 2020). We assume that this increase in revenues came from a combination of licensed and unlicensed retailers, although no statements were made by Weedmaps or the journalists covering the story about the license status of retailers that had experienced increases in business during COVID-19 lockdown.

Our research suggests that a larger share of delivery-only retailers are unlicensed, whereas licensed retailers have a higher proportion of storefronts. The shift to delivery generated by COVID-19 restrictions is thus likely to cause a temporary increase in the share of unlicensed cannabis, and a decrease in the share of licensed cannabis, in the California market for in-state consumption.

Effects of COVID-19 on overall consumption are unclear, but with consumers spending more time at home, recreational consumption may increase as other forms of recreation are limited by COVID-19 restrictions. This is consistent with the early Weedmaps data (*Wall Street Journal*, 2020).

CONCLUSION

After the first two years of the introduction of California state cannabis regulations and taxes, it is clear that the licensed cannabis market will continue to account for only a minority of retail sales for as long as unlicensed and untaxed sellers continue to maintain a substantial price advantage, as they do now. Licensed producers and sellers could eventually gain more market share if their prices fall as scale increases, the industry consolidates, and a few large, highly efficient producers and distributors dominate the market. This happened historically in other highly regulated industries, where significant compliance costs are introduced by the government, such as tobacco, alcohol, and pharmaceuticals. A policy option would be to lower costs of taxes and regulations enough that prices in the licensed market could decline substantially. So far, this option has not been pursued in California. On the contrary, state cannabis tax rates were raised in 2020, which we expect will have the effect of expanding the unlicensed market and shrinking the licensed market.

REFERENCES

- Bureau of Cannabis Control (BCC). 2019. Cannabis Regulations. Available at: www.bcc.ca.gov.
- CDTFA. 2020. California Department of Tax and Fee Administration Reports Cannabis Tax Revenues for the Fourth Quarter of 2019. News Release, March 6, 2020. Available at: <http://bit.ly/3nzoQGo>.
- Cannabis Benchmarks, 2018–2020. Premium Reports, Wholesale Price Data Archive. New Leaf Data Services. Available at: www.cannabisbenchmarks.com.
- Eschker, E., J. Kaplan, J. Zender, F. Krissman, J. Meisel, and A. Silvaggio, 2018. "Standardized Regulatory Impact Assessment (SRIA). Proposed Regulations for Manufacturers of Adult-Use and Medicinal Cannabis." Humboldt Institute for Interdisciplinary Marijuana Research. Available at: <https://bit.ly/3870UUv>.
- Goldstein, R. 2019. "Half-blind Tasting: A Deception-Free Method for Sizing Placebo and Nocebo Responses to Price and Packaging Attributes." *Journal of Wine Economics* 14(3): 321-331.
- Goldstein, R., and D.A. Sumner 2019. "California Cannabis Regulation: An Overview." *California Agriculture* 73 (3-4): 101-102. Available at: <http://bit.ly/2IQGAy0>.
- Goldstein, R., R. Saposhnik, and D.A. Sumner. 2020. "Prices of Cannabis in California from Licensed and Unlicensed Retailers." *ARE Update* 23(3): 1-4. University of California Giannini Foundation of Agricultural Economics. Available at: <https://bit.ly/3oUO7v1>.
- Goldstein, R., D.A. Sumner, and A. Fafard. 2019. "Retail Cannabis Prices in California Through Legalization, Regulation and Taxation." *California Agriculture* 73 (3-4): 136-145. Available at: <http://bit.ly/2LASP2J>.
- Gray, R.S., D.A. Sumner, J.M. Alston, H. Brunke, and A.K.A. Acquaye. 2005. "Economic Consequences of Mandated Grading and Food Safety Assurance: Ex Ante Analysis of the Federal Marketing Order for California Pistachios." Monograph 46. University of California Giannini Foundation of Agricultural Economics, March 2005. Available at: <https://bit.ly/3aetW7t>.
- Jacobi, L. and M. Sovinsky. 2016. "Marijuana on Main Street? Estimating Demand in Markets with Limited Access." *American Economic Review* 106-8: 2009-45.
- MacEwan, D., D. Newman, R.E. Howitt, J. Noel, and M. Driver. 2017. "Economic Impact Analysis of CalCannabis Cultivation Licensing Program Regulations. Standardized Regulatory Impact Assessment (SRIA)." ERA Economics LLC. Available at: <https://bit.ly/384WzB7>.
- Matthews, W.A., D.A. Sumner, J. Medellín-Azuara, and T. Hanon. 2017. "Economics of the California Cut Flower Industry and Potential Impacts of Legal Cannabis." University of California Agricultural Issues Center. Available at: <https://bit.ly/386plRR>.
- Pouliot, S. and D.A. Sumner. 2008. "Traceability, Liability, and Incentives for Food Safety and Quality." *American Journal of Agricultural Economics* 90(1): 15-27.
- Saitone, T.L., R.J. Sexton, and D.A. Sumner. 2015. "What Happens When Food Marketers Require Restrictive Farming Practices?" *American Journal of Agricultural Economics* 97(4): 1021-1043.
- Schroyer, J. 2020. "Proposed Regulatory and Tax Reforms in California Could Make Life Simpler for Marijuana Businesses." *Marijuana Business Daily*, January 16, 2020. Available at: <http://bit.ly/2WIOHxO>.
- Substance Abuse and Mental Health Services Administration. 2014. Results from the 2013 National Survey on Drug Use and Health: Summary of National Findings. NSDUH Series H-48, HHS Publication No. (SMA) 14-4863. Substance Abuse and Mental Health Services Administration.
- Sumner, D.A., R.S. Goldstein, H. Lee, W.A. Matthews, Q. Pan, J. Medellin-Azuara, T. Hanon, P. Valdes-Donoso, and J. Lapsley. 2018. "Economic Costs and Benefits of Proposed Regulations for the Implementation of the Medicinal and Adult Use Cannabis Regulation and Safety Act (MAUCRSA)." Standardized Regulatory Impact Analysis, including Appendix.
- Valdes-Donoso, P., D.A. Sumner, and R.S. Goldstein. 2019. "Costs of Mandatory Cannabis Testing in California." *California Agriculture* 73(3-4): 154-160.
- Valdes-Donoso, P., D.A. Sumner, and R.S. Goldstein. 2020. "Costs of Cannabis Testing Compliance: Assessing Mandatory Testing in the California Cannabis Market." *PLOS One*, 15(4): e0232041. Available at: <http://bit.ly/3rSZAxD>.
- Wall Street Journal*. 2020. Staff Editorial. "California Deems Pot an Essential Coronavirus Business." 24 March 2020. Available at: <http://on.wsj.com/2Ku3KdW>.
- Weedmaps. Available at: <http://weedmaps.com>.

