

**Standardized Regulatory Impact Assessment (SRIA)
Proposed Regulations for Manufacturers of Adult-Use and Medicinal Cannabis**

Prepared for the California Department of Public Health

by the Humboldt Institute for Interdisciplinary Marijuana Research



Authors

Erick Eschker, Ph.D.
Jonathan Kaplan, Ph.D.
Joshua Zender, Ph.D.
Fred Krissman, Ph.D.
Joshua Meisel, Ph.D.
Anthony Silvaggio, Ph.D.

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Summary

Proposed regulations on cannabis manufacturers by the California Department of Public Health (CDPH) under the Medicinal and Adult-Use Cannabis Regulation and Safety Act (MAUCRSA) are expected to lead to increased annual industry costs of \$138 million or 17.7 percent of manufacturer sales to retailers on an ongoing basis. In the first year of regulation, industry costs are estimated to be \$195 million for cannabis manufacturers. Currently, California manufactured cannabis sales to customers are estimated to be \$1.5 billion with \$611 million in manufacturer sales out of the factory. We predict there will be a noticeable fall in the risk premium after manufactured cannabis is regulated which will increase supply and offset regulatory costs. Regulations will also lead to an increase in demand which will raise the quantity of manufactured cannabis sold and the dollar value of retail sales. We estimate that the benefits of the proposed regulations outweigh the costs. The expected impact of the proposed CDPH regulations on manufactured cannabis is an increase in California Gross State Product by \$37 million annually.

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Introduction

This Standardized Regulatory Impact Analysis (SRIA) is written by faculty affiliated with the Humboldt Institute for Interdisciplinary Marijuana Research (HIIMR) and analyzes the economic impact of regulations proposed by the California Department of Public Health (CDPH) for the manufacture of adult-use and medicinal cannabis. HIIMR began work for this impact analysis in January, 2017, and completed an initial draft in December 2017.

The Medicinal and Adult-Use Cannabis Regulation and Safety Act (MAUCRSA)

The authority to regulate medicinal cannabis was first authorized in the Medical Cannabis Regulation and Safety Act (MCRSA), enacted through several bills in 2015 and 2016.¹ Adult-use cannabis was legalized by Proposition 64, passed by the voters in November 2016. Subsequent legislation, Senate Bill (SB) 94 (Chapter 27, Statutes of 2017), passed in June 2017, reconciled the MCRSA and Proposition 64 into a single law, known as the Medicinal and Adult-Use Cannabis Regulation and Safety Act (MAUCRSA). MAUCRSA eliminated most of the regulatory differences between medicinal and adult-use cannabis to allow for a more consistent oversight program.

In addition to CDPH, the Bureau of Cannabis Control (BCC) under the Department of Consumer Affairs and the California Department of Food and Agriculture (CDFA) also have regulatory authority over aspects of medicinal and adult-use commercial cannabis production and sale.

Relationship to SRIA on Manufacturers of Medicinal Cannabis

In February 2017, HIIMR delivered to the CDPH a SRIA on proposed regulations of medicinal cannabis manufacturers under MCRSA. We refer to the February 2017, report as the “MCRSA SRIA”. While the focus of the MCRSA SRIA was medicinal cannabis manufacturing, it included assumptions and estimates about adult-use manufactured cannabis, as Proposition 64 would be in effect when medicinal cannabis regulations came about.

This SRIA updates assumptions and estimates of both medicinal and adult-use cannabis segments. Specifically, we have:

- Obtained new estimates of cannabis manufacturer profit margins and costs.
- Included analysis that differentiates between manufactured concentrates, edibles, and topicals.

¹ Assembly Bill (AB) 243 (Chapter 688, Statutes of 2015), AB 266 (Chapter 689, Statutes of 2015), SB 643 (Chapter 719, Statutes of 2015), and SB 837 (Chapter 32, Statutes of 2016)

- Added changes in consumer demand and producer supply to our model of the cannabis market.
- Refined parameter values and supply and demand shock magnitudes in our model of the cannabis market.
- Produced more exact estimates of the adult-use cannabis segment.
- Revised impacts of the risk premium.
- Obtained new estimates of the number of likely license applicants.
- Refined regulatory cost estimates.

We have also addressed in this SRIA the issues raised in DOF comments on the MCRSA SRIA. We also note that where called for, text from the MCRSA SRIA is reproduced here.

Scope of Work

Beginning January 1, 2018, commercial cannabis sales for the adult-use and medicinal markets will be regulated. This SRIA estimates the impact of CDPH MAUCRSA regulations on manufacturers of both adult-use and medicinal cannabis.

The sales of manufactured cannabis products can be divided into three markets: (1) concentrates; (2) edibles; and (3) topicals. Each of these three markets can be further divided into segments that are distinguished by legal status and regulatory requirements. Currently, the two segments for cannabis are: (1) legal medicinal sales under Proposition 215, and (2) unlicensed domestic sales within California.² The passage of Proposition 64 creates a third segment: (3) the adult-use segment.³ This analysis addresses the question, “What will MAUCRSA regulations do to the relative prices of cannabis in the medicinal, adult-use and unlicensed segments, and what are the economic impacts on the State of California?”

In addition to CDPH and manufactured products, MAUCRSA grants authority to BCC to regulate cannabis distribution, transportation, testing, and retail sales and authority to CDFA to regulate cannabis cultivation. While this report considers those areas in the supply chain, it is beyond the scope of this work to explicitly detail regulations in those areas.

Public Input Description

CDPH, along with BCC, conducted pre-regulatory stakeholders meetings to provide the public with an opportunity to participate in discussions on specific topics regarding dispensaries, distributors, manufacturers, testing laboratories, and transporters. The meetings were held in Redding, Sacramento, Santa Rosa, Oakland, Fresno, Los Angeles, San Diego, and Santa Ana

² The “unlicensed segment” refers to domestic sales within California that are not legal as either medicinal or adult-use sales.

³ We limit our analysis to production of cannabis in the medicinal, adult-use, and unlicensed segments and ignore illegal exports out of state and home production. Additionally, we do not consider cannabis purchased out of state and imported to California.

during September and October 2016. Members of HIIMR attended over half of the meetings to solicit input from stakeholders and to compile a contact list for our survey. Additionally, the MCRSA SRIA was available for public comment during the spring of 2017.

Description of Cannabis Manufacturing and Products

Cannabis Manufacturing Methods

Manufactured cannabis products include a process of extracting compounds from the cannabis plant or infusing extracted compounds into other products. Cannabis that is simply dried and packaged, such as dried cannabis flowers or pre-rolled cannabis cigarettes is not considered a manufactured product. There are a variety of processing methods used in cannabis extractions: Pressurized Solvent-Based Extraction, Distillation, Pressing, Tumbling, and Dry Sifting.⁴

Pressurized Solvent-Based Extraction – Home and commercial grade extraction machines commonly used to produce food and medicinal grade essential oils and flavors use butane, CO₂, hexane, water, and/or propane that bonds to cannabinoids and terpenes. The resulting oil is purified through evaporation or distillation.

Distillation – This method uses cold water, dry ice, or alcohol to extract the oils and terpenes from cannabis flower or trim.⁵ It is also used as a method to remove unwanted compounds from existing cannabis oil.

Pressing - Cannabis flowers and/or kief are pressed between heated metal plates protected by parchment paper, forcing the oils, cannabinoids, and terpenes to leave the plant.⁶

Tumbling - Cannabis flower and/or trim is placed in a perforated chamber and spun to allow *tetrahydrocannabinol* (THC)-rich trichomes, called kief, to fall onto a collection tray. Kief is used to make tinctures, rosin, and hash.⁷

Dry Sift – A series of mesh silk screens or sieves are used to separate the trichomes from the cannabis flower or leaf.

⁴ See <https://blackrockog.com/blogs/learn/78049414-what-are-cannabis-concentrates-a-guide-to-extraction-techniques>

⁵ "Trim" is the industry term for trimming materials that are removed from the cannabis flower before sale.

⁶ Kief is a grade of dry sift that contains a mixture of trichome heads, stalks, and cannabis plant matter.

⁷ Rosin tech is a solvent less hash oil that utilizes heat and pressure to extract oil from cannabis flower.

Cannabis Manufactured Products

Concentrates

Butane Hash Oil (BHO) - Sold in liquid or hardened form, it is also known as shatter, wax, crumble, and BHO. Pressurized butane is forced through a vessel containing cannabis buds, trim, and/or kief. Cannabinoids, terpenes, and flavonoids adhere to the butane, forming oil. The butane-rich oil is then left exposed to evaporate or is placed in a vacuum oven where the butane is forced to evaporate. The consistency of BHO products varies depending on cannabis quality, strain, and post-extraction processes. BHO is often mixed with glycol to enhance viscosity for use in vaporizer cartridges.

CO₂ Oil - Liquid CO₂ is heated and pressurized to a supercritical state that hovers between liquid and gas, which is forced through a vessel containing cannabis. Finely ground cannabis trim is most often used, but buds, leaf, and kief are also popular. CO₂ extraction allows manufacturers to separate terpenes from cannabinoids. The oil is sold raw or decarboxylated (heated to 110°C for approximately two hours) in gel caps, syringes, and vaporizer cartridges. Most large-scale manufacturers add glycol (propylene and ethylene) to CO₂ oil in order to maintain a level of viscosity amenable for use in vaporizer cartridges. CO₂ oil is the most common medium for low-THC, cannabidiol (CBD⁸)-rich oils.

Rosin Tech - Cannabis flowers and/or kief are pressed between heated metal plates protected by parchment paper forcing the oils, cannabinoids, and terpenes to leave the plant.⁹ The rosin that is collected hardens into a gum-like consistency.

Edibles

Foods and Beverages - Cannabis is used in nearly every food product commonly available in stores such as chocolates, candies, cookies, pretzels, pasta, butter, soda, infused juices, salad dressing, beer, wine, barbecue sauce, and corn chips. Large-scale manufacturers often use steam distillers and/or supercritical CO₂ extractors to produce oil for edibles. Small- and medium-scale producers of edibles, especially bakers, often infuse butter, coconut oil, olive oil, or other typical cooking fats with cannabis.¹⁰

Tinctures -Tinctures are made from cannabis trim, leaf, and/or bud that are soaked in alcohol and/or glycol or vegetable glycerin. Carbon filters are often used to remove chlorophyll from the finished product. Home and commercial grade distillation units use water or alcohol to remove cannabinoids, which produces concentrated cannabis oil. Many tinctures are infused with common herbs like lavender, basil, rose petals, and mint, and are sold in small bottles.

⁸ CBD or cannabidiol is a chemical in extracted cannabis oil.

⁹ See <https://erlax.com/2015/03/24/rosin-tech-explained/>

¹⁰ One large-scale manufacturer of chocolate-based candies melts finely ground hashish into their products.

Topicals

Topicals - Topicals are cannabis infused lotions, salves, sprays, balms, and oils that are applied to the skin.

Description of Three Product Markets

In the models that follow, we describe three different cannabis markets (concentrates, edibles, and topicals). Within each of these markets, there are three segments (adult-use, medicinal, and unlicensed segments). Our terminology implicitly assumes that people consider segments within a given market closer substitutes than they consider the individual markets to be substitutes. In other words, we assume that adult-use edible consumers pay more attention to the price of edibles in the medicinal market, rather than the price of adult-use topicals. This means that people will shift quantity demanded between a market's segments in response to relative price changes due to regulation. By having three markets, we can have a richer description of cannabis consumption rather than just talking about one composite "manufactured cannabis" market with three different segments.

Major Regulatory Status Determination

The MCRSA SRIA identified initial year industry regulatory costs that exceeded \$50 million. MAUCRSA largely includes the same regulations on medicinal manufacturers, and additionally regulates adult-use manufacturers. Our primary assumption is that adult-use manufactured cannabis market is at least as large as the medicinal market; consequently, we expect increased direct costs to all cannabis manufacturers will be well over the \$50 million threshold for a major regulation.

Current Market

Data Sources and Uncertainty

There is no legal adult-use manufactured cannabis segment in California at the time of this analysis. We believe that most of the adult-use manufactured cannabis segment will come from existing customers in the current unlicensed manufactured segment. The remaining adult-use manufactured cannabis customers will come from the medicinal manufactured segment or will be new consumers of manufactured cannabis.

Reliable and current data on manufactured cannabis are difficult to find. Therefore, we relied to a large degree on primary data collected through our own surveys.¹¹ In fall 2016 and spring 2017, we surveyed manufacturers through an online survey that was advertised to hundreds of

¹¹ We tried to get as many businesses as possible to respond, but it is difficult to know if our respondents are representative of businesses in California.

manufacturers that we had identified through the pre-regulatory process, and by other means. We also spoke with individual industry business representatives. In summer 2016, we surveyed dispensaries. Finally, we used preliminary data from an ongoing survey of dispensary patients. We made every effort to use data from peer-reviewed or official sources, but at times we have had to rely on the popular press or other non-refereed published sources. All of these online data sources are referenced and described below.

Medicinal Segment

Estimates - Sales

Estimates on the baseline size of the medicinal segment were based on information gathered from the California Department of Tax and Fee Administration (CDTFA), as well as industry surveys. Medicinal cannabis dispensaries are required to obtain a seller's permit and to collect and pay sales tax to CDTFA. Manufacturers and cultivators are also asked to obtain a seller's permit, and in our survey of manufacturers all respondents held a seller's permit.¹²

However, estimating the size of the cannabis market is not as straightforward as aggregating the data from CDTFA. When applying for a seller's permit, businesses are asked to provide their North American Industry Classification System (NAICS) code, and there is no NAICS code for the cannabis industry. Businesses may put a different industry code or leave it blank because CDTFA does not require businesses to disclose what they sell. In an effort to ascertain a better estimate of the number of cannabis businesses, CDTFA has partnered with HdL Companies to use publicly available information to identify cannabis businesses and estimate the amount of remitted sales and use taxes. CDTFA estimated that in 2015, publicly disclosed medicinal cannabis sellers registered with CDTFA filed returns and remitted sales and use tax in the amount of \$58,012,269. For the first six months of 2016, remitted sales and use taxes totaled \$50,507,006. We attribute the increased revenue to greater compliance by dispensaries due to the desire to have proper documentation in anticipation of state licensing. This makes it difficult to compare 2015 to 2016 (first six months) tax receipts, so we averaged annualized collections to arrive at \$79,513,141.¹³ We use this as the official number upon which we base our medicinal cannabis segment estimate.

Next, we adjusted this base assumption to account for unreported sales and non-cannabis product sales and dispensaries. First, we assume that 40 percent of sales are not reported.¹⁴ Second, we assume that, on average, four percent of sales are for items other than cannabis, such as t-shirts.¹⁵ California sales tax is 7.25 percent, but districts can set higher rates up to ten

¹² See <http://www.cdtfa.ca.gov/industry/cannabis.htm>

¹³ 2016 annualized sales are \$101,014,012.

¹⁴ Based on comments by BOE Chairwoman Fiona Ma. See <http://www.sfchronicle.com/bayarea/article/State-pot-measure-may-cost-millions-before-it-10596009.php>

¹⁵ This result comes from our summer 2016 dispensary survey.

percent. The most recent CDTFA data indicates an average sales tax rate of 8.8 percent that dispensaries collect.¹⁶ After making these two adjustments, we arrive at an estimate of total medicinal cannabis dispensary dollar sales in 2016 of \$2.2 billion.

We can compare our estimates to others' estimates. New Frontier Data and ArcView Market Research estimate the California 2016 medicinal cannabis segment to be \$2.81 billion.¹⁷ We also consider Washington, which legalized medicinal cannabis in 1998, soon after California. Kleiman, Davenport, and Rowe, et al., (2015) estimate the size of the medicinal marijuana segment in Washington to be \$480 million.¹⁸ The U.S. Census estimates Washington's population in 2015 to be 7.2 million, while California's population to be 39.1 million, or 5.4 times greater.¹⁹ If cannabis sales are proportional to population, California's medicinal cannabis segment would be \$2.6 billion.

We next work backward from our estimate of total dispensary sales to medicinal cannabis manufactured products sales. We assign 30 percent of dispensary sales to manufactured products and 70 percent of sales to cannabis flower sales. This number is similar to what we have been told when talking with dispensaries, although some report manufactured products sales of 40 to 50 percent, and is the same reported by BDS Analytics.²⁰ The Marijuana Business Factbook, 2016, estimates the percent of manufactured cannabis sales to be 30 percent.²¹ Preliminary survey data of dispensary patients finds that 50 percent of dispensary patients bought a manufactured product on their last visit, while 25 percent bought both a manufactured product and flower cannabis.²² Using the 30 percent share of manufactured products, our estimate of total manufactured medicinal cannabis sales from dispensaries in 2016 is \$651 million.

Because dispensaries sell product to the public at a higher price than the dispensary purchased it from the manufacturer, the estimate must be further adjusted. Sales from manufacturers to dispensaries are equal to dispensary manufactured product sales minus the dispensary marketing margin, which we take to be 60 percent.²³ Thus, if retail manufactured product sales are \$651 million, then manufacturer sales to dispensaries are 40 percent of this amount, or \$260 million. Throughout this document, manufactured cannabis "retail sales" refer to the dollar value of sales paid by final customers at dispensaries, retail stores, or through informal

¹⁶ See <https://www.boe.ca.gov/news/marijuana.htm>

¹⁷ ArcView (2016) "2016 Legal Cannabis Market: California State Profile."

¹⁸ See <http://www.lcb.wa.gov/publications/Marijuana/BOTEC%20reports/BOTEC-MMJ-Report.pdf>

¹⁹ See <http://www.census.gov/quickfacts/>

²⁰ BDS Analytics, Inc. collects point of sale data. The most recent data show manufactured cannabis sales at all locations equal to about 30 percent of cannabis sales. Three years ago, this percent was about 15 percent, indicating a steady upward trend in the percent of manufactured cannabis sales.

²¹ See <https://mjbizdaily.com/wp-content/uploads/2016/03/Factbook2016ExecutiveSummary.pdf>

²² See Eschker and Gold (2016), "Medicinal Marijuana Patient Survey," preliminary findings.

²³ This estimate comes from our surveys and discussions with BCC and CDFA economists. Marketing margin is (Retail Price-Wholesale Cost)/Retail Price.

transactions in the unlicensed segments. “Manufacturer sales” refer to the dollar value of sales out the factory gate, or wholesale, that the manufacturer receives from the retailer.

Estimates – Number of Manufacturers

There is no direct count of the number of medicinal cannabis manufacturers in the state, and estimating this number is difficult. There is no central registry for cannabis manufacturers, and before the passing of AB 2679 in September 2016, manufacturers could generally not legally operate in California.²⁴ While there are multiple ways to arrive at the number of manufacturers, the estimates often generate implausible values for employees per business or output per employee. In summer 2016, CDFA conducted a widespread survey of the cannabis industry and found that 1,971 people said they intend to apply for either a Type 6 or Type 7 manufacturer license. This number represents respondents’ future intent and is not necessarily equal to the total number of current medicinal cannabis manufacturers. In Colorado, there are currently 248 licensed “medicinal marijuana infused products manufacturers.” Colorado’s medicinal cannabis sales in 2015 were \$408,350,569, which yields retail sales of \$1,646,575 per medicinal manufacturer. Using the same ratio to our estimate of California retail sales, there would be 1,317 medicinal manufacturers in California as long as there are not significant differences between the Colorado and California medicinal segments. However, both of these estimates for the number of California manufacturers are inconsistent with our survey results and discussions with industry business people regarding average employees per firm and sales per firm. The CDPH uses 1,000 as the estimate for the number of manufacturing businesses in the medicinal segment in California, and this number falls within the wide range of estimates we obtained from industry people.

Combining concentrates, edibles and topicals

In order to make comparisons between the markets of concentrates, edibles, and topicals, we need to find a way to make the products directly comparable. Because extracted oil is common to all manufactured products, we use “oil grams” as the standard quantity measure for concentrates, edibles and topicals. We simply ask, “How many units are made with one gram of oil?” We then use the average price per unit to calculate the price for one oil gram production equivalent. For example, we find that edibles are typically priced at \$3 per 10mg THC content.²⁵ Oil typically has 60 percent THC content, which means that one gram of oil will make 600 mg of THC content, or the equivalent of 60 10mg edibles. Thus, one oil gram is found in \$180 of edibles on average, and we use \$180 as the price of edibles.²⁶ We also use \$180 per oil gram

²⁴ AB 2679 clarifies for local governments the types of manufacturing of medicinal cannabis allowed before MCRSA is fully implemented in January, 2018. See <https://www.eastbayexpress.com/LegalizationNation/archives/2016/10/04/california-medicinal-marijuana-extract-makers-get-historic-protections>

²⁵ THC stands for Tetrahydrocannabinol and is the main psychoactive compound in cannabis.

²⁶ There is an incredible range in the price of all manufactured products, but we tried to find the typical or average price. For example, bulk concentrates tend to be much cheaper than individually packaged products. Perceived quality also has a large effect on price.

as the price for topicals, although it is particularly challenging to find a typical unit of measure or price for topicals. For concentrates it is more straightforward, since clearly one gram of oil goes into producing one gram of concentrates. We use \$60 per oil gram as the price of concentrates. With these oil gram prices, we estimate the amount of cannabis oil used in the manufacture of medicinal cannabis sales in 2016 to be 7.2 million grams of oil [or 7.2 metric tons].

We assume that manufactured sales in the medicinal cannabis segment are 45 percent edibles, 50 percent concentrates, and 5 percent topicals. This breakdown of the manufactured sector is based on conversations with dispensaries and manufacturers and point of sale data.²⁷ For fiscal year 2015-16, Washington reports a similar breakdown.²⁸ We can thus convert total manufactured medicinal sales into sales in three markets: concentrates, edibles, and topicals. Later in this document we explore the three separate markets, while here we report total manufactured sales. The 2016 California medicinal cannabis segment baseline is shown in the table below.

Table 1: California Medicinal Cannabis Manufacturing, 2016

| | |
|---|--|
| Manufactured Products Dispensary Retail Sales | \$651 million |
| Manufacturer Sales to Dispensaries | \$260 million |
| Amount of Cannabis Oil Used in Production | 7,228,467 oil grams [or 7.2 metric tons] |
| Number of Manufacturers | 1,000 |

Current Unlicensed Segment Estimate

Calculating current non-medicinal (unlicensed) cannabis sales in California is much more difficult than calculating medicinal cannabis sales. We are also not aware of an estimate of the amount of unlicensed manufactured cannabis products in California. We are also unaware of any estimate of the proportion of the unlicensed medicinal market that is concentrates, edibles, and topicals. In order to estimate unlicensed manufactured cannabis quantities, our methodology is to use survey data to scale up manufactured medicinal quantities.

We follow other research in estimating the amount of unlicensed cannabis consumed based on the National Survey on Drug Use and Health (NSDUH) conducted by the Substance Abuse and

²⁷ The most recent BDS Analytics data show concentrate and edible sales percentages very similar, with an upward trend in concentrate percentage.

²⁸ See <http://lcb.wa.gov/publications/Marijuana/MJ-Dashboard/FY%202016%20Dashboard%20Data.xlsx>. The amounts calculated from this report are 46 percent edibles, 53 percent concentrates, and about 1 percent topicals.

Mental Health Services Administration (SAMHSA).²⁹ The NSDUH reports various measures of cannabis use for those aged twelve and older, including the time since last use and the days used in the past month and year. The NSDUH also asks about hashish use.³⁰ The surveys describe marijuana and hashish and say that marijuana “is sometimes cooked in food” and that “another form of hashish is hash oil.”³¹ These are the only references to manufactured cannabis products, but they indicate that survey respondents should include manufactured cannabis in their estimate of cannabis use. However, the questionnaire does not ask respondents to differentiate manufactured cannabis use from flower cannabis use.

In order to estimate the total (manufactured and flower) amount of cannabis consumed in both the medicinal and unlicensed segments in California, we estimate the amount of cannabis consumed for each type of consumer, where consumer type is based on the number of days consumed per month. The four ranges are 1-3 days consumed per month, 4-19 per month, 20 or more days per month, and less than once per month but within the last year.³² These ranges correspond with ranges use by Kilmer et al (2014b).³³ For each range, we calculate the amount consumed as the product

Amount Consumed in Range =

$$(\text{Number of users}) \times (\text{Average days used}) \times (\text{Joints per day used}) \times (\text{Grams per joint})$$

For monthly users, this product is the monthly amount, which we multiply by twelve to get the annual amount. For those who use less than once a month, this product is the annual amount. Consider the 873,296 people in California who consumed cannabis 1-3 days per month. On average, people in this range used cannabis 1.72 times per month.³⁴ Kilmer et al (2014b) estimates that these people consume 1.68 joints per day used, and that there is 0.43 grams of cannabis in a typical joint. That means total monthly grams consumed by people in this range are just over 1 million grams and just over 13 million grams per year. Summing across all ranges, in total, 820 million grams are consumed. We then adjust upwards this amount by 33

²⁹ See Kilmer et al. 2014 https://obamawhitehouse.archives.gov/sites/default/files/ondcp/policy-and-research/wausid_results_report.pdf , Cooper et al. 2016 https://www.icf.com/-/media/files/icf/white-papers/2016/economic_benefits_of_marijuana.pdf , and Light et al. 2016 <http://mipolicygroup.com/pubs/MPG%20Impact%20of%20Marijuana%20on%20Colorado-Final.pdf> .

³⁰ <https://www.samhsa.gov/data/sites/default/files/NSDUH2010MRB/NSDUH2010MRB/2k10Q.pdf>

³¹ There has been no change to the survey language that describes marijuana from 2010 to 2017.

³² The number of users in each range is based on the population of cannabis users and the prevalence rate by number of days per month. The population of cannabis users comes from the 2015 NSDUH with an adjustment using DOF population growth to 2016. Unfortunately, the 2015 public use NSDUH files do not contain the state of the respondent, so we use the U.S. prevalence rate by number of days per month and assume that this distribution is the same for California.

³³ See Kilmer et al. (2014b) https://obamawhitehouse.archives.gov/sites/default/files/ondcp/policy-and-research/wausid_technical_report.pdf

³⁴ The average days used in each range is equal to the average number of days used per month in each range weighted by the number of users at each number of days used per month.

percent to reflect underreporting in the NSDUH data.³⁵ Our estimate of the total “flower weight” of cannabis consumed in California is 2.4 million pounds.

Table 2: Estimated California Unlicensed and Medicinal Cannabis Consumption (Assuming only Flower Consumption) 2016

| Days per month Range | Number of users | Average days used | Joints per day used | Grams per joint | Total monthly grams in range | Total annual amount in range |
|---------------------------------------|-----------------|-------------------|---------------------|-----------------|------------------------------|------------------------------|
| 1-3 days | 883,776 | 1.72 per month | 1.68 | 0.43 | 1,098,194 g | 13,178,328 g |
| 4-19 days | 964,645 | 8.80 per month | 1.92 | 0.43 | 7,006,330 g | 84,075,959 g |
| 20 or more days | 1,322,175 | 27.08 per month | 3.87 | 0.43 | 59,583,666 g | 715,003,994 g |
| Annually but less than once per month | 1,824,636 | 8.8 per year | 1.17 | 0.43 | | 8,045,563 g |
| | | | | | Total Grams | 820,303,844 g |
| | | | | | Adjustment factor | 33% |
| | | | | | Total adjusted pounds | 2,403,093 pounds |

This estimate of the total quantity of cannabis consumed in California assumes that people only use cannabis in flower form, such as smoking “joints,” and assumes that people do not consume manufactured cannabis. This is because we are aware of no estimate of the amount of manufactured products consumed in relation to the amount of flower cannabis consumed and we are also unaware of any estimate of the typical amount of manufactured cannabis consumed each day. Without such estimates, we cannot directly estimate manufactured cannabis use from the NSDUH data.

Instead, we indirectly estimate the ratio of unlicensed to medicinal cannabis sector use and multiply our previous estimate of manufactured medicinal cannabis by that ratio. Suppose we assume that all medicinal cannabis is consumed in flower form. We then obtain an estimate of 600,000 pounds of flower cannabis consumed in the medicinal segment.³⁶ Cannabis consumption in the medicinal market is thus estimated to be 25 percent (=600,000 pounds

³⁵ Kilmer et al. 2014 also uses an adjustment of 33 percent but note that both smaller and larger adjustments have been used in other research.

³⁶ 600,000 pounds is \$2.2 billion in medicinal sales divided by a retail flower price of \$3,632 per pound, or \$8 per gram.

divided by 2.4 million pounds) of overall cannabis consumption in California.³⁷ Equivalently, we estimate a ratio of three grams of unlicensed segment sales to one gram of medicinal segment sales.

If we apply this 3 to 1 ratio to concentrates sales, we estimate unlicensed segment concentrate sales to be 16.3 million (=5.4 million * 3) grams of oil. We believe the percentage of concentrate sales in the unlicensed segment is comparable to the percentage in the medicinal segment. Extracted oil is an attractive low-volume, high-value alternative to dried flower for sellers in the unlicensed segment and manufacturers with only a limited capital investment and training can extract oil from unsold trim. The risk of confiscation would appear to be similar compared to risk of selling unlicensed flower cannabis. Concentrates are often sold unlabeled in bulk containers, even in medicinal dispensaries, and there is far less potential for confiscated products to identify the producer.

In contrast, we believe that the percentage of edible and topical sales in the unlicensed segment is very small compared to the percentage in the medicinal segment. This assumption is supported through informal talks with manufacturers and our survey.³⁸ It is relatively risky to have a fixed traditional manufacturing facility, such as a bakery, with a network of suppliers, inventory, workers, etc. since it is easy for law enforcement to target the facility. Equipment may be large and less mobile for edible and topical makers compared to concentrate extractors. For example, bakeries have ovens and infused product beverage makers may have canning or bottling machinery, which means that current edible and topical manufacturers are more likely to seek the legal coverage of operating in the legal medicinal segment. Additionally, edibles and topicals typically include the manufacturer label and it is more risky to the manufacturer since the products may eventually be confiscated and traced back to the producer. We also note that anti-inflammatory topicals have many non-cannabis over-the-counter or prescription substitutes, which limits sales opportunities in the non-medicinal segment. We therefore assume production of edible and topical cannabis in the current unlicensed segment to be very small and only one percent of production in the current medicinal segment.³⁹

The table below shows estimates for the current unlicensed and medicinal segments as well as the current California cannabis overall market.⁴⁰ Overall, retail medicinal sales are estimated to

³⁷ This estimate of 25 percent falls within the range given in discussions with industry insiders.

³⁸ Our spring 2016 survey asked "In thinking about your current manufactured topicals business, what percentage (between 0% and 100%) of your sales would you estimate involve medicinal dispensaries?" For concentrate manufacturers, the number responding 100 percent was 6 out of 9 (67 percent). For edible and topical manufacturers, the number responding 100 percent was 6 out of 8 (75 percent) and 6 out of 7 (87 percent) respectively. The low number of responses precludes us from having great confidence in the percents or the distinction between manufacturer types, however.

³⁹ There are manufactured edible and topical products for sale outside of dispensaries, but we believe much of this is resale from dispensary customers. Manufacturers we spoke with expressed displeasure at seeing their products advertised for sale on Craigslist or through other outlets.

⁴⁰ In order to be consistent with the unlicensed to medicinal ratio of 3 to 1, we have adjusted upward the amount of flower cannabis produced in the unlicensed segment to take into account the fact that we estimate edible and topical quantities to be less than three times the medicinal segment quantities.

be \$651 million. About 5.4 million grams of oil were sold as concentrates in the medicinal segment. This represents 75 percent of the manufactured medicinal cannabis sold in oil gram equivalents. The retail price is \$60 per oil gram, on average. Retail sales to dispensaries are \$325 million which is 50 percent of manufactured medicinal cannabis sales. Edible and topical sales are 45 percent and 5 percent of the manufactured medicinal segment, respectively, although their percent of quantities sold is lower due to their high price compared to concentrates. Medicinal flower production is estimated to be 418,000 pounds and is valued at about \$1.5 billion.

Table 3: Total Estimated Cannabis Market by Segment and Product Type, 2016

| Segment | Product Market | Quantities Sold | Retail Price | Retail Sales to Consumers |
|-----------------------|--------------------------|-----------------|--------------|---------------------------|
| Medicinal | Concentrates (oil grams) | 5,421,350 | \$60/gram | \$325,281,029 |
| | Edibles (oil grams) | 1,626,405 | \$180/gram | \$292,752,926 |
| | Topicals (oil grams) | 180,712 | \$180/gram | \$32,528,103 |
| | Flower (lbs.) | 417,946 | \$3,632/lb. | \$1,517,978,137 |
| Unlicensed | Concentrates (oil grams) | 16,264,050 | \$51/gram | \$829,466,550 |
| | Edibles (oil grams) | 16,264 | \$153/gram | \$2,488,400 |
| | Topicals (oil grams) | 1,807 | \$153/gram | \$276,489 |
| | Flower (lbs.) | 1,521,639 | \$3,087/lb. | \$4,697,299,720 |
| Overall Market | cannabis oil (grams) | 23,510,588 | | \$1,482,793,497 |
| | flower (lbs.) | 1,939,585 | | \$6,215,277,857 |

Concentrate production is almost the whole of the unlicensed segment manufactured cannabis. Production is about 16.2 million grams and is valued at about \$830 million. Unlicensed segment prices are lower than medicinal segment prices, and we assume the price difference is fifteen percent.⁴¹ Edibles and topical production combined is about 18 thousand grams of oil. For comparison, unlicensed segment flower sales are estimated to be 1.5 million pounds and valued at \$4.7 billion. Overall in the California market, manufactured cannabis is about 23.5 million

Specifically, we assign to flower products the dollars that would have gone to edible and topical products and calculate flower quantities at the unlicensed segment price.

⁴¹ The most recent data on California unlicensed versus medicinal retail prices that we could find states that unlicensed prices are 27 percent lower than dispensary prices. This strikes us as a large difference and it is more than twice the price difference of other markets. We use 15 percent as our preferred price differential. See <https://priceconomics.com/the-most-expensive-and-cheapest-cities-to-buy/>

grams of oil with sales totaling about \$1.5 billion.⁴² Flower cannabis is about 1.9 million pounds with sales of \$6.2 billion in the California market. Combining manufactured cannabis and flower, the overall California cannabis market is valued at about \$7.7 billion. The current product segment estimated amounts are reproduced in the following table.

Table 4: Total Estimated Manufactured Cannabis Market by Product Type and Segment, 2016

| Product Market | Segment | Quantities Sold (grams of oil) | Percent of Product Quantities | Retail Sales to Consumers | Percent of Product Sales |
|---------------------------|---------------------------|---------------------------------------|--------------------------------------|----------------------------------|---------------------------------|
| Concentrates | Medicinal | 5,421,350 | 25% | \$325,281,029 | 28% |
| | Unlicensed | 16,264,050 | 75% | \$829,466,550 | 72% |
| | Concentrates total | 21,685,400 | | \$1,154,747,579 | |
| Edibles | Medicinal | 1,626,405 | 99% | \$292,752,926 | 99% |
| | Unlicensed | 16,264 | 1% | \$2,488,400 | 1% |
| | Edibles total | 1,642,669 | | \$295,241,326 | |
| Topicals | Medicinal | 180,712 | 99% | \$32,528,103 | 99% |
| | Unlicensed | 1,807 | 1% | \$276,489 | 1% |
| | Topicals total | 182,519 | | \$32,804,592 | |
| Manufactured Total | | 23,510,588 | | \$1,482,793,497 | |

⁴² Manufactured sales are 23 percent of the overall cannabis market, and 20 percent of the unlicensed segment, and 30 percent of the medicinal market. Flower cannabis makes up the rest of sales.

Financial Information and Profit Margins

We surveyed a small number of current cannabis manufacturers in order to obtain financial information, including profit margins. They provided income statement and balance sheet information, including revenues and detailed costs. We also obtained information about the businesses such as employee headcount and the number of full time equivalent workers. Our goal was to collect data from a range of business sizes and a range of product offerings. However, we cannot be certain that the individual firms we surveyed are representative of cannabis manufacturers more broadly. With that caveat in mind, we present stylized income and balance statements below, which are based on averages of businesses we surveyed. The appendix contains much more detail on our financial findings. Here we present the most relevant results.

We triangulate financial results at the firm level to create a more accurate economic picture. Triangulation is a mixed-method research design in which both quantitative and qualitative data is collected to answer a single research question. Using this technique, we benchmark our survey data with financial ratios of related industries, such as tobacco, pharmaceuticals, chemical products, and medicinal cannabis manufacturers.

The principal focus of our survey was to construct illustrative financial statements for the cannabis industry as of the fiscal period ending December 31, 2016. We focused on building the two most important financial statements of any business enterprise: the income statement and balance sheet. The tables below reflect the average account balances of the survey participants of this study, which were similarly sized business entities, presented in a standardized format.⁴³ It is important to remember that we cannot be certain that our very small sample is representative of the entire industry. In an effort to convert the reported data to a form more akin to US GAAP, owner draws were removed from the income statement. Owners derive a return on their investment by either salary or dividend deductions derived from net income within the firm. We recognize that business owners will have a choice as to how much they take out as salary and interest versus how much they take out as dividends. Also, the portion of labor attributed to manufacturing activities was reallocated to cost of goods sold. As reflected by the low tax burden, we discovered little to no “regulatory” compliance for cannabis manufacturers in our sample in the current environment.

⁴³ The survey participants did not recognize depreciation, an essential element of the income statement. Due to insufficient data, no attempt was made to recognize depreciation expense. In the case of the balance sheet, adjustments were made to owner's equity and retained earnings. For instance, retained earnings are net of owner's draws. We suspect that the beginning balances of our participants' accounts were not valued accurately and/or the accounting system was not initially set up appropriately. All reclassifications occurred using our best judgement of standard business practices.

Table 5: Stylized Cannabis Manufacturer Income Statement, January to December, 2016

| | | | |
|---|------------|------------|------|
| Sales: | | | |
| Products | \$875,676 | | 95% |
| Services | \$29,932 | | 3% |
| Miscellaneous | \$13,205 | | 1% |
| Total Sales | | \$918,812 | 100% |
| | | | |
| Cost of Goods Sold | | \$594,987 | 65% |
| Gross Margin | | \$323,825 | 35% |
| Selling and administrative expenses: | | | |
| Administrative | \$56,783 | | 6% |
| Shipping | \$11,579 | | 1% |
| Total selling and administrative | | \$68,362 | 7% |
| | | | |
| Net operating income | | \$255,463 | 28% |
| | | | |
| Other income (expenses): | | | |
| Loss on inventory spoilage | \$(33,333) | | -4% |
| Interest expense | \$(14,120) | | -2% |
| Total other income (expenses) | | \$(47,454) | -5% |
| | | | |
| Income before taxes | | | |
| Taxes | | \$(8,268) | -1% |
| | | | |
| Net Income | | \$199,742 | 22% |

Table 6: Stylized Cannabis Manufacturer Balance Sheet, December, 2016

| | | | |
|-------------------------------------|-----------|------------------|-------------|
| <u>Assets</u> | | | |
| Cash | | \$69,317 | 12% |
| Accounts Receivable | | \$91,330 | 16% |
| Raw materials | \$109,459 | | 20% |
| WIP | \$89,790 | | 16% |
| Finished Goods | \$107,748 | | 19% |
| Total inventory | | \$306,996 | 55% |
| Notes Receivable | | \$50,000 | 9% |
| Equipment | | \$40,142 | 7% |
| Total Assets | | \$557,785 | 100% |
| <u>Liabilities</u> | | | |
| Accounts Payable | | \$180,944 | 32% |
| Wages Payable | | \$5,000 | 1% |
| Loans Payable | | \$357,693 | 64% |
| Federal Income Tax Payable | | \$2,000 | 0% |
| Sales tax liabilities | | \$1,355 | 0% |
| Total Liabilities | | \$546,991 | 98% |
| <u>Equity</u> | | | |
| Owners Equity | | \$10,000 | 2% |
| Retained earnings | | \$794 | 0% |
| Total equity | | \$10,794 | 2% |
| | | | |
| Total liabilities and equity | | \$557,785 | 100% |

The tables above demonstrate that cannabis manufacturers are running profitable operations within the current market, approximately a 22% profit margin. Rarely were profits reinvested into the business enterprise as evidenced by a low retained earnings account balance. Most business owners elected to immediately transfer excess earnings into their personal bank accounts. The biggest cost drivers within the industry include labor, direct materials, and rents. Cannabis testing, shipping, professional services, utilities and equipment costs make up the second tier of significant expenses. The businesses we sampled were not heavily invested in capital assets with many opting to lease equipment as opposed to purchasing the equipment outright. These businesses relied heavily upon informal business loans or equity from silent partners to fund daily operations and meet payroll obligations. We believe the aforementioned financial statements reflect a short-term orientation, essentially acknowledging that the operation could be closed on short notice by drug enforcement or other regulatory authorities.

We find that our sample firms generate average revenue per full-time equivalent (FTE) employee of approximately \$275,000. Our survey finds that participants employed approximately four FTEs, an increase of 50% from a year prior.

In addition to evaluating firm level costs, survey participants were asked to consider the incremental costs and benefits of producing additional batches. Informants were asked to furnish figures assuming one more “batch” or one more production “run” for their top product. What would be the sales revenue, costs, and margin of producing this batch? In essence, we attempted to assess the additional profit that would be derived by producing one additional unit assuming all fixed costs had been already paid. The table below reflects the data furnished by one firm. As reflected, the contribution margin for this batch would be 2,480 (51% of sales). Assuming the fixed costs of the entity are \$350,000 (approx. 30% of all costs), the break-even point in units would be 49,350 grams or 141 batches of product. This particular firm currently produces about 89,000 grams of this top selling product annually; therefore, we can roughly assume at constant production levels this business would reach its break-even point approximately 6-7 months into the year. The remaining months in the fiscal year represent profit to the firm. This analysis suggests the profits of a firm could be higher than the previous aggregate level suggested. However, the assumption that firms operate at 100% capacity, 12 months out of the year, is not realistic and likely explains the discrepancy in profit calculations.

Table 7: Batch Processing Costs (One Firm)

| | |
|--|-----------|
| <u>Revenue</u> | |
| How many units produced in the "batch"? | 350 grams |
| What is the typical price per unit? | \$14 |
| Revenue from additional batch | \$4,900 |
| <u>Variable Costs</u> | |
| Manufacturing Labor cost (non-owners) | \$900 |
| Trim/Flower/Concentrate | \$1,000 |
| Rent | \$180 |
| Payroll Taxes | \$90 |
| Lab Supplies | \$60 |
| Testing | \$50 |
| Electricity | \$45 |
| Extra batch manufacturing All Remaining Costs | \$95 |
| Total extra cost of batch | \$2,420 |
| Product Contribution Margin from batch | |
| | \$2,480 |
| <u>Hours</u> | |
| Labor hours directly manufacturing batch (employees) | 24 |
| Labor hours directly manufacturing batch (owners) | 16 |

Current Market Estimate Summary

In the table below, we present the 2017 current California manufactured cannabis overall total market estimates. The reported amounts are the sum of the concentrate, edible, and topical markets. We want to repeat that these estimates are formed with a large degree of uncertainty.

We derive the current 2017 market based on the 2016 amounts estimated above, and this 2017 market estimate will be used to derive the model baseline as described below. We assume that the current 2017 market quantities are 3.0 percent greater compared to 2016 and that the market price is unchanged.⁴⁴ We leave the market share of manufactured products unchanged. There is no adult-use segment in 2017. While the amount of production, as measured in oil grams, is over twice as much in the unlicensed segment as the medicinal segment, the dollar value of sales is less than twice as much. This is due to the fact that unlicensed segment sales are mostly concentrate sales, which have a much lower price per gram of oil. The CDPH estimates that the number of firms in the unlicensed segment is 2,000, although there is considerable uncertainty with this estimate.⁴⁵

There is also uncertainty regarding the number of employees in the industry. If we assume \$200,000 in manufacturer sales per employee, there are about three thousand full time equivalent (FTE) employees in the overall market (\$611 million total manufacturer sales divided by \$200,000 per employee gives an approximate employee count of 3,055 FTE). The actual headcount of workers, which includes part time workers, will be larger than the number of FTE employees. Our surveys indicate considerable hiring of part time employees currently, and a headcount of perhaps 12,000 workers. There appear to be many very small manufacturers with seasonal work forces that do not produce throughout the year. Some of these are cultivators who largely manufacture with trim that they grow themselves.

⁴⁴ 3.0 percent is the Department of Finance forecasted growth of total personal income in California from the fourth quarter in 2016 to the third quarter of 2017. See http://www.dof.ca.gov/Forecasting/Economics/Eco_Forecasts_US_Ca/documents/FR_CAFOR0417.xlsx

⁴⁵ Industry leaders, when asked how many total manufacturers were in the state (medicinal plus unlicensed) gave a range between 800 and 3,000. Our sales estimate squares with an overall number of 3,000 firms only if the distribution of firms is heavily weighted toward smaller-sized firms.

Table 8: Current Estimated California Manufactured Cannabis Overall Total Market, 2017

| | Medicinal Segment | Unlicensed Segment | Overall Market |
|---|--|--|--|
| Manufactured Products Dispensary Retail Sales | \$670 million | \$857 million | \$1,527 million |
| Manufacturer Sales to Dispensaries | \$268 million | \$343 million | \$611 million |
| Amount of Cannabis Oil Used in Production | 7.4 million oil grams [or 7.4 metric tons] | 16.8 million oil grams [or 16.8 metric tons] | 24.2 million oil grams [or 24.2 metric tons] |
| Number of Manufacturers | 1,000 | 2,000 | 3,000 |
| Number of full time equivalent Employees | | | 3,055 |

Regulation Summary

License Types

MAUCRSA creates two license types for manufacturers: Type 6 manufacturers (level 1) extract using nonvolatile solvents, and Type 7 manufacturers (level 2) extract using volatile solvents. CDPH is creating three additional license categories: Type N for manufacturers that produce edible products, topical products, or other types of cannabis products (infusion), and that do not extract oils, Type P for manufacturers that do not manufacture the actual product, but only package and label those products, and Type S for shared facilities (a facility in which multiple manufacturers can share manufacturing space under certain conditions). Under the proposed regulations, a Type 7 licensee may also conduct extractions using nonvolatile solvents or mechanical methods on the licensed premises, provided the extraction process is noted on the application form, and the relevant information is provided to CDPH. A Type 6 or Type 7 licensee may also conduct infusion operations and/or packaging on the licensed premises without needing an additional license. Additionally, licenses will be designated as "A" or "M" which stands for adult-use or medicinal. A market-specific license is required to conduct commercial cannabis activities within that market (adult-use manufacturers must hold an A-license; medicinal use manufacturers must hold an M-license).

Microbusinesses

MAUCRSA additionally establishes a Type 12, microbusiness license. Microbusinesses are vertically integrated businesses that receive one license from the BCC. This one license allows them to cultivate, manufacture, distribute, and retail cannabis, rather than obtain separate licenses for each activity from the appropriate licensing authority. However, microbusinesses must meet the same regulatory requirements set by CDPH for standalone manufacturing licenses.

Microbusinesses are subject to some limitations by statute: (1) cultivation is limited to no more than 10,000 square feet, which puts them in the “specialty” Type 1 and “small” Type 2 category of cultivators; and (2) extractions are limited to non-volatile solvents only. It will be up to each individual business to determine whether the limitations on activities are worth the trade-off of the convenience of receiving a single license. Our survey asked manufacturers to indicate which types of business best describe their operations, and they were allowed to give multiple responses. Forty-three percent of manufacturers indicated they were also cultivators and twelve percent indicated they were also dispensaries.

We believe that the key factor for manufacturers is the price of the microbusiness license in comparison to the price of individual licenses. Regardless, the same regulatory costs apply to microbusiness manufacturers as to other manufacturers. So while some manufacturers may become microbusinesses, it will not have an impact on our analysis, and we therefore do not distinguish microbusinesses from standalone manufacturers.

Regulation Description

The proposed regulation covers labeling, testing for content on labeling, packaging, background checks, license fees, bonding, infrastructure standards, closed loop extraction systems, standard operating procedures, general licensing requirements, limits on additives, and the Track and Trace requirement. The costs of these requirements are discussed below.

Methodology and Assumptions

Approach

The analysis considers concentrates, edibles, and topicals as three separate output markets. This was to simplify the analysis and to focus on the key impact of regulations which shift sales between the adult-use, medicinal, and unlicensed market segments. Our approach is to determine how CDPH regulations affect prices in each segment and then to determine how quantities change in each segment. A rise in the price in, say, the medicinal cannabis segment will lead to a decrease in the quantity demanded in the medicinal segment and an increase in quantity demanded in the adult-use and unlicensed segments. We feel that interactions

between the price of manufactured cannabis in the medicinal segment and prices of manufactured cannabis in the adult-use and unlicensed segments were most important for the impact of regulations. We do not consider substitution between manufactured and raw flower cannabis. In addition to the CDPH costs specified later, we describe below other cost and segment impacts of MAUCRSA, and we divide them into supply and demand side effects.

Model Description

The Equilibrium Displacement Model for Manufactured Cannabis

The equilibrium displacement model (EDM) of supply and demand was first introduced by Muth (1964) and later extended by Gardner (1975).⁴⁶ The model captures the effect of shifts in supply and demand on prices and quantities when these shifts are relatively small and allows us to measure the net cost of regulating a market or sector. The EDM has been widely used in policy analysis (see for example, Alston et al. 2006 or Alston et al. 2009) to measure benefits and costs associated with implementing policy.⁴⁷ We adapt the model to the manufactured cannabis sector in the following section so we can estimate the cost of regulating the manufactured cannabis oil markets.

An EDM is a mathematical representation of the supply and demand for an aggregate market and underlying market segments. The Three segments are medicinal, adult use and unlicensed manufacturers. Following an exogenous policy shock, such as regulating manufactured cannabis products, a new system equilibrium will result. The EDM consists of logarithmic differential equations characterizing rates of change for prices and quantities for the market system. Select own-price and cross-price elasticities characterize the various market segments where the relationships are expressed in percentage terms and are unaffected by varying empirical scales that come with a more structural modeling method. Given the limited empirical studies on cannabis markets, some parameters are derived from the literature and from survey data, however information for other parameters has proven unobtainable and instead their values have been adapted from knowledge about agricultural commodities with potentially similar supply conditions.

This analysis models three separate manufactured cannabis oil markets (concentrates, edibles, and topicals) as aggregates of three market segments: medicinal (m), adult-use (a), and unlicensed (u). For each cannabis market, the model reflects a two-stage budgeting process, first considered in Deaton and Muellbauer (1980a, 1980b), where consumers consider each

⁴⁶ Muth, R. F. 1964. The derived demand curve for a productive factor and the industry supply curve. *Oxford Economic Papers* 16(2), 221-234 and Gardner, B. L. 1975. The farm-retail price spread in a competitive food industry. *American Journal of Agricultural Economics* 57(3), 399-409.

⁴⁷ Alston, J. M., Balagtas, J. V., Brunke, H., Sumner, D. A. 2006. Supply and demand for commodity components: implications of free trade versus the AUSFTA for the US dairy industry. *Australian Journal of Agricultural and Resource Economics* 50(2), 131-152 and Alston, J. M., Mullally, C.C., Sumner, D. A., Townsend, M., and Vosti, S. J. 2009. Likely effects on obesity from proposed changes to the US food stamp program *Food Policy* 34: 176-184.

manufactured cannabis product as an individual group and the individual segments as subgroups of that cannabis market.⁴⁸ That is, in this analysis the cannabis market is weakly separable from all other goods and that the group market segments are weakly separable within the group. Furthermore, it is assumed that the markets for cannabis oil concentrates, edibles, and topicals are also weakly separable. In addition, the analysis assumes that in each manufactured cannabis oil market the medicinal, adult-use, and unlicensed market segments are related in consumption, such that the quantity demanded in each market segment is a function of the prices in the other two. Marginal cost functions describe supply to the three market segments. Supply to each market segment is based on the prices in that market segment only.

In the first stage of the two-stage budgeting process a system of individual demand functions for allocating total expenditures among commodity categories is derived. The second stage produces a system of individual segment-specific demand functions within each manufactured cannabis oil market. An extensive review of the literature on two-stage budgeting can be found in Deaton (1986).⁴⁹ The two-stage budgeting approach is widely used in demand simulations as it is able to capture changes in supply and demand without having to model the complexity between the number of own-price and cross-price elasticities of demand, which increases with the square of the number of commodities. Under the two-stage budgeting and accompanying assumptions, the number of products is kept relatively small.

Although in the analysis we consider three separate manufactured cannabis oil markets (concentrates, edibles, and topicals), the following model description presents the manufactured cannabis oil concentrates market equilibrium where demand in each segment depends on the price in all three segments. The formulation for the other two manufactured cannabis oil markets (edibles and topicals) is specified similarly. These three markets will differ, however, in terms of the varying elasticity assumptions, prices, and quantities.

Mathematical Representation

In the EDM we define consumer demand as:

$$Q_j^D = D_j(P_m, P_a, P_u, A_j) \quad j = m, a, u \quad (1)$$

The supply-side of the market is defined as:

$$Q_j^S = S_j(P_j, B_j) \quad j = m, a, u \quad (2)$$

⁴⁸ Deaton, A. and Muellbauer, J.S. 1980a. *Economics and Consumer Behavior*. Cambridge, U.K.: Cambridge University Press and

Deaton, A. and Muellbauer, J.S. 1980b. An Almost Ideal Demand System. *American Economic Review* 70: 312-26.

⁴⁹ Deaton, A., 1986. Demand Analysis. In Z. Griliches and M.D. Intriligator (Eds.). *Handbook of Econometrics* 3: 1767-1839.

Finally, the market clearing condition is:

$$Q_j^D = Q_j^S \quad j = m, a, u \quad (3)$$

Equation (1) is consumer market demand in each of the three market segments, $j = m, a, u$. Equation (2) is cannabis market supply in each of the three market segments. Equation (3) is a market clearing condition that requires that the total market segment demand is satisfied or supplied by the aggregate quantities produced by the supplier for that segment. The parameters A_j and B_j are exogenous market segment demand quantity shifts and supply price shifts, respectively.

Endogenous variables in the model are output to each market segment, $Q_j = Q_j^D = Q_j^S$, and the price in each market segment, P_j . Totally differentiating equations (1) – (3) to convert to log-differential form yields the following system of equations expressed in terms of relative changes in equilibrium prices, quantities, and elasticities.

$$d\ln Q_m^D = \eta_{mm}d\ln P_m + \eta_{ma}d\ln P_a + \eta_{mu}d\ln P_u + \alpha_m \quad (4)$$

$$d\ln Q_a^D = \eta_{am}d\ln P_m + \eta_{aa}d\ln P_a + \eta_{au}d\ln P_u + \alpha_a \quad (5)$$

$$d\ln Q_u^D = \eta_{um}d\ln P_m + \eta_{ua}d\ln P_a + \eta_{uu}d\ln P_u + \alpha_u \quad (6)$$

$$d\ln Q_j^S = \epsilon_j d\ln P_j - \epsilon_j \beta_j \quad j = m, a, u \quad (7)$$

$$d\ln Q_j^D = d\ln Q_j^S \quad (8)$$

where η_{jj} are the Marshallian own-price elasticities of demand, η_{jk} are the Marshallian cross-price elasticities of demand, ϵ_j are the own-price elasticities of supply, and α_j and β_j are the relative increases in market segment j demand (i.e., a horizontal shift right in the quantity direction) and the relative decrease in supply for segment j (vertical shift up in the price direction), respectively. Substituting Equations (4) – (7) into (8) reduces the system to 3 equations and 3 unknowns which can be expressed as follows.

$$\begin{bmatrix} \eta_{mm} - \epsilon_m & \eta_{ma} & \eta_{mu} \\ \eta_{am} & \eta_{aa} - \epsilon_a & \eta_{au} \\ \eta_{um} & \eta_{ua} & \eta_{uu} - \epsilon_u \end{bmatrix} \begin{bmatrix} d\ln P_m \\ d\ln P_a \\ d\ln P_u \end{bmatrix} = \begin{bmatrix} -\alpha_m - \epsilon_m \beta_m \\ -\alpha_a - \epsilon_a \beta_a \\ -\alpha_u - \epsilon_u \beta_u \end{bmatrix} \quad (9)$$

or

$$\begin{bmatrix} d\ln P_m \\ d\ln P_a \\ d\ln P_u \end{bmatrix} = \begin{bmatrix} \eta_{mm} - \epsilon_m & \eta_{ma} & \eta_{mu} \\ \eta_{am} & \eta_{aa} - \epsilon_a & \eta_{au} \\ \eta_{um} & \eta_{ua} & \eta_{uu} - \epsilon_u \end{bmatrix}^{-1} \begin{bmatrix} -\alpha_m - \epsilon_m \beta_m \\ -\alpha_a - \epsilon_a \beta_a \\ -\alpha_u - \epsilon_u \beta_u \end{bmatrix} \quad (10)$$

This analysis assumes that the cannabis groups are weakly separable from other (non-cannabis) consumption, therefore the cross price demand elasticities in (4) – (7) can be decomposed into functions of the overall cannabis group demand elasticity (η_c), market segment expenditure shares (w_j), elasticities of substitution between market segments (σ_{jk}), and the expenditure elasticity of segment j (η_{jY}) (Edgerton 1997).⁵⁰ In addition, following Carpentier and Guyomard (2001), the unconditional elasticity of demand for medicinal cannabis and the cross-price demand elasticities between medicinal, adult-use, and unlicensed cannabis, using an approximation to the Slutsky substitution term, could be approximated in general forms as follows.⁵¹

$$\eta_{mm} = -w_u\sigma_{mu} - w_a\sigma_{ma} + w_m\eta_c \quad (11)$$

$$\eta_{aa} = -w_u\sigma_{au} - w_m\sigma_{ma} + w_a\eta_c \quad (12)$$

$$\eta_{uu} = -w_a\sigma_{au} - w_m\sigma_{ma} + w_u\eta_c \quad (13)$$

$$\eta_{jk} = w_k(\sigma_{jk} + \eta_c) \quad (14)$$

The total change in cannabis output (oil grams produced) and price in each market segment can be calculated as:

$$dQ_j = Q_j d\ln Q_j, j = m, a, u \quad (15)$$

$$dP_j = P_j d\ln P_j, j = m, a, u \quad (16)$$

Total revenue (TR) for in segment j equals,

$$TR_j = P_j Q_j \quad (17)$$

And thus, it can be shown that the percentage change in total revenue is,

$$d\ln TR_j = d\ln P_j + d\ln Q_j + d\ln P_j \cdot d\ln Q_j \quad (18)$$

⁵⁰ Edgerton, D. L. 1997. Weak separability and the estimation of elasticities in multistage demand systems" *American Journal of Agricultural Economics* 79 (1): 62-79.

⁵¹ Carpentier, A., and Guyomard, H. 2001. Unconditional Elasticities in Two-Stage Demand Systems: An Approximate Solution. *American Journal of Agricultural Economics* 83(1): 222-229.

Parameter and Elasticity Assumptions

Empirical studies on the effects of price on the use of addictive drugs such as cocaine, cannabis, and heroin are sparse. In 1972, Nisbet and Vakil,⁵² using a survey of college students, estimated a price elasticity of demand for cannabis ranging from -0.36 to -1.51 . Subsequently, Pacula et al. (2001) derived elasticity estimates spanning -0.002 to -0.69 for high school seniors and Van Ours and Williams (2007) looking at young Australians, found elasticity estimates in between -0.31 and -0.70 .⁵³ More recently, Lkhdar et al. (2016) estimates for the price elasticity of demand for cannabis using 250 French users from a 2005 survey are between -1.7 and -2.1 , which were relatively high compared to others.⁵⁴ In addition, Gallet (2014) performs a meta-analysis of illicit drug demand and derives an estimate of -0.15 for the own-price elasticity of demand for cannabis.⁵⁵ Most recently, Jacobi and Sovinski (2016), relying on data from the Australian National Drug Household Survey suggest an own-price elasticity of demand for cannabis is -0.2 .⁵⁶ In the analysis, we adopt an own-price elasticity of demand for cannabis at -0.15 , following the work of Gallet (2014). The meta-analysis he uses controls for specification differences among prior studies, which explain some of the variation in estimates.

On the supply side, we assume an inelastic supply elasticity for all manufactured cannabis products, as the manufacturing sector conditions make short run adjustments extremely costly. Our assumptions are embedded in the supply elasticities and expenditure shares for each product found in the table below. We consider a supply elasticity of 0.75 for the supply of cannabis concentrates in all three segments. We assume this market is more elastic than the other two given its market size. The supply elasticity for edibles and topicals is set to 0.5 for all segments, which assumes that these suppliers face more restrictions in contracting supply than concentrates.

In order to approximate the demand system we make additional elasticity assumptions as shown in the table below. The elasticity of substitution between medicinal, adult-use, and unlicensed use captures the inherent tradeoff between the products from each segment as prices change. In the concentrate market, we assume medicinal and adult-use by consumers will be easily substituted with an elasticity of substitution of 7 . A similar argument can be made between adult-use and unlicensed segments as it is assumed that many of the initial adult-use

⁵² Nisbet, C.T. and Vakil, F., 1972. Some estimates of the price and expenditure elasticities of demand for marijuana among U.C.L.A. students. *Review of Economics and Statistics* 54-4: 473-475.

⁵³ Pacula, R.L., Grossman, M., Chaloupka, F.J., O'Malley, P., Johnston, L.D., and Farrelly, M.C., 2001. Marijuana and youth. In: Gruber, Ed., *Risky Behavior among Youth: An Economic Analysis*. University of Chicago Press; Chicago, IL: 2001. pp. 271-326 and Van Ours, J.C. and Williams, J., 2007. Cannabis Prices and Dynamics of Cannabis Use. *Journal of Health Economics* 26:578-596. [PubMed]

⁵⁴ Lkhdar et al. (2016) Price elasticity of demand for cannabis: does potency matter? *Christian Ben Lakhdar, Nicolas G. Vaillant & François-Charles Wolff Addiction Research & Theory* Vol. 24, Iss. 4, 2016

⁵⁵ Gallet, C. A. 2014. Can price get the monkey off our back? A meta-analysis of illicit drug demand. *Health Economics* 23: 55-68.

⁵⁶ Jacobi, L. and Sovinsky, M., 2016. Marijuana on Main Street? Estimating Demand in Markets with Limited Access. *American Economic Review* 106-8: 2009-45.

concentrate consumers come from those who previously were part of the concentrates unlicensed segment. As such the value for this elasticity is also 7. It is less likely that consumers will switch from concentrates medicinal use to unlicensed use and thus there is a low elasticity of substitution of 0.5. In the edible and topical markets, we also expect consumer substitution between medicinal and adult-use to be relatively easy and thus assume an elasticity of substitution of 7. Since most of the adult edible and topical markets don't come from consumers in the unlicensed market, we do not expect it to be easy for these consumers to substitute unlicensed products for the adult-use products. For this reason, we assume a low elasticity of substitution between adult-use and unlicensed use of 0.5 for both the edibles and topical markets. We hold a similar view about substituting between medicinal and unlicensed segments of these markets and use a value of 0.5 again. In addition, we set the income elasticity of demand for these products as well as the expenditure elasticities to 1, in line with past work. Lastly, we assume income shares for each of the concentrates, edibles, and topicals, are 0.01, 0.0075, and 0.005, respectively.

Table 9: Equilibrium Displacement Model Parameters by Market

| Parameter | Concentrates | Edibles | Topicals |
|---|--------------|---------|----------|
| Cannabis Group Demand | | | |
| η_c | -0.15 | -0.15 | -0.15 |
| η_Y | 1 | 1 | 1 |
| w_Y | 0.01 | 0.0075 | 0.005 |
| | | | |
| Elasticity of Substitution | | | |
| $\sigma_{ma} = \sigma_{am}$ | 7 | 7 | 7 |
| $\sigma_{mu} = \sigma_{um}$ | 0.5 | 0.5 | 0.5 |
| $\sigma_{au} = \sigma_{ua}$ | 7 | 0.5 | 0.5 |
| | | | |
| Conditional Expenditure Elasticities | | | |
| η_{mY} | 1 | 1 | 1 |
| η_{aY} | 1 | 1 | 1 |
| η_{uY} | 1 | 1 | 1 |
| | | | |
| Market Segment Expenditure Share | | | |
| w_m | 27.03 | 49.86 | 49.86 |
| w_a | 27.03 | 49.86 | 49.86 |
| w_u | 45.95 | 0.28 | 0.28 |
| | | | |
| Supply Elasticities | | | |
| ϵ_m | 0.75 | 0.5 | 0.5 |
| ϵ_a | 0.75 | 0.5 | 0.5 |
| ϵ_u | 0.75 | 0.5 | 0.5 |

The underlying parameters and initial shares lead to the matrix of own- and cross-price elasticities of demand as shown below.

Table 10: Cross and Own-Price Elasticities for the Medicinal, Adult-Use, and Unlicensed Segments in Concentrates, Edibles, and Topical Markets.

| Concentrates | medicinal | adult-use | unlicensed |
|-----------------------------|-----------|-----------|------------|
| medicinal | -2.162395 | 1.851555 | 0.160825 |
| adult-use | 1.851555 | -5.15 | 3.147575 |
| unlicensed | 0.094605 | 1.851555 | -2.096175 |
| Edibles and Topicals | | | |
| Edibles and Topicals | medicinal | adult-use | Unlicensed |
| medicinal | -3.70499 | 3.41541 | 0.098 |
| adult-use | 3.41541 | -3.70 | 0.098 |
| unlicensed | 0.17451 | 0.17451 | -0.5406 |

Demand Side Considerations

Demand Change for Medicinal Cannabis

We believe that some initial consumers for the new adult-use segment will come from the existing unlicensed segment. We also expect additional demand from new in-state customers that formerly did not purchase from the medicinal or unlicensed segments. Finally, we expect new out of state tourists to come to California to purchase cannabis. The demand for manufactured medicinal and adult-use cannabis is also likely to rise with the new CDPH regulations because consumers are likely to perceive that, after regulations, manufactured cannabis is safer and there will be better and more uniform information on the labels. Consumers are willing to pay for these desirable features.

Supply Side Considerations

Fall in the Risk Premium

Industry regulation typically has the impact of raising costs for industry, which leads to a reduction in the industry supply curve, an increase in cost to the consumer, and a corresponding reduction in the quantity sold. In the case of cannabis regulation, MAUCRSA will reduce the risk premium associated with cannabis manufacturing, which will offset the expected rise in price of cannabis. The risk premium is the extra amount that producers and workers must receive in order to be compensated for the risk of incarceration, asset forfeiture, and other losses that are associated with an unlicensed activity. Cannabis manufacturing is federally illegal and even manufacturers of medicinal cannabis could not obtain local licenses before AB 2679, Chapter 828, was signed on September 29, 2016. Manufacturers have certainly been well aware that

their activity may lead to criminal conviction.⁵⁷ By some accounts, the risk premium in the cannabis industry has been substantial.⁵⁸ If MAUCRSA reduces the risks associated with manufactured cannabis production, then MAUCRSA lowers the risk premium and effectively lowers costs to existing producers and encourages new producers to enter these segments.⁵⁹ This will increase supply and lower the price, which will increase the quantities sold. Manufacturers tell us they are already seeing an increase in the number of manufacturers in anticipation of licensing. In Washington, the ratio of sales revenue to weight (\$/gram) has fallen by over 50 percent in the first 21 months after adult-use use was legalized, which we believe is partly due to a drop in the risk premium.⁶⁰ In discussions with BCC and CDFA SRIA economists, we find that marketing margins are currently large at all points in the supply chain. Part of this is the risk premium, although part of it is due to inefficient production resulting from the uncertain legal status of the industry. We believe that MAUCRSA will lower but not eliminate the risk premium, since access to traditional banking services and funding will continue to be limited due to the illegal federal status.

The key question is, “How much does the fall in the risk premium reduce the retail price, and will it compensate for the increases in regulatory costs?” We believe the evidence is clear that in states where legalization has occurred, there has been an increase in manufacturing suppliers and prices have been falling despite new taxes and the costs of regulation. In other words, after states legalized adult-use cannabis, the supply has increased and more than offsets the increase in regulatory costs. However, the degree to which the risk premium falls is a key source of uncertainty in this report. Our survey of manufacturers showed an average profit rate of over twenty percent, which, as shown in the appendix, is noticeably greater than the average of firms in other industries. We assume that the state and local risk premium falls by 10 percent for adult-use manufacturers and 5 percent for medicinal manufacturers one MAUCRSA is

⁵⁷ At a pre-regulatory meeting, manufacturers remarked that many manufacturers are hesitant to share their business data since they are worried about law enforcement action.

⁵⁸ See Caulkins 2010

http://www.rand.org/content/dam/rand/pubs/working_papers/2010/RAND_WR764.pdf See Hawken and Prieger 2013

http://lcb.wa.gov/publications/Marijuana/BOTEC%20reports/5c_Economies_Scale_Production_Cannabis_Oct-22-2013.pdf

⁵⁹ The Cole Memorandum from the U.S. Department of Justice dated August 29, 2013, explains that the threat of federal marijuana enforcement should be low in states with robust regulatory and enforcement systems. See <https://www.justice.gov/iso/opa/resources/3052013829132756857467.pdf>. However, in January, 2018, U.S. Attorney General Jeff Sessions rescinded the Cole Memorandum. Still, we see no evidence that federal law enforcement efforts have increased, and Mr. Sessions said in March, 2018 that U.S. prosecutors will not focus on small-time cannabis cases. See <http://time.com/5194505/jeff-sessions-marijuana-cases/>. Additionally, in the same month President Trump signed a spending bill that bars the Department of Justice from using federal funds to prosecute medical cannabis programs in states where they are legal. See <https://www.nbcnewyork.com/news/national-international/Spending-Bill-Includes-Medical-Marijuana-Protections-From-DOJ-Sessions-477772893.html>. While there is uncertainty in scale, we assume that MAUCRSA reduces the risk of federal prosecution.

⁶⁰ See <https://www.washingtonpost.com/news/wonk/wp/2016/05/04/the-price-of-legal-pot-is-collapsing/>

implemented. We allow the medicinal segment to have a smaller decline in risk premium because that segment has had a more solid legal foundation under the passage of Proposition 215 and, therefore, the effect of regulations in the medicinal segment should be less than in the adult-use segment. The federal risk premium falls by 5 percent for both adult-use and medicinal manufacturers once CDPH regulations are implemented.

The Medicinal Segment

The medicinal cannabis segment does not disappear even with the legalization of adult-use cannabis. We assume a large elasticity of substitution between medicinal and adult-use cannabis, meaning that the price change in one segment leads to a large change in quantity demanded in the other segment. The two are not perfect substitutes, however. First, for frequent users that spend a lot on cannabis, the sales tax savings provide incentives to remain in the medicinal segment. Second, adults aged 18-21 will not be able to purchase in the adult-use segment. Third, some people will have a preference to purchase cannabis from traditional medicinal retailers instead of a retailer selling for “adult-use.” Lastly, CDPH regulations allow for non-edible products to be sold to medicinal users in packages containing twice the amount of THC.

Proposition 64 established that medicinal consumers are not subject to sales tax on their cannabis purchases. We wanted to estimate the amount of cannabis an individual would need to purchase annually for the savings in sales tax to offset the cost of obtaining a physician’s recommendation. Medicinal consumers can purchase medicinal cannabis with just a physician’s recommendation, or they can obtain a valid county-issued identification card. The physician’s recommendations cost less and the online price is as low as \$60. We believe that it was fairly easy for someone aged 18 and older to receive a doctor’s recommendation. There is also the time opportunity cost of visiting the local county health department and doctor, which we assume to be four hours valued at minimum wage, which is equal to \$44.⁶¹ This means that the cost of obtaining a medicinal cannabis card is \$104. We use an average sales tax rate of 8.8 percent to calculate that one would have to purchase at least \$1,182 worth of medicinal cannabis annually in order for sales tax savings to exceed the cost of obtaining an identification card. The medicinal segment may thus come to be dominated by relatively heavy users of cannabis.

Potential Trim Bottleneck

Another factor in the consideration of the supply side is the potential bottleneck of needed input materials, namely trim. We made a few key assumptions about how trim is used in the production process based on our conversations with manufacturers and cultivators. There is some range of these estimates, however, based on quality of cannabis oil produced, technology used, and other factors. Thus, these estimates should be taken as our sense of what the typical

⁶¹ The California minimum wage rises to \$11 on January 1, 2018. See https://www.gov.ca.gov/docs/Fact_Sheet_Boosting_Californias_Minimum_Wage.pdf

cultivator or manufacturer experiences. First, we assume that one pound of trim yields one ounce, or 0.0625 pounds, of cannabis oil. Second, one pound of flower yields three ounces, or 0.1875 pounds, of cannabis oil. Third, we assume that currently ten percent of cannabis oil production comes from flower and the remaining oil is produced from trim.⁶²

We also need to know how much dried trim is obtained at harvest for every pound of dried cannabis flower. The range of responses for this estimate was large, with some indicating that for one pound of flower, one quarter of a pound of trim is obtained, while some report that one pound of trim or more is obtained.⁶³ It seems to depend on the amount of leaves and stems packaged with the trim, the strain, and the level of THC obtained. Cannabis plants grown outdoors also have a different trim to flower ratio than plants grown indoors. We assume that at harvest time, for every one pound of dried cannabis flower cultivated, there is 0.40 pounds of dried trim obtained. This figure is in the middle of our responses and is consistent with about ten percent of oil extracted from flower in our simulations of the combined medicinal and unlicensed segments.

Applying these estimates to the medicinal segment identifies a potential bottleneck in oil supply.⁶⁴ In the current medicinal segment, the trim that is collected from the flowers harvested for medicinal sale only produces about two thirds of the oil needed to make cannabis oil for the medicinal segment. The remaining needed oil comes from trim from flower cultivation in the unlicensed segment. The unlicensed segment generates surplus trim since there are relatively fewer manufactured cannabis sales versus flower cannabis sales compared to the medicinal segment.⁶⁵

Under MAUCRSA, the medicinal and adult-use segments must each produce their own flower and trim for oil extraction. We assume that adult-use sales of manufactured cannabis will be proportionately similar to sales in the medicinal segment, so the “shortage” of trim just described for the medicinal segment will also present itself in the adult-use segment. There are a number of solutions, including the fact that cultivators may harvest more trim. Our simulations show that if 0.60 pounds of dried trim is obtained for every pound of dried flower harvested, the current medicinal segment can produce enough oil for manufactured products.⁶⁶ It is also likely that more cultivators will begin harvesting trim.⁶⁷ The market price of trim will also rise.⁶⁸ This will

⁶² Medicinal cannabis manufacturers that make high CBD oil utilize the entire plant and convert the majority of the flower produced by the plant to oil.

⁶³ This is after sorting out water leaves, which is standard practice, and not counting the weight of the stalks.

⁶⁴ See the description of the Track and Trace system below.

⁶⁵ There is still a slight overall shortfall in oil production equal to about one percent of flower production in the medicinal and unlicensed segments combined. We believe that this shortfall is likely made up with oil produced with trim from the export (out of state) segment.

⁶⁶ Harvesting a greater amount per plant may result in trim with lower THC content.

⁶⁷ Our simulations assume that all the trim obtained from harvested flower is used for oil extraction, but it is likely that trim continues to be discarded. Only within the last ten years has trim gained commercial value as the amount of oil extraction rose.

prompt more extractors to obtain oil from flowers, which in turn raises flower prices. Overall, this bottleneck will tend to raise both flower and manufactured cannabis prices, reducing the quantity demanded in the market.

Colorado and Washington Examples

We use the experiences of Colorado and Washington to estimate the impact of adult-use legalization on user prevalence rates in California. Colorado, Washington, and California had legal medicinal cannabis use before adult-use legislation was passed.⁶⁸ The table below shows monthly prevalence rates for ages twelve and older from the NSDUH data from 2008-2009 to 2014-2015. These years span a number of years before adult legalization in Colorado and Washington up until the most recent data available. Colorado has a monthly prevalence rate of 9.77 in 2008-2009 and this increased by 6.8 percentage point to 16.57 in 2014-2015. The increase in prevalence rate in Washington was 4.0 percentage points while for the U.S. and California the increase was a similar 1.9 and 2.0 percentage points, respectively. The average of the Colorado and Washington increases is 5.4 percentage points. Nationally and regionally, cannabis prevalence was increasing, so we can't use this raw increase in the average Colorado and Washington prevalence to predict the increase in California after adult-use legalization. We must first remove the upward trend in use rates. The difference in differences approach subtracts the upward trend from the Colorado and Washington average increase, where the upward trend is the increase in a similar or comparison states that did not enact adult-use legalization. We use the ten states, excluding Colorado and Washington, that had enacted medicinal cannabis legislation before 2008 as our comparison group.⁷⁰ There is considerable variation between the increase in prevalence use from 2008-2009 to 2014-2015 for our comparison states. The Hawaii prevalence rate fell 0.5 percentage points, while it rose 3.9 points for Vermont and Maine. On average, the prevalence rate in our comparison states rose by 2.6 percentage points. The difference in differences estimate of the effect of adult-use legalization in Colorado is a 4.2 (=6.8-2.6) percentage point increase in the monthly prevalence rate of cannabis use. For Washington, the effect is smaller at 1.4 percentage points. If we use the average of the Colorado and Washington increases in prevalence rates, the impact of adult-use legalization is an increase in the California monthly cannabis prevalence rate of 2.8 percentage points.

⁶⁸ In Colorado an established inventory tracking system exists, and the price of trim is much higher relative to the price of flower cannabis. Trim in Colorado has a median price of \$426 while flower has a median price of \$1,298 which means trim is one third the price of flower cannabis. In California, trim sells for around \$100 per pound while flower sells for around \$1,300 per pound, which means trim sells for less than one tenth the price of flower cannabis. See the Average Market Rate at <https://www.colorado.gov/pacific/sites/default/files/AverageMarketRate.pdf>

⁶⁹ Oregon also had legalized medicinal cannabis use before adult-use legislation, but we focus on Colorado and Washington since they were the first with adult-use legalization and therefore may be a better indicator of the long run changes coming to California.

⁷⁰ The ten states are California, Oregon, New Mexico, Nevada, Alaska, Hawaii, Vermont, Rhode Island, Montana, and Maine. See <http://medicinalmarijuana.procon.org/view.resource.php?resourceID=000881>

Table 11: Past Month Cannabis Use Ages 12 + from 2008-2009 to 2014-2015

| | 2008-2009 | 2014-2015 | Increase | Increase versus Comparison States Average |
|----------------------------------|-----------|-----------|----------|---|
| Colorado | 9.77 | 16.57 | 6.8 | 4.2 |
| Washington | 7.21 | 11.22 | 4.0 | 1.4 |
| Total U.S. | 6.40 | 8.34 | 1.9 | |
| California | 7.67 | 9.67 | 2.0 | |
| CO/WA Average | | | 5.4 | 2.8 |
| Comparison States Average | | | 2.6 | |

**Numbers may not equal sum due to rounding.*

In the table below, we repeat the process for the increase in past year prevalence rates. Past year cannabis prevalence rates are greater across the board. The increase in the prevalence rates for Colorado and Washington and the comparison states is greater as well. However, comparing Colorado and Washington to similar states, the difference in differences estimator shows similar impacts of adult-use legalization. We estimate that the impact of adult-use legalization is an increase in the yearly cannabis prevalence rate of 2.6 percentage points.

Table 12: Past Year Cannabis Use Ages 12 + from 2008-2009 to 2014-2015

| | 2008-2009 | 2014-2015 | Increase | Increase versus Comparison States Average |
|----------------------------------|-----------|-----------|----------|---|
| Colorado | 15.12 | 23.09 | 8.0 | 4.2 |
| Washington | 12.81 | 17.49 | 4.7 | 0.9 |
| Total U.S. | 10.88 | 13.36 | 2.5 | |
| California | 12.91 | 15.25 | 2.3 | |
| CO/WA Average | | | 6.3 | 2.6 |
| Comparison States Average | | | 3.8 | |

**Numbers may not equal sum due to rounding.*

This 2.8 point increase in monthly and 2.6 point increase in yearly prevalence rates after adult-use legalization leads to an increase in the estimate of overall cannabis consumed. If California were to see a similar increase in consumption then, compared to 2016, the number of people consuming cannabis in California would rise by over eight hundred thousand. If the distribution of days used per month doesn't change, and if the quantities consumed per day used doesn't change, then cannabis consumption in California would be 3.1 million pounds of flower weight cannabis. Since we previously estimated that current cannabis consumption in California totals

2.4 million pounds, this implies an increase of 29 percent in cannabis consumption if California's experience is similar to that of Colorado and Washington.

We do not expect that legalization in California will lead to a similarly large increase in cannabis consumption in the short run. First, California was the first state to pass a medicinal marijuana law and cannabis is readily available to state residents. One paper has shown that the price of cannabis rises the further one is from California.⁷¹ This suggests legalization in California may lead to a smaller increase in resident demand compared to Colorado. Second, it is likely that some of Colorado's purchases by out of state residents is by distributors with the intent to resell in other states, although direct estimates of these purchases is unavailable. One manufacturer in Colorado told us that about forty percent of sales of high end manufactured products are to out of state residents. California, however, already has highly developed out of state distribution systems, and it seems less likely that cannabis distributors disguised as tourists will purchase large amounts with the intent to resell. Lastly, it is important to recall that we are most concerned about the impact of regulation on prices and the cannabis markets once regulations are implemented. Longer term speculation about the evolution of the market, such as what happens to demand in the medium to long run, is not the focus of this report. Therefore, we decide to be conservative on our estimate of the impact of legalization on demand.

This rise of 29 percent in Colorado and Washington is the equilibrium market rise in cannabis consumed, and is not solely the rise in demand. We expect supply to rise as well. In those states, cannabis prices have been falling since adult-use legalization, which implies that the increase in supply is relatively more pronounced than the increase in demand.⁷² The chart below shows flower price indexes in Colorado and Washington before and after adult-use legalization.⁷³ The indexes are set to be 100 in the base month, which is January, 2014 in Colorado and July, 2014 in Washington. In both adult-use markets, prices have been falling after an initial increase that is likely due to adjustments from the implementation process. The current flower price in the Colorado adult-use segment is 61 percent of the peak price after adult-use legalization, while current flower prices are 67 percent of the peak price and 23 percent of the peak price in the Colorado medicinal and Washington adult-use segments, respectively. Thus, using Colorado and Washington as examples, we expect there to be downward pressure on cannabis retail prices in the medium to long run.

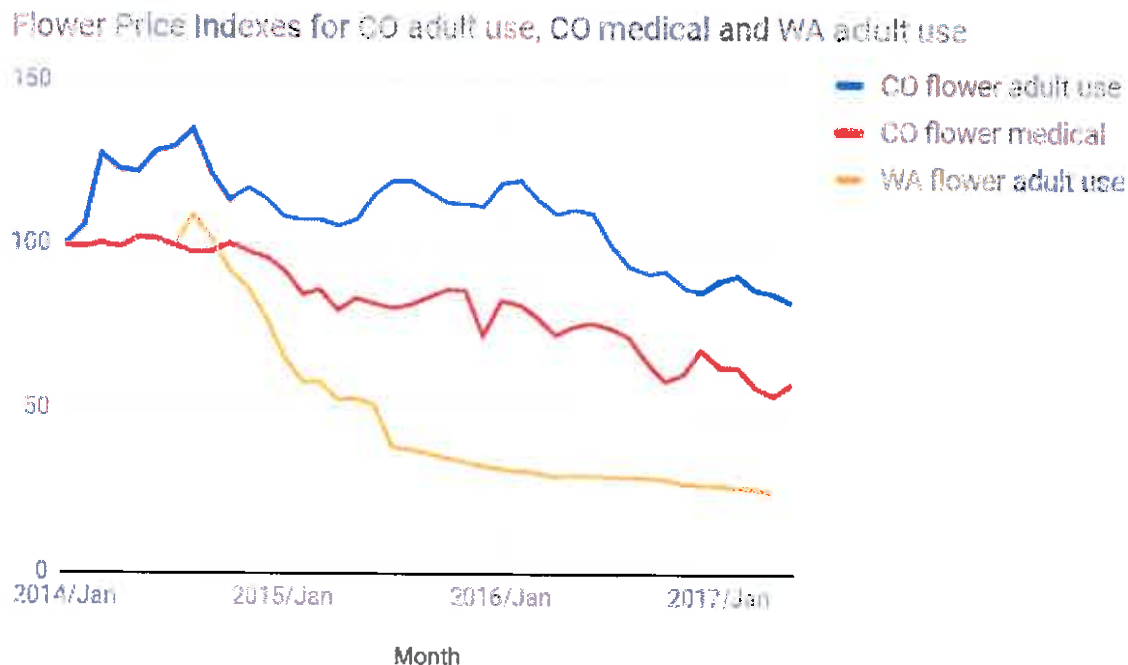
⁷¹ See Zook, Graham, and Stephens (2011)

<https://drive.google.com/file/d/0B0eDX6K2hsNeZDJiNTkwZDQtMmVlZC00NTQ1LTlmMWQrYjQ1YzBhMzdhY2Ez/view>

⁷² If the increase in demand were more important than the supply increase, prices of cannabis would rise and quantities consumed rise.

⁷³ These indexes are based on price data kindly obtained from BDS Analytics, Inc.

Figure 1: Cannabis Flower Price Indexes for CO adult-use, CO medicinal and WA adult-use



Source: Indexes are based on price data obtained from BDS Analytics, Inc.

IMPLAN

Overview

This analysis uses the IMPLAN Pro software and accompanying California state and county level data. IMPLAN is a widely accepted, economic input-output model that starts with the direct effect of business regulation (calculated independently), and then calculates the indirect impacts on other businesses, and the induced effects on employee spending. We used the analysis by parts method of inputting our estimated direct increase in manufacturer commodity spending and labor income earning in order to calculate the overall impacts on jobs and California Gross State Product along with the breakdown by industry.

IMPLAN does not have a cannabis sector. IMPLAN uses data collected by the U.S. Bureau of Economic Analysis (BEA), among other sources, and currently the BEA does not track cannabis manufacturing. We therefore had to form the cannabis industry for the modeling using the estimates developed for this SRIA.

Forming the Cannabis Industry

We customized a proxy sector within IMPLAN based on cost and other data obtained from an online survey and in-person survey of cannabis manufacturers. We asked for total manufactured cannabis sales, costs of manufacturing, wages and benefits paid to employees, and top ten costs of production. Additionally, we asked for total costs of manufacturing. Overall, there is great variety among cannabis manufacturers and their costs, given that manufactured cannabis includes edible products, topicals, and concentrates. Our strategy was to form a “typical” cannabis manufacturer that was a blend of the collected data. This allows our analysis to focus on an overall industry story, while also incorporating the heterogeneity of the market. We also focus on the top costs to manufacturers, since these are the factors that will impact the analysis the most. Our proxy industry was spice and extract manufacturing, which we felt was similar in terms of commodity use to cannabis manufacturing. We customized that sector based on 14 top commodity purchases by cannabis manufacturers as determined through our survey and a recent 2016 report.⁷⁴

Packaging was reported as a top ten cost 25 percent of the time. About one in five reported that marketing costs were in the top ten. The survey reports only one business that lists security or testing costs among their top ten. Two costs are particularly relevant. The cost of raw cannabis, which is flower and trim, was reported in the top ten costs by 57 percent of respondents. There is no raw cannabis commodity in IMPLAN, so we used the flower production sector as a substitute for that input. Solvents, such as butane, alcohol, and CO₂, were cited among the top ten costs by 29 percent of respondents. Other commodities that we selected represented the food production sectors in order to include costs important to edible manufacturers. We also used information from our survey to form estimates of the proportion of sales that goes to labor income and intermediate goods purchased.⁷⁵

Regulatory Costs

Overview

MAUCRSA moves the manufactured cannabis industry in California from an unregulated industry with uncertain legal status to an industry with regulations typical of an industry that uses a federally controlled substance. For manufacturers, this move toward regulation is particularly impactful since there was essentially no previous statewide or local regulation.

⁷⁴ See http://www.pacific.edu/Documents/school-business/BFC/CannabisStudy/Sacramento%20Area%20Legal%20Cannabis%20Sector%20Impact%20Study_2016_10_12.pdf

⁷⁵ We used the same IMPLAN parameters for adult-use and unlicensed manufacturers as we do for medicinal manufacturers.

Costs

There are 12 categories of key new requirements. We estimated the additional industry costs of implementing the specific regulatory requirements. However, for general licensing requirements, we combined them into a broad category and made an overall estimate of their costs. Below, we describe the key assumptions used in forming our cost estimates.

Labeling

Proposed regulations require a primary and informational panel that: identifies the product as cannabis-infused; has a “universal symbol;” lists THC and CBD content in milligrams; identifies manufacture dates; lists warnings, such as “For medicinal use only,” ingredients, allergens; and identifies the “best by” date of the product, among other requirements. Label font size is also specified and there is a list of label restrictions. We contacted a number of label makers to find the cost of a label, and we assume that one label can contain both primary and informational panels. Common label sizes were 2”x3” and 4”x6,” and we discovered the average cost per label in bulk. Averaging between the two label sizes gave an estimated cost of 11.3 cents per label. Many oils and concentrates sold in bulk currently have no label, but many manufactured products currently have labels already, including most edibles and topicals. We estimate that on average, one-half of manufactured units currently sold by the manufacturer have labels and manufacturers must begin adding labels to the other half of the units they produce.

Cannabinoid Content Testing

In order to properly label their products with accurate THC or CBD content, we assume that manufacturers will test their products for THC and CBD levels prior to finalization of the product. This testing is in addition to the required testing for product safety that is required to be performed by an independent, licensed laboratory.⁷⁶ We contacted testing labs and a large manufacturer about the costs involved. Bulk discounts lowered laboratory charges to about \$50, and indicated that manufacturers typically tested each batch they produce. It is also possible to conduct testing in-house, if the manufacturer is willing to purchase the machinery and train employees, and these costs could run over \$100,000. We assumed a testing cost per batch of between \$25 for in-house testing and \$50 for lab testing. We also assumed a mix of “full-time” large (25 percent), “full-time” small (25 percent), and “part-time” small (50 percent) manufacturers. The full-time producers test about 16 batches a month and the part-time producers test about two per month. Our estimated average cost per firm in the industry is \$4,225 per year.

Packaging

Proposed regulations require tamper-evident and child-resistant packaging. We assume that all edible and topical makers already package their products, and that half of the concentrate

⁷⁶ The BCC, not CDPH, regulates final product testing.

makers use packaging. We contacted a number of packaging makers and obtained costs for both tamper-evident and child-resistant packaging, and compared the cost to packaging that does not meet that requirement. We looked at a range of packaging that included pouches and bottles suitable for solids and liquids, and prices ranged from seven cents to \$1.10 per unit. We wanted to know what the extra cost would be to purchase compliant packages. The extra cost was estimated to be 4.4 cents per package.

Live Scan and Background Checks

CDPH will require Live Scan background checks for “owners” of manufacturing businesses, where ownership is anyone that participates in the direction or control of the business, such as the business manager or director, or has a twenty percent financial interest or more. This also includes the board of directors for non-profits and business partners.

Direct prices for Live Scan vary depending on where fingerprints need to be sent, but prices can be as high as \$87 and take as long as four to six weeks to be processed by the Department of Justice and sent to CDPH. Perhaps more important is the opportunity cost of the time to apply for the background check. We assume that cost to be equal to four hours of time valued at \$100 (at an hourly cost of \$25 per hour, which was reported as the hourly wage of a manager at a manufacturing site). Finally, we have no direct evidence of the average number of owners and associated owners per manufacturer and we assume this number to be three people on average.⁷⁷ We estimate industry costs to rise by \$187 per owner.⁷⁸

We cannot find reliable data on how many current workers in the cannabis industry have prior criminal convictions, and we decided against asking for criminal backgrounds in our surveys because we were not convinced that respondents would be truthful. CDPH anticipates reviewing cases on an individual basis, and it may be that only serious felonies and assaults, or selling cannabis to minors, may disqualify someone from obtaining a license. Additionally, Proposition 64 allows those with prior criminal convictions to be resentenced according to new sentencing standards and potentially have their records purged.⁷⁹ CDPH will also review evidence of rehabilitation. The combined effect of regulatory forbearance and record purging may mean that all would-be owners with all but the most egregious convictions will be allowed to participate in the industry. Nevertheless, we believe this regulation has the potential to limit the number of experienced owners and managers in the industry and that may lead to reduced efficiency as talented managers and owners are denied the opportunity to run a business. These effects are difficult to quantify, and we assume the cost of reduced talent in the industry at 0.1 percent of current sales per owner.

⁷⁷ Not all owners are actively engaged in business operations.

⁷⁸ Background checks are only required for new owners. We assume that after the first year when companies obtain their initial license, Live Scan checks are required of only ten percent of existing owners each year.

⁷⁹ See <http://www.lao.ca.gov/ballot/2016/Prop64-110816.pdf>

License Fees

CDPH will require an initial non-refundable application processing fee of \$1,000. There will also be an annual license fee according to the fee schedule in the table below. These fees are intended to cover CDPH expenses of administering the licensing and regulatory requirements.

Table 13: Ongoing Annual Fees by Tier and Projected Revenue

| Tier Based on Gross Revenue | Annual Fee | Estimated Number of Licensees | Projected Revenue Ongoing |
|-----------------------------|------------|-------------------------------|---------------------------|
| \$0-100,000 | \$2,000 | 1050 | \$2,100,000 |
| \$100,001-500,000 | \$7,500 | 870 | \$6,525,000 |
| \$500,001-1,500,000 | \$15,000 | 720 | \$10,800,000 |
| \$1,500,001- 3,000,000 | \$25,000 | 300 | \$7,500,000 |
| \$3,000,001 – 5,000,000 | \$35,000 | 56 | \$1,960,000 |
| \$5,000,001- 10,000,000 | \$50,000 | 3 | \$150,000 |
| \$10,000,001 + | \$75,000 | 1 | \$75,000 |
| Total | | 3,000 | \$29,110,000 |

Application Fee:

The number of FTEs (Full-Time Equivalent employees) was determined by calculating the number of hours it would take to complete a task (processing hours) multiplied by the number of licenses (3,000) divided by 1,800 (equivalent of one FTE annually).⁸⁰ The total cost was derived by multiplying the annual classification salary by the FTEs needed to complete the task annually.⁸¹

License Fee:

The license fees were determined by accounting for the cost of administering the manufactured cannabis safety program. These costs include operational staff, administrative staff, an IT system for licensing, Track and Trace fees, and documenting local license compliance.

⁸⁰ CDPH assumes that the number of firms that will seek manufacturer licenses is 3,000, which is what we assume to be the number of firms currently in the industry. There are a number of reasons why these assumptions are consistent. First, and most importantly, there is a great deal of uncertainty about the number of firms currently in the unlicensed segments. Second, we show below that industry dollar sales and quantities rise quite a bit after legalization and regulation, and the total number of licensed firms in the industry can grow. Third, we show that the unlicensed segments sales fall by between 25 and 30 percent which may mean fewer unlicensed firms. Finally, we might expect firms in the unlicensed segments to obtain a license as a “placeholder” in order to begin the process of establishing a licensed business, even if they have very little sales currently in the medicinal or adult-use segments.

⁸¹ See the discussion below about alternate assumptions of the number of firms.

Bonding Requirement

CDPH plans to require manufacturers to show proof of a \$5,000 bond in an amount suitable to cover the cost of destruction of a batch of manufactured cannabis product should testing require. We value the cost of the bond as the opportunity cost of the funds used to purchase the bond. We use a three percent interest rate to calculate ongoing costs at \$150 per firm.

Facility Compliance and Video Surveillance

Manufacturing will need to take place in facilities that meet sanitation, safety, and security standards. Sanitation standards include using food-grade equipment and surfaces, maintaining dressing and locker rooms, among others. Safety standards include complying with local and state requirements. Security standards include electronically secure records and maintaining a security alarm. Without hard data for guidance, we assume that half of existing manufacturers already meet these standards, and we assume the initial cost of complying with the standards is \$12,500. The Type S license allows edible and topical manufacturers to share a facility, meaning that each individual licensee may not bear the cost of compliance. We assume that one in five of the Tier I and II manufacturers will share facilities.

Security cameras are required, and they must allow for remote access, video capture in low light settings, and camera placement in a number of rooms, among other requirements. Surveillance recordings shall be kept for a minimum of 60 days on the licensee's recording device. We assume that half of existing manufacturers already have video equipment that meets these standards. We obtained prices for conforming video equipment online and we found that the initial cost of compliant equipment is approximately \$2,500 with an ongoing annual expense of about \$500.

Closed Loop Extraction System

Type 7 (volatile compounds) license holders will be required to extract cannabis oil from trim or flower using a closed loop system, which captures solvent vapors produced during the extraction process. The closed loop system means that little flammable gas escapes during extraction, which greatly reduces the chance of explosion and fire. CDPH requirements are: a) a licensed engineer certifies the system was commercially manufactured and the system was built to code; b) the manufacturer maintains approval from the local fire official for the closed loop system; and, c) the system meets required fire, safety, and building code requirements. This closed loop requirement is essentially a response to the fires from butane solvent extraction already mentioned. In terms of extra cost, we assume that b) and c) are already part of the local permitting fees. Washington currently requires extractors to use "I-502" compliant machines, which have very similar requirements to CDPH's proposed requirements, and we used I-502 machines as the basis for pricing.⁸² Larger manufacturers may pay for larger capacity machines in order to have quicker run times and process more trim. There are, however, lower priced

⁸² For a description of the requirements, see <http://apps.leg.wa.gov/wac/default.aspx?cite=314-55-104>

options. Online price searches obtain a range of approximately \$10,000 to over \$100,000. We use \$25,000 as the price of a “typical” compliant machine.

Our survey directly asks whether manufacturers use hydrocarbons in production, and 28 percent indicated they did.⁸³ While many of our survey respondents that produce with volatile hydrocarbons indicate they already use a closed loop system, it is likely that many existing systems will not meet CDPH guidelines. Overall, we estimate that 22 percent of manufacturers must acquire compliant closed loop systems.

Standard Operating Procedures

CDPH will require that manufacturers write Standard Operating Procedures (SOPs) and have those available for review. We categorize SOPs into the following six general categories: cannabis acquisition and tracking; employees; security; safety and sanitation; hazard and recalls; and manufacturing protocols. We do not know what percent of manufacturers currently have SOPs in these areas, but we suspect most do not, and we assume that three-quarters will need to write SOPs.⁸⁴ We use \$20,000 as our estimate of cost for writing the SOPs.

General Licensing Requirements

CDPH will require sound recordkeeping and making documents available, such as employee records, shipments, etc. Additionally, manufacturers must also provide a list of employees, site plans, estimated gross revenue, etc., for the annual renewal application and must comply with Track and Trace requirements. Firms must receive and document landlord approval for their cannabis production. CDPH will conduct onsite inspections. All of this requires labor effort in the areas of bookkeeping and compliance. These are common costs that are not specific to cannabis manufacturers, and are usually part of most businesses and certainly part of industries that require statewide licensing or permitting. We value effort at general licensing requirements to be equal to 15 percent of the time of a manager who earns \$40,000 per year. It is difficult to say how many firms will need to devote more manager time in these areas, but we believe that most firms are currently devoting very little time toward compliance and bookkeeping, and we assume that 80 percent of firms will be affected by general licensing requirements.

Adulterated and Potentially Hazardous Products Prohibited and THC Limits

CDPH will prohibit additives, such as nicotine, alcohol, caffeine, and other chemicals from being combined into cannabis products. There already exists a market for cannabis infused energy

⁸³ These are not adjusted for sales level.

⁸⁴ We contacted a handful of cannabis industry consultants that are able to write SOPs. The typical cost is about \$30,000 for six SOP categories. This amount seems very large to us, and we expect that business owners that write their own SOPs will face a smaller opportunity cost. Additionally, we expect a number of consultants to enter the market to provide standardized SOPs at a lower cost.

drinks and alcohol.⁸⁵ Prohibiting these additives reduces future sales, and this leads to the standard loss of consumer and producer surplus when choices are limited because the gains from trade are reduced. Prohibition also reduces industry innovation, but this effect is difficult to quantify. CDPH will also prohibit potentially hazardous food, which largely means the product has an unstable shelf life, which limits the size and scope of products manufactured. Without concrete data on the potential size of adulterated products or those with unstable shelf lives, we estimate lost sales to be one percent of current medicinal cannabis sales, and we use this amount to capture the impact of prohibiting these types of products.

CDPH will place THC concentration or per-serving limits on some forms of manufactured medicinal cannabis edibles. We believe that these limits will not be very costly for manufacturers, who, due to labeling requirements described earlier, will already have to determine product THC content. The nature of the costs will be to restrict the supply somewhat of products, and we assume that THC limits costs one tenth of a percent of sales.

Track and Trace

MAUCRSA requires that manufacturers use the Track and Trace system to inventory cannabis throughout the supply chain. The Track and Trace system will also be used to ensure that manufacturers only purchase cannabis from licensed cultivators and only sell to licensed distributors. The fees for Track and Trace are included in the CDPH license fees and are not enumerated here. But because manufacturers will only be allowed to purchase from licensed cultivators, and this is likely to reduce the supply of cannabis available, at least initially.⁸⁶ It will mean that manufacturers will have fewer choices between cultivators than they do at present. It is difficult to assign a dollar value to the supply restriction, but we assume that the uncertainty and reduction in suppliers is one percent of sales.

Local Permitting

CDPH regulations require manufacturers to comply with all local requirements, including permitting and other compliance requirements. The costs of a business to comply with any local requirements are therefore included in this analysis.

Under MAUCRSA, local jurisdictions can implement cannabis-specific business requirements, permit cannabis businesses under the jurisdiction's general business permitting, or ban cannabis activity altogether. At the time of this analysis, the development of local ordinances was in flux, so an assessment of the full costs of local compliance is not possible at this time. Early indications are that local permitting by cities and counties may turn out to be expensive for

⁸⁵ See <http://www.forbes.com/sites/julieweed/2015/05/31/catapult-wants-to-be-the-starbucks-of-marijuana-infused-coffee/#37c4409052fe> or <https://www.bloomberg.com/news/articles/2015-02-11/is-it-time-to-take-cannabis-cocktails-seriously->

⁸⁶ Washington had supply difficulties when adult-use cannabis was first legalized. See <http://www.newsweek.com/washington-supply-legal-weed-cant-meet-demand-257541>

cannabis manufacturers.⁸⁷ In August 2017, we did a short statewide survey of cities and counties. Most did not have ordinances in place regarding cannabis manufacturing, but many were in the process of doing so. The range for application fees and annual fees was considerable, with one locality charging about \$30,000 for both the application and annual fees.

In a typical industry, businesses would be likely to simply move their location if the local costs were exorbitant. The result would be many firms in low-fee cities and few firms in high-fee cities, and the average fees paid by firms is relatively low. However, because local jurisdictions can limit cannabis activity to just medicinal businesses or ban cannabis activity altogether, this may impact cannabis businesses ability to move locations. Additionally, evidence from the medical dispensaries shows that in 2015, 24 out of 58 California counties had no active medicinal cannabis dispensary and many jurisdictions banned dispensaries.⁸⁸

Among jurisdictions with existing cannabis manufacturer fees below \$15,000, the average application fee was \$5,400 and the average ongoing annual fee was \$2,600. The average tax on cannabis manufacturer sales was 5.8 percent with a range between 2 percent and 10 percent. For purposes of this analysis, due to the shifting nature of status of local ordinances, we assume that one-half of cannabis businesses will be located in jurisdictions with cannabis-specific permitting requirements and the other half will be in jurisdictions that only require general business licenses.

In order to assess the fiscal impact of a ban on manufacturing in some localities we assume the manufacturer incurs the cost of moving operations to a nearby jurisdiction that allows cannabis activities. We also assume that some businesses move to lower cost jurisdictions. We assume a cost of moving a modestly sized business at \$15,000 and assume that ten percent of businesses must move location.⁸⁹

There is exceptional uncertainty about the impact of local fees on cannabis manufacturers, but we estimate that local costs are over one half of the cost of the other CDPH regulations both in the first year of regulation, and ongoing. In other words, over one third of the total CDPH regulatory costs on manufacturers is due to the local component while less than two thirds is due to the state component.

⁸⁷ <http://www.times-standard.com/article/NJ/20161101/NEWS/161109982>

⁸⁸ See <http://www2.humboldt.edu/hiimr/docs/california%20dispensaries.pdf>

⁸⁹ A larger percent of firms could move, of course, especially if there are large differences between high and low cost jurisdictions. That would mean that average fees and taxes collected are lower since firms will move to where local regulatory costs are lower.

Cost Summary

The table below lists the additional industry costs for each category in the first year of costs and ongoing.⁹⁰ Manufacturers will obtain a license and immediately face the ongoing costs. All costs and calculations are in 2017 dollars. These costs are extra expenses for each category due to the new regulations as described above, not the total cost in each category. For example, in 2018, we anticipate the labeling requirements will add \$1,191,847 in additional costs to the industry in the first year and each year ongoing. Facility compliance, the closed loop system, and SOP costs are one-time costs for each business, and we anticipate turnover, with ten percent of new firms that enter the industry each year having to pay these costs. We estimate that as a result of regulation, total industry additional costs will be \$195 million in 2018 and then \$138 million each year thereafter. Spread over all firms, the initial costs will be \$65,000 per firm and ongoing costs \$46,000 per firm. “Ongoing costs” are 17.7 percent of manufacturer sales revenue. We assume that costs keep up with inflation and we use \$138 million as our “ongoing” value of lifetime annual costs. If we assume an interest rate of 3 percent, then the total costs over the lifetime are \$4.6 billion.⁹¹

We estimate that the CDPH regulations will raise firm ongoing costs by 23 percent, industry wide. In the first year, however, costs are greater given the large amount of fixed expenses that must be made in order to become compliant. In year one, the \$195 million in additional costs is a 32 percent increase in costs and represents 25 percent of manufacturer sales revenue. There is some variation in year one regulatory cost impact by market, although ongoing costs are about the same. Regulations impact concentrate manufacturers the most, with their costs rising by 33 percent in the first year while costs rise by 30 percent for edible and topical makers.

⁹⁰ Some manufacturers will prepare for licensing in 2017 to some degree, but we place all first-year costs in 2018 in order to capture the full costs of regulatory implementation. We then model all costs to be fully incorporated into the market each year in 2019 and beyond.

⁹¹ If we assume regulations continue indefinitely, then \$4.6 billion = \$138 million / 3%.

Table 14: Year One and Ongoing Additional Costs in all Manufactured Cannabis Markets Due to Proposed CDPH Regulations

| Cost Category | Total Additional Industry Costs of Regulation, Year One | Total Additional Industry Costs of Regulation Ongoing | Ongoing Costs as Percent of Manufacturer Sales |
|--|--|--|---|
| Labeling | \$1,191,847 | \$1,191,847 | 0.2% |
| Testing for Labeling | \$12,675,003 | \$12,675,003 | 1.6% |
| Packaging | \$2,761,181 | \$2,761,181 | 0.4% |
| Live Scan Background Checks | \$7,538,303 | \$6,023,603 | 0.8% |
| License Fees | \$24,000,000 | \$29,100,000 | 3.7% |
| Bond for Destroyed Batches | \$450,000 | \$450,000 | 0.1% |
| Facility Compliance and Video Surveillance | \$20,443,602 | \$3,203,634 | 0.4% |
| Closed Loop System | \$10,639,096 | \$1,063,910 | 0.1% |
| SOPs | \$22,500,006 | \$2,250,001 | 0.3% |
| General Licensing Requirements | \$14,400,004 | \$14,400,004 | 1.8% |
| Unadulterated Product and THC Limitations | \$8,587,777 | \$7,807,070 | 1.0% |
| Track and Trace Supply Restrictions | \$7,807,070 | \$7,807,070 | 1.0% |
| Local Permitting | \$62,231,011 | \$49,631,008 | 6.4% |
| TOTAL Increased Cost to Industry* | \$195,224,900 | \$138,364,331 | 17.7% |

**Totals do not equal sum of costs due to rounding.*

These costs will be passed through, to some degree, from the manufacturer to the retailer to the consumer. There is a large literature on cost pass-through, which is the amount that an increase in costs shows up as an increase in the retail price.⁹² In general, economic theory says that the supply curve is the marginal cost curve, and an increase in marginal costs will shift up the supply curve by the dollar value of the cost increase.⁹³ We assume that all of the costs identified in this section are constant marginal costs.⁹⁴ We also assume that the dollar increase in costs is passed from manufacturer to retailer to consumer, which means that the supply curve facing consumers shifts up by the dollar value of the cost increase. Based on the cost increases above, we calculate that the supply curve will shift upwards by about 7 percent in the concentrate, edible, and topical markets due to compliance with CDPH regulations.⁹⁵

Non-CDPH Regulatory Costs

Seller's Permit from CDTFA

Cannabis manufacturers are required to obtain a seller's permit from CDTFA, and CDPH will require recordkeeping that substantiates a valid permit.⁹⁶ Our survey finds that only about two-thirds of existing cannabis businesses reporting having a permit. However, CDTFA told us that there is no fee for a seller's permit and that no security deposit is required. We, therefore, only consider the value of time in obtaining a seller's permit and in recordkeeping in our cost estimates, and we assume this to be 0.5 percent of the value of a company manager's time.

Other Agency Costs

The Department of Pesticide Regulation, State Water Resources Control Board, Department of Fish and Wildlife, among other agencies, will issue regulations on cultivators and dispensaries, as well as on cannabis manufacturers. CDFA, BCC, and CDTFA regulations will also impact manufacturers. It is beyond the scope of work of this SRIA to calculate the impacts of those regulations, and many of those agencies are currently writing their own related SRIA. The total magnitude of regulatory costs on cannabis manufacturers from these other agencies will be a multiple of CDPH costs.

⁹² See for example

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/320912/Cost_Pass-Through_Report.pdf

⁹³ Manufacturer and retailer markups will fall if they pass the absolute value of the cost increase to their customers.

⁹⁴ While some of the identified costs are fixed costs, we believe they are particularly relevant to manufacturer pricing when there are new regulations and firms must decide whether or not to remain in the market.

⁹⁵ There are small differences in retail price impact by market.

⁹⁶ See https://www.boe.ca.gov/industry/medicinal_cannabis.html#Growers

Baseline

Regulations

The overall impact to current market conditions in cannabis can be broken down into two factors: (1) the impact associated with legalization of commercial cannabis activity; and (2) the additional impact associated with CDPH regulations. The CDPH regulations assumptions includes CDPH regulations, local permitting costs, and changes that directly flow from CDPH regulations, but exclude all the market changes due to legalization (such as regulation from other statewide agencies, tax consideration, and demand changes). We compare the CDPH regulated market to the baseline in order to answer the question “what is the marginal impact of the CDPH regulations, given that other market changes will occur beyond the control of CDPH?” This is the most relevant question for the purpose of this SRIA. Most economic impact analysis uses the current landscape as the baseline, and compares the current landscape to a future with regulations. This SRIA compares a hypothetical “legalization and partial regulation” future to a hypothetical future with “legalization and full regulations.”

Supply and Demand shifts

Regulations will affect both the Demand and Supply of manufactured cannabis across all three markets. Increased Demand, say due to regulations leading to a safer perceived product, will shift the demand *curve* horizontally to the right and lead to a higher market price and a greater quantity sold. Likewise, a drop in demand shifts the demand curve to the left. A rise in producer costs will decrease Supply, which is a leftward shift in the supply *curve*, and lead to a higher market price and a smaller quantity sold. Equivalently, this decrease in the supply curve can be described as an *upward vertical shift* in the supply curve. Likewise, a reduction in production costs due to, say, a reduction in the risk premium, will increase Supply and shift the supply curve vertically downward. In the discussion that follows about our model, and in the table below, we will talk of a decrease in Supply as a vertical shift upwards in the supply curve, and indicate an upward shift by a positive amount. Thus, Demand changes are described as horizontal shifts in the demand curve, while Supply changes are described as vertical shifts in the supply curve.

The figure below illustrates these shifts. Originally the market starts at equilibrium point A. Supply shifts upwards due to regulatory cost increases but also shifts downward due to reduction in the risk premium. Demand for the newly regulated products increases. The overall net impact as drawn is an increase in the price and quantity of manufactured cannabis products.

Figure 2: Supply and Demand Shifts in the Manufactured Cannabis Market

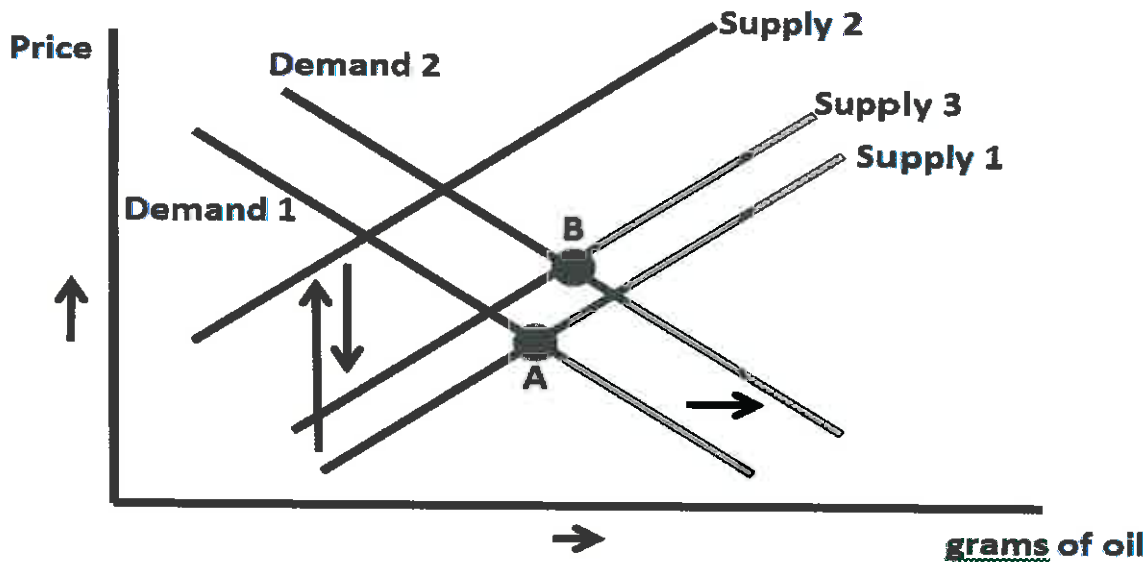


Table 15: Features of the Manufactured Cannabis Adult-use, Medicinal and Unlicensed Segments in Three Periods

| Period | Description | Adult-Use | Medicinal | Unlicensed |
|------------------------------|---|---|---|---|
| <u>CURRENT PERIOD</u> | Currently in 2017 <i><u>Description of current market segments.</u></i> | Does not exist | 31% market share of manufactured oil quantities - Pays no sales tax* - No regulations | 69% market share of manufactured oil quantities - Pays no taxes - No regulations |
| <u>2018 SPLIT</u> | Beginning of 2018 <i><u>Assumes Adult-Use segment "splits" from unlicensed segment, with one third going to adult-use in 2018.</u></i> | -Created from 1/3 unlicensed segment -Increased demand for edibles and topicals -Initially 29% market share of manufactured oil quantities -Final market share determined in model | -Initially 29% market share of manufactured oil quantities -Final market share determined in model | -Initially 43% market share of manufactured oil quantities -Final market share determined in model |

| Period | Description | Adult-Use | Medicinal | Unlicensed |
|---|--|---|--|--|
| <u>MAUCRSA BASELINE</u> | 2018 <i><u>This is what the market would look like with MAUCRSA legalization but without CDPH regulations.</u></i> | -New domestic consumer demand -New tourist demand -Pays sales tax -Pays Excise and cultivation taxes -Risk premium falls at State level -Other state requirements such as water and pesticides regulations | -Pays no sales tax -Pays Excise and cultivation taxes -Risk premium falls at State level -Other state requirements such as water and pesticides regulations | -Pays no taxes -No regulations -Risk premium rises at State level |
| <u>CDPH REGULA- TED MARKET</u> | Ongoing <i><u>This is what the market will look like, and it includes both the CDPH regulations and the baseline assumptions.</u></i> | -Includes all model baseline assumptions <i>Due to CDPH</i> -Demand up for safe product -Risk premium falls at federal level -Local licensing fees -MAUCRSA regulatory costs and vertical integration | -Includes all model baseline assumptions <i>Due to CDPH</i> -Demand up for safe product -Risk premium falls at federal level -Local licensing fees -MAUCRSA regulatory costs and vertical integration | -Includes all model baseline assumptions -Risk premium rises at federal level |

* Medicinal dispensaries paid sales tax through 2016, but MAUCRSA specifies that medicinal cannabis is not subject to sales tax. Proposition 64 allowed medicinal dispensaries to stop paying sales tax before implementation of regulations on January 1, 2018.

The table above describes the three periods. Compared to the current market, the model MAUCRSA baseline and CDPH regulated market contain various supply and demand shifts that

alter the quantities and prices in the concentrate, edible, and topical markets. Below we describe our assumptions for these shifts in our model.

2018 Split

We assume that the baseline market medicinal segment quantity starts 2018 at 2.1 percent greater than the current year 2017 and that prices are unchanged.⁹⁷ For the adult-use market, the model baseline must be created. We assume that the legal adult-use segment is formed from one-third of the quantity produced in the unlicensed segment (the remaining two thirds remains in the unlicensed segment). For edible and topical segments, we also allow demand and supply to increase by enough to make the amount sold in the adult-use segment equal to the amount sold in the medicinal segment. Thus, for manufactured products, adult-use quantities in the baseline are the same as in the medicinal segment. Across the total manufactured cannabis market, the adult-use and medicinal segments are each 29 percent of manufactured oil sold by weight and the unlicensed segment is 43 percent of manufactured oil sold.

In terms of our EDM, we begin with the following starting values and then add the demand and supply shifts as described in the Baseline and CDPH Regulations cases.

Table 16: 2018 “Split” Medicinal, Adult-Use, and Unlicensed Prices and Quantities by Market

| | Concentrates | Edibles | Topicals |
|-------|---------------------|----------------|-----------------|
| P_m | \$60 | \$180 | \$180 |
| P_a | \$60 | \$180 | \$180 |
| P_i | \$51 | \$153 | \$153 |
| Q_m | 5,701,254 | 1,710,376 | 190,042 |
| Q_a | 5,701,254 | 1,710,376 | 190,042 |
| Q_i | 11,402,509 | 11,403 | 1,267 |

Baseline Post-Legalization

Next, the model baseline must take into account demand and supply changes resulting from legalizing manufactured cannabis at the state level. We assume an increase in domestic resident demand for adult-use cannabis by 10 percent and an increase in demand by tourists to California by 5 percent.⁹⁸ Both the adult-use and medicinal segments pay the state excise tax of

⁹⁷ 2.1 percent is the Department of Finance forecasted growth of total personal income in California from the third quarter in 2017 to the first quarter of 2018. See http://www.dof.ca.gov/Forecasting/Economics/Eco_Forecasts_Us_Ca/documents/FR_CAFOR0417.xlsx

⁹⁸ Cannabis tourism may not represent new spending in the state if the cannatourists simply divert spending in other areas of the state, such as spending on wine or traditional drinking establishments. This study assumes that the increase in cannabis demand represents new spending within the state.

15 percent of the average market price of the retail sale. Both segments also pay the cultivation tax on flowers and leaves (trim).⁹⁹ The tax on flower is set at \$9.25 per dry weight ounce of cannabis flower and the tax on leaves is set at \$2.75 per dry weight ounce of cannabis leaves (trim), or 2.5 percent of the retail price on average.¹⁰⁰ The adult-use segment pays the state sales tax which averages 8.8 percent.

Costs will fall for licensed adult-use and medicinal manufacturers due to reduced risk of law enforcement action from state or local authorities. To the degree that state and local law enforcement increase scrutiny of unlicensed production facilities, costs will rise in the unlicensed sector. These effects affect the risk premium that firms face, and will increase the supply curve by 10 percent in the adult-use and 5 percent in the medicinal segment. We allow there to be a larger impact in the newly created adult-use segment because we think medicinal cannabis has enjoyed some legal protection since the passing of Proposition 215 two decades ago. For unlicensed manufacturers, local and state law enforcement may become more intrusive since law enforcement can focus on the unlicensed operations. We estimate that the supply curve will shift up by 5 percent in the unlicensed segment.

There are other state requirements and regulations that are common to both the adult-use and medicinal segments, such as residue regulations from the Department of Pesticide Regulation or the State Water Resources Control Board. There are also regulations that stem from MAUCRSA that are not part of CDPH regulations. All of these regulations from other states agencies and local licensing are applied to both medicinal and adult-use segments. We estimate other state requirements to cost 12.5 percent. The net impacts on the demand and supply curves are given for each segment in the table below.

CDPH regulated market

The CDPH regulated market includes all of the baseline assumptions plus the effects of CDPH regulations on the adult-use, medicinal, and unlicensed segments. Other MAUCRSA regulations that are not part of the CDPH rulemaking action are considered in the baseline. We expect demand for both adult-use and medicinal segments to rise by 5 percent due to increases in perceived safety due to CDPH regulations. The threat of federal law enforcement intervention falls after regulation and we assume that for both adult-use and medicinal segments, the supply

⁹⁹ Our survey respondents tell us that one pound of trim produces one ounce of concentrate oil and one pound of flowers produces three ounces of concentrate oil. Given these flower and trim input requirements, the effective tax on an ounce of oil is approximately the same. The flower tax costs \$49 per ounce of oil produced and the trim tax costs \$44 per ounce of oil produced. We also assume that ten percent of oil concentrates come from cannabis flowers and 90 percent from trim leaves.

¹⁰⁰ The cultivation tax of \$2.75 per ounce of trim is equal to a tax of \$44 per pound of trim ($\$44 = \2.75×16) and it takes one pound of trim to make one ounce of cannabis oil. The weighted average combined cultivation tax on trim and flowers is \$45 per ounce of cannabis oil or equivalently \$1.59 per gram of cannabis oil. The weighted average current price of cannabis oil is \$63 per gram, which is equal to total manufactured dollar sales of cannabis oil divided by the quantity of cannabis oil sold. Thus, the cultivation tax on average is 2.5 percent of the retail price of cannabis oil.

curve increases by 5 percent due to the drop in risk premium. Since federal authorities can now turn their attention to unlicensed manufacturers, we assume that the risk premium rises for unlicensed manufacturers by 5 percent.¹⁰¹ We estimate that local licensing requirements will shift up the supply curve by 2.5 percent. CDPH regulatory costs differ slightly for each market, but are the same for both adult-use and medicinal segments within each market. We calculate that the supply curve will shift upwards by 4.3 percent in the concentrate market, 4.4 percent in the edible market, and 4.5 percent in the topical market due to compliance with CDPH regulations. The net impacts on the demand and supply curves are given for each segment in the table below. Compared to other MAUCRSA impacts, total CDPH regulatory impacts are small.

Table 17: Demand and Supply model shifts in the Manufactured Cannabis Adult-use, Medicinal and Unlicensed Segments in the MAUCRSA Baseline and CDPH Regulated Periods

| Segment | Adult-use | Adult-use | Medicinal | Medicinal | Un-licensed | Un-licensed |
|-----------------------------------|-----------------------|-------------------------------|-----------------------|-------------------------------|-----------------------|-------------------------------|
| Shift | Demand quantity shift | Supply price (vertical) shift | Demand quantity shift | Supply price (vertical) shift | Demand quantity shift | Supply price (vertical) shift |
| MAUCRSA Baseline | | | | | | |
| New consumer demand | 10% | | | | | |
| New tourists | 5% | | | | | |
| Excise tax | | 15% | | 15% | | |
| Sales tax | | 8.8% | | | | |
| Average of cultivation tax | | 2.5% | | 2.5% | | |
| State and local risk premium fall | | -10% | | -5% | | 5% |

¹⁰¹ While we argue that MAUCRSA lowers, but does not eliminate, the threat of federal prosecution for licensed manufacturers, here we argue that federal law enforcement resources may be focused on the unlicensed manufacturers.

| | | | | | | |
|------------------------------|-----|--|----|--|--|----|
| Other state requirements | | 12.5% | | 12.5% | | |
| <i>Net impact</i> | 15% | 28.8% | | 25% | | 5% |
| CDPH Regulated Market | | | | | | |
| Product safer | 5% | | 5% | | | |
| Federal risk premium falls | | -5% | | -5% | | 5% |
| Local licensing | | 2.5% | | 2.5% | | |
| CDPH regulations | | 4.3% concentrates, 4.4% edibles, 4.5% topicals | | 4.3% concentrates, 4.4% edibles, 4.5% topicals | | |
| <i>Net Impact</i> | 5% | 1.8% concentrates, 1.9% edibles, 2.0% topicals | 5% | 1.8% concentrates, 1.9% edibles, 2.0% topicals | | 5% |

Economic Impacts

Impact on Manufacturer Sales

The table below shows the total sum of all manufactured cannabis markets (concentrates, edibles, and topicals) and all segments (adult-use, medicinal, and unlicensed) in three different periods. The Appendix provides more detail, including price changes, by individual market and segment. The first period is the “current” period and the numbers given were reported earlier. The “baseline” period includes the impact of the legalization 2018 split and all the non-CDPH regulations as described above. The “CDPH regulations” period shows the sum total of all market impacts and is our best estimate of what the sum of the markets will look like after implementation of all MAUCRSA regulations. The last two columns of each table show the

percentage changes. The “Baseline to CDPH Change” shows the marginal impact of CDPH and local regulations compared to the baseline. We expect the quantity of manufactured cannabis products to rise by 0.5 million grams of oil due to CDPH regulations. We also expect retail dollar sales to rise by \$217 million and manufacturer sales to rise by \$87 million due to the CDPH regulations.¹⁰² The impact of CDPH regulations on the markets is fairly modest. The half million gram increase in oil quantities is less than 2 percent of the baseline amount. Retail sales rise by about 9 percent, which means that on average prices rise by about 7 percent.¹⁰³ Thus, CDPH regulations impact prices more than the quantity of manufactured cannabis.

Table 18 below shows that manufacturer sales summed across the concentrates, edibles, and topicals markets and across the medicinal and unlicensed segments totals \$611 million in 2017. After the adult-use market is formed, and after all non-CDPH regulations are applied such as the cultivation tax, our simulations show that the sum of all manufacturer sales rises to \$960 million. Once CDPH regulations are applied, our simulations show that the sum of manufactured cannabis sales across all markets and across the adult-use, medical, and unlicensed segments rises to \$1,047 million or about \$1 billion.

Table 18: Sum of All Manufactured Cannabis Markets and All Segments in Three Periods

| | Current (2017) | Baseline | CDPH Regulations | Baseline to CDPH Change | Current to CDPH Change |
|---------------------------|-----------------------|-----------------|-------------------------|--------------------------------|-------------------------------|
| Grams of oil | 24.2 million | 27.0 million | 27.5 million | 0.5 million | 3.3 million |
| Manufacturer Sales | \$611 million | \$960 million | \$1,047 million | \$87 million | \$436 million |
| Retail Sales | \$1,527 million | \$2,400 million | \$2,617 million | \$217 million | \$1,090 million |

While CDPH regulations may have a small impact, total MAUCRSA regulations have a larger impact. The “Current to CDPH Change” shows how the markets are predicted to look post regulation compared to today. The 3.3 million increase in grams of oil is an almost 14 percent increase over the current amount. CDPH regulations contribute about 2 percentage points to the increase, with about 12 percentage points contributed by the process of legalization and non-CDPH regulations. The \$1,090 million increase (71 percent) in sales compared to today is mostly due to non-CDPH regulatory effects. On average, prices that consumers pay (including

¹⁰² Manufacturer and retailer sales rise by the same percent, since we are assuming a constant retailer margin.

¹⁰³ Since retail sales is the product of quantity times price, then one plus the sales growth rate equals one plus the quantity growth rate times one plus the price growth rate (g). Solving for (g) $(1.09) = (1.02) * (1+g)$ yields $g = 0.07$ or 7 percent.

taxes) rise by about 50 percent.¹⁰⁴ It is not clear how manufacturers and retailers will pass along taxes to consumers, but in the long-run, the experiences of Colorado and Washington indicate that before tax prices may actually fall.¹⁰⁵

In the first year or so of legalization, however, inventories and prices may fluctuate as the industry figures out how to comply with regulations. Because of this, we look at the on-going costs and impacts of regulations a year or so after implementation rather than explicitly model the dynamics after legalization. Our model is a medium-run model and we believe that regulations will be implemented, and industry will feel the effects, quickly after initial adjustments. Our focus is not to look very far ahead into the long-run as the market evolves. We could expect to see prices fall in the long run, as firms experience cost savings through vertical integration and new technology that will be developed, once adult-use manufacturing is legal in California. These long run effects, however, don't affect our conclusion about the impact of CDPH regulations.

The Creation or Elimination of Jobs within the State

The CDPH regulatory changes have increased the quantity sold of manufactured cannabis overall by half a million grams of oil across all markets and segments.¹⁰⁶ That will lead to more manufacturing and greater spending on intermediate goods by manufacturers, as well as more workers hired. The key input into IMPLAN is the value of the increased manufactured cannabis, which we estimate to be \$22.7 million.¹⁰⁷ IMPLAN calculates direct, indirect, and induced effects on the California economy. The direct effects stem from the spending by cannabis manufacturers to meet the increased demand for their product. The indirect effects stem from spending by companies that must produce more intermediate goods to meet the demand from cannabis manufacturers. Induced effects originate with household spending due to the additional income that workers and proprietors receive. All three effects are combined into the total effect. The table below shows these effects. Looking at the Employment column, the direct effect of the new production is an additional 114 new workers.¹⁰⁸ Businesses that produce goods for cannabis manufacturers see an increase of 117 workers, and workers and proprietors earn extra income and their spending supports an additional 82 workers. The total effect is an

¹⁰⁴ Solving for (g) in $(1.71) = (1.12) * (1+g)$ yields $g = 0.53$ or 53 percent.

¹⁰⁵ The supply and demand curves in our model are inelastic and with the increase in demand due to legalization, the equilibrium price will rise.

¹⁰⁶ We consider the impact of overall manufactured cannabis production, including the unlicensed segment, because we want to report economy-wide impacts.

¹⁰⁷ Manufacturer sales increase by \$87 million, but this is largely due to price increases. IMPLAN assumes prices are fixed, so for each market segment, we value the increase in manufactured cannabis oil by the average of the manufacturer prices (that the retailers pay) before and after the regulations. We then sum together the market segment values to get an overall change in manufacturer sales.

¹⁰⁸ This number is based on our revised estimate of output per full time equivalent worker as described above.

extra 312 workers hired in California as a result of the greater cannabis oil production due to the proposed CDPH regulations.

Table 19: Impacts from Increased Manufactured Cannabis Production in Medicinal, Adult-use, and Unlicensed Segments Due to Proposed CDPH Regulations, Ongoing*

| Impact Type | Employment | Labor Income | Total Value Added | Output |
|-----------------------|------------|---------------------|---------------------|---------------------|
| Direct Effect | 114 | \$6,810,000 | \$14,755,000 | \$22,700,000 |
| Indirect Effect | 117 | \$8,551,687 | \$14,319,335 | \$24,075,024 |
| Induced Effect | 82 | \$4,516,043 | \$7,995,089 | \$13,450,019 |
| Total Effect** | 312 | \$19,877,731 | \$37,069,424 | \$60,225,043 |

*Estimated using IMPLAN software and data sets. See text for discussion.

**Total may not equal sum of effects due to rounding.

The Creation of New Businesses or the Elimination of Existing Businesses within the State

The initial increase in spending on manufactured cannabis is \$22.7 million which leads to indirect spending on suppliers of \$24 million. The workers and owners in manufactured cannabis and supplying firms earn greater incomes and this induces them to spend \$13.4 million additional in the economy. Additional spending across the economy sums to \$60 million. IMPLAN estimates the top ten industries affected by the increase in demand for manufactured cannabis are cannabis cultivators, wholesale trade, all other crop farming, owner-occupied dwellings, real estate, support activities for agriculture and forestry, management of companies and enterprises, food product machinery manufacturing, monetary authorities and depository credit intermediation, and hospitals.

Manufacturers we spoke with believe that in the next two to three years there will be an increase in demand, but also an increase in the number of manufacturers. We believe that small companies may be at a disadvantage as industry consolidation occurs. One factor mitigating the elimination of small manufacturers is the opportunity to produce for the illegal export segment, where being a smaller, less visible business is often an advantage. Overall, we largely see the new regulations moving existing manufacturers in the unlicensed segment to the adult-use segment. We estimate that approximately 100 new firms will be created in the manufactured cannabis industry as a result of the increase of \$22.7 million in manufacturer sales.¹⁰⁹

¹⁰⁹ We assume sales per cannabis manufacturer of between \$200,000 and \$300,000. If sales are \$225,000 per manufacturer, then the increase in sales of \$22.7 million leads to 100 new firms in cannabis manufacturing (\$22,700,000 divided by \$225,000 is about 100)

The Competitive Advantages or Disadvantages for Businesses Currently Doing Business within the State

Cannabis manufacturers and their suppliers currently doing business within the state should continue to enjoy competitive advantages given their experience in the industry. Small businesses will find the new fixed costs of regulation challenging. In general, since the new regulations apply to all manufacturers, we do not see the proposed regulations as creating either competitive advantages or disadvantages for current businesses within the state.

There may be an increase in market concentration, with fewer but larger manufacturers than exist today. This may be going on to some degree in states that have already legalized, but in general, data from the other states does not indicate a significant decrease in the number of licensees. We simply don't have a good sense of the degree of consolidation to expect. Later, in the alternatives section, we present a scenario where fewer, but larger, manufacturers obtain licenses.

The Increase of Investment in the State

The table above shows that manufacturers will directly create \$14.8 million in additional value added to the economy, which is the increase in Gross State Product (GSP) as a result of the initial increase in sales. These direct effects will lead to more indirect spending by businesses that supply cannabis manufacturers. Workers that earn extra income, both in the cannabis manufacturing sector and in affected industries, will spend this income, which will create additional induced demand in the economy. Labor income will rise by \$19.9 million. Overall, we predict that California GSP, or Value Added, will permanently rise by \$37 million in future years as a result of the regulations.

The Incentives for Innovation in Products, Materials, or Processes

We believe the proposed regulations, by reducing the risk premium, will encourage new businesses to form, and this will lead to innovation. As an example, manufacturers we spoke with told us that the concentrate market is evolving. In the past, a failed harvest due to mold or mildew could not be sold. This failed harvest would sometimes be up to 30 percent of the total outdoor harvest. Cultivators are now producing oil concentrates since the mold can sometimes be removed in the manufacturing process. As another example, there is no industry standard for concentration and the industry will likely create new technology in order to sharpen delivery consistency.

Benefits of Regulations

Categories and Measurement

Proposed regulations improve health benefits through requirements regarding packaging and labeling, facility compliance, and adulterated cannabis product restriction.¹¹⁰ Overall, the result should be a cleaner and safer product that results in reducing harmful toxins in manufactured products, minimizing the potential for overdoses, has the potential to reduce driving while impaired, and prevent foodborne illnesses. There is evidence that more cannabis consumption will lead to less alcohol consumption and, therefore, fewer alcohol-related driving accidents.¹¹¹ There is not much evidence of disease outbreaks associated with cannabis, although at least one outbreak has happened.¹¹² There is also evidence that recalls of manufactured products will not be a rare event, since there have been over 30 recalls of cannabis edibles in Denver since July 2015.¹¹³ We believe the realized health benefits can be significant, but we are aware of no systematic measure of potential health benefits from cannabis regulation.

Regulations also improve public safety. Closed loop requirements for oil extractors can reduce fires and explosions from production accidents using volatile compounds. However, there is little statewide direct data on accidents related to cannabis oil extraction. A recent HIIMR survey of dispensary patients found that 20 out of 48 people responded “yes” to the question, “Have you or someone you know been injured while making dabs?”¹¹⁴ All but one of these people said that the injury was “got burned,” while a few other injuries were also indicated. At the same time, 14 out of 48 people responded “yes” to the question, “Do you personally know of any items or property that was accidentally damaged while making dabs?” Eleven of these people reported that the damage was fire, while eight said the damage was an explosion.¹¹⁵ A draft Eureka City ordinance in 2016 contains some relevant information about fire hazards.¹¹⁶ It describes how butane gas used in making concentrated cannabis oil can collect and ignite. It reports that “injuries from butane hash oil explosions account for eight to ten percent of severe burn cases.” The local fire district lists ten fire incidents from 2012 to 2016 at cannabis extraction sites using butane solvent and finds fire suppression costs total \$35,000 and property damages total over

¹¹⁰ There is a long history of regulating the manufacture of products for human consumption. For example, the U.S. Food and Drug Administration regulates food manufacturing, dietary supplements manufacturing, and medicine manufacturing, among other products

¹¹¹ See http://legacy.iza.org/en/webcontent/publications/papers/viewAbstract?dp_id=6112

¹¹² See <http://www.nejm.org/doi/pdf/10.1056/NEJM198205273062101>

¹¹³ See <https://www.denvergov.org/content/denvergov/en/environmental-health/public-health-inspections/food-safety-section.html>

¹¹⁴ “Dabs” is a popular name for cannabis concentrates. Dabs are small doses of the wax-like material produced from extracted oil. See Eschker and Gold (2016) “Medicinal Marijuana Patient Survey,” for preliminary findings.

¹¹⁵ People could give multiple responses to the question, “What was the damage?”

¹¹⁶ See <https://legistarweb->

[production.s3.amazonaws.com/uploads/attachment/pdf/31314/Agenda_Summary_Butane_Ordinance.pdf](https://legistarweb-production.s3.amazonaws.com/uploads/attachment/pdf/31314/Agenda_Summary_Butane_Ordinance.pdf)

half a million dollars.¹¹⁷ CDPH's proposed regulations will establish safety standards for manufacturers conducting extraction through closed loop extraction systems.¹¹⁸ Once again, we are aware of no systematic measure of potential safety benefits from cannabis regulation.

We estimate that ongoing regulatory costs total \$138 million per year. Our simulations show that the impact of CDPH regulations is to increase retail sales \$217 million ongoing (with a total lifetime statewide benefit of \$7.2 billion¹¹⁹), meaning that consumers of manufactured cannabis products are willing to pay \$217 million per year for the benefits derived from the proposed regulations. Consumer willingness to pay is significantly more than our estimate of regulatory costs. Indicating that potential benefits from the proposed regulations outweigh added monetary costs.

Geographic Distributional Effects

Survey results indicate that cannabis manufacturers are currently concentrated in rural Northern California counties. We surveyed manufacturers and asked where they manufacture medicinal cannabis.¹²⁰ They were allowed to list more than one county. The two largest locations for manufacturing were Humboldt and Sonoma Counties, with 16 percent of respondents reporting manufacturing in both of these locations. Other counties that reported were San Diego (nine percent); Alameda, Los Angeles, and Mendocino (seven percent each); Riverside, Sacramento, and Shasta (four percent each); Contra Costa, El Dorado, Orange, San Luis Obispo, and Trinity (three percent each); and, Calaveras, Kern, Lake, Marin, Monterey, San Bernardino, San Francisco, and Tehama (one percent each).

We also asked manufacturers to indicate which types of business best describe their operations, and they were allowed to give multiple responses. Forty-three percent of manufacturers indicated they were also cultivators and twelve percent indicated they were also dispensaries. This evidence suggests that manufacturers also cultivate to a large degree, and their location is relatively more similar to cultivators than dispensaries.

In contrast, previous work shows that the distribution of dispensaries by counties is relatively located in major population areas with Los Angeles having 28 percent of dispensaries.¹²¹ Other counties with dispensaries include San Diego (14 percent); Riverside and Orange (7 percent each); Alameda (5 percent); Sacramento, Kern, San Bernardino, Santa Barbara, Santa Clara,

¹¹⁷ These costs may not be representative of other cities in California. Eureka has a population of about 27,000.

¹¹⁸ Some extracting businesses will sell to the unlicensed domestic segment or to the illegal out-of-state segment and these will not be obtaining permits under MCRSA.

¹¹⁹ If we assume regulations continue indefinitely and use a real interest rate of 3 percent, then \$7.2 billion = \$217 million / 3%.

¹²⁰ These findings are based on self-reported answers to our survey and may not be representative of manufacturers in general.

¹²¹ See <http://www2.humboldt.edu/hiimr/docs/california%20dispensaries.pdf>

San Luis Obispo, and Santa Cruz (3 percent each); Solano, San Francisco, San Joaquin, Contra Costa, Ventura, and Fresno (2 percent each); and, Marin, Shasta, Humboldt, El Dorado, and Monterey (1 percent each). We believe that consumers that purchase manufactured medicinal cannabis products live where these dispensaries are located.

These geographic differences indicate different benefits and costs of regulation. Current manufacturers that will see profit margins decline and increased competition from new companies are located relatively more in northern rural counties, while consumers that will see gains from falling prices and better regulated products, are located in relatively more urban counties.

Alternatives

Imprinted Warning Label

CDPH considered two alternatives to the draft regulations that made a change in one area of regulation. The first alternative considered is to imprint a warning label to the manufactured product itself, in addition to the other labeling requirements described earlier. This warning label is applied directly to the surface of the product, either by being marked, stamped, or imprinted. Many infused products such as cookies and candies have a surface conducive to printing, stamping, or marking the THC warning symbol, using edible ink. The benefit of an imprinted warning label is that the warning label is still visible even after outside packaging is removed.

For many baked and porous goods, special equipment such as ink jet printers, is needed to apply such a label and costs could be substantial for many small businesses. We found a range of prices between \$65,000 and \$150,000 for a printer that could imprint edible ink on cookies and harder foods, while we found a price range of \$25,000 to \$160,000 for printers for cakes. Ink prices varied between 0.001 cents and two cents per print. For some edible makers, such as chocolate makers, the imprinted warning label requirement means purchasing new molds for their products, with costs that could run into the tens of thousands.¹²² We use a cost per printer of \$65,000 and a cost of new molds of \$15,000. We also assume that eighty percent firms must obtain the relevant equipment, twenty five percent of edible makers need a printing machine rather than a mold, and ten percent new firms enter each year. We estimate initial industry costs to be \$21 million dollars in the first year, as edible makers purchase the required equipment. Ongoing costs are about \$2.3 million per year.

People would not be willing to pay much for imprinted labels if they believe those labels are ineffective. The imprinted label may not be effective for very small children who cannot read and do not realize what the label means. Additionally, the label could still be physically removed. A recent paper shows that while accidental consumption of cannabis by children appears to rise

¹²² See <https://hightimes.com/edibles/thc-warnings-appear-on-colorado-cannabis-edibles/>

after legalizing cannabis, in one hospital, about one-third of cases are due to poor supervision or storage by the adult, and the median age of the child was two years.¹²³ In our discussions with industry insiders, we hear that people over-consume edible cannabis because they consume too much, not because they are unaware that they are consuming cannabis edibles. For these people, an imprinted warning would seem to not be helpful.

We could find no evidence there is additional safety benefits of imprinted labeling beyond the standard labeling requirements which state, "The package shall be child-resistant, which means the package is designed or constructed to be significantly difficult for children under five years of age to open or obtain access to the product contained therein within a reasonable time," and packaging shall not contain ". . . any likeness to images, characters, or phrases that are popularly used to advertise to children." We are aware of no study that estimates the marginal increase in safety from imprinted label requirements. One recent study found that colors, tastes, and marketing products with cartoons may be important for the attraction to cannabis edibles.¹²⁴ Colorado recently passed legislation to make imprinted labels a requirement. However, one study finds that emergency room visit for in-state residents did not increase in the first year of legalization.¹²⁵ Lastly, imprinted labels will reduce the attractiveness of edible products for some consumers, which lowers the demand from those consumers.

We believe that extra benefits of imprinted warning labels would be nonexistent or very small, and we believe people are not willing to pay for such small benefits. We assume that demand for edible cannabis is unchanged after regulation. In our simulations, the effect in the first year of this \$21 million increase in costs is to only increase sales revenue in the edibles market by \$13.5 million. Even after the first year, on an ongoing basis, revenue increases only by \$1.6 million versus an industry cost increase of \$2.3 million.¹²⁶ In both the first year and ongoing, consumers value this alternate regulation less than the cost of the alternate regulation.

Using an imprinted warning label was ultimately rejected because we could find no evidence that imprinted labeling was cost-effective at reducing over-exposure to cannabis.

Background Checks for All Employees

An alternative to a Live Scan requirement for owners with a twenty percent or more financial stake in firms is to require Live Scan background checks for all participants (employees and owners) in a company. Requiring background checks on current employees is a different

¹²³ See <http://jamanetwork.com/journals/jamapediatrics/article-abstract/2534480>

¹²⁴ See <http://lcb.wa.gov/publications/Marijuana/Concerning-MJ-Infused-Edibles-Factors-That-Attract-Children.pdf>

¹²⁵ It appears that out of state visits increased, however. See <http://www.nejm.org/doi/full/10.1056/NEJMc1515009#t=article>

¹²⁶ These costs and benefits are in addition to the estimated regulatory costs of \$138 million and benefits of \$217 million. Summed together, the alternative costs are \$140.3 million and the benefits are \$218.6 million.

consideration than requiring background checks on owners. If owners with more serious past criminal activity are not allowed to own businesses, then the remaining businesses may be more compliant with regulations.

Pre-employment background checks for employees are designed to help the employer identify better qualified job applicants, reduce theft and job turnover, and increase productivity. But we believe these benefits of background checks are less likely to materialize in this case. First, current employees must be competent employees: otherwise they would no longer be working at the firm. One could imagine that background checks on current employees may not reveal much relevant information, at least as it relates to worker productivity. Second, the cannabis industry has had only a quasi-legal status, and employers would have been particularly hesitant to hire troublesome workers.¹²⁷ It is likely that cannabis workers were pre-screened through shared acquaintances and others who would vouch for their trustworthiness. We do not believe that any additional benefits will be realized by requiring background checks for all employees.¹²⁸

The draft regulations indicate the CDPH will only reject those with a record of serious crimes such as violent felonies (e.g., homicide or assault) and providing cannabis to a minor. We assume that CDPH will follow procedures similar to Federal Law and safeguards from the U.S. Equal Opportunity Employment Commission.¹²⁹

If CDPH staff had to check the background of all workers employed in manufacturing cannabis, we estimate the caseload to be about 12,000 workers. Some employee background checks will necessitate detailed review. We could find no direct estimate of typical criminal conviction rates for workers employed in cannabis manufacturing or workers in California in general.¹³⁰ Nationally, some estimate that about 30 percent of adults have an arrest that can show up in a criminal records search.¹³¹ Thirty percent of 12,000 is 3,600 workers, which we take to be the upper limit for how many California cannabis workers would require a detailed review. We assume that staff costs are approximately three full-time staff at a salary of \$120,000 each

¹²⁷ As described above, cannabis manufacturers could not get local permits until fall 2016 under AB 2679. See <http://www.eastbayexpress.com/LegalizationNation/archives/2016/10/04/california-medicinal-marijuana-extract-makers-get-historic-protections>

¹²⁸ The economic justification for regulation is usually that regulations will improve upon the market outcome. Cannabis manufacturers may currently conduct background checks, and it is likely that some do because it is worth the expense, but we are not aware of a published report on the percent that conduct checks. Other manufacturers will not believe that the effort and cost of a background check will improve the quality of their workforce. We cannot think of a market failure that mandatory background checks would address.

¹²⁹ See https://www.eeoc.gov/eeoc/publications/background_checks_employers.cfm

¹³⁰ See <http://www.cbpp.org/research/full-employment/strategies-for-full-employment-through-reform-of-the-criminal-justice>

¹³¹ See http://www.cbpp.org/research/full-employment/strategies-for-full-employment-through-reform-of-the-criminal-justice#_ftnref17

including benefits per year to evaluate background checks needing detailed review, to handle appeals of denials, and to generally administer background check compliance.

Extending background checks to employees increases the number of individuals in each firm subject to a background check from about three owners to three owners plus four employees. Denying employment also limits the talent pool of workers just as it does with owners. We estimate that background checks on all employees will increase costs for the industry by \$6.1 million in the first year and \$4.1 million per year thereafter. Adding this cost to the extra costs of CDPH staff time yields total costs of about \$6.5 million in the first year and \$4.5 million per year thereafter.¹³²

In addition to costs, there are concerns over the distributional impacts of background checks. Stakeholders at the pre-regulatory meetings identified background checks as a key area of concern, especially for small manufacturers. Many cannabis manufacturers are relatively small, and we find many employ about three to four people with annual sales of \$50,000 to \$100,000. Small firms are less likely to use background checks.¹³³

We believe that people do not find additional benefits of employee background checks and we assume that demand for manufactured cannabis is unchanged with this alternate regulation. In our simulations, the effect in the first year of this \$6.5 million increase in costs is to only increase total manufactured sales revenue \$5.8 million. Even after the first year, on an ongoing basis, sales revenue increases only by \$2.2 million versus an industry cost increase of \$4.5 million.¹³⁴ In both the first year and ongoing, consumers value this alternate regulation less than the cost of the regulation.

Requiring background checks on all employees was ultimately rejected because we could find no evidence that such a requirement had benefits that were greater than costs.

Uncertainty about the Number of Firms and License Fees

As discussed above, there is a great deal of uncertainty about the number of cannabis manufacturing firms in California, which was assumed to be 3,000. There is also uncertainty about the number of firms that will decide to comply with regulations and seek a license. These amounts will become clearer a few years after MAUCRSA has been implemented. If our

¹³² One additional cost is that some employees will hire an attorney to purge their criminal records, as allowed under AUMA.

¹³³ Forty-eight percent of firms sized 1-99 employees conducted criminal background checks on all employees, compared to 69 percent of firms sized 100-499 as reported in <http://www.esrcheck.com/wordpress/2012/07/25/shrm-background-check-survey-finds-nearly-70-percent-of-organizations-conduct-criminal-checks-on-all-job-candidates/>

¹³⁴ These costs and benefits are in addition to the estimated regulatory costs of \$138 million and benefits of \$217 million. Summed together, the alternative costs are \$142.5 million and the benefits are \$219.2 million.

estimates about the number and distribution of firms are incorrect, then it will ultimately impact the license fee structure.

We consider two alternate scenarios that change the number or distribution of firms. In the first, the number of firms ranges between one third higher and one third lower than 3,000. In the second scenario, the relative number of large firms grows in comparison to smaller firms. We then present possible license fee structures that maintain that same aggregate total fee revenue at \$29 million. For these new fee structures, we scaled the original fees up or down by the same percent in each tier. These scenarios are meant to capture the degree of uncertainty in the SRIA estimates and not meant to state what actual CDPH fees will be should these scenarios come true.

If the number of firms is greater than we expect, then CDPH costs can be spread over more licenses.¹³⁵ Below we show the impact of 4,000 firms and 2,000 firms obtaining a license. In the former case, fees can decrease 25 percent and result in the same collected fee revenue. In the case of 2,000 firms, fees will need to rise by 50 percent in order to maintain the amount of revenue collected.

**Table 20: Ongoing Annual Fees by Tier and Projected Revenue,
Alternative Scenario: 4,000 Firms**

| Tier Based on Gross Revenue | Alternative Annual Fee | Estimated Number of Licensees | Projected Revenue Ongoing |
|------------------------------------|-------------------------------|--------------------------------------|----------------------------------|
| \$0-100,000 | \$1,500 | 1400 | \$2,100,000 |
| \$100,001 - 500,000 | \$5,625 | 1200 | \$6,750,000 |
| \$500,001- 1,500,000 | \$11,250 | 920 | \$10,350,000 |
| \$1,500,001 – 3,000,000 | \$18,750 | 408 | \$7,650,000 |
| \$3,000,001 – 5,000,000 | \$26,250 | 54 | \$1,417,500 |
| \$5,000,001 – 10,000,000 | \$37,500 | 14 | \$525,000 |
| \$10,000,001 + | \$56,250 | 4 | \$225,000 |
| Total | | 4000 | \$29,017,500 |

¹³⁵ Some CDPH costs will rise with the number of firms, of course. Our alternative fee structure should be considered an upper bound to the change in annual fees that may result.

**Table 21: Ongoing Annual Fees by Tier and Projected Revenue,
Alternative Scenario: 2,000 Firms**

| Tier Based on Gross Revenue | Alternative Annual Fee | Estimated Number of Licensees | Projected Revenue Ongoing |
|------------------------------------|-------------------------------|--------------------------------------|----------------------------------|
| \$0-100,000 | \$3,000 | 700 | \$2,100,000 |
| \$100,001 - 500,000 | \$11,250 | 600 | \$6,750,000 |
| \$500,001- 1,500,000 | \$22,500 | 460 | \$10,350,000 |
| \$1,500,001 – 3,000,000 | \$37,500 | 204 | \$7,650,000 |
| \$3,000,001 – 5,000,000 | \$52,500 | 27 | \$1,417,500 |
| \$5,000,001 – 10,000,000 | \$75,000 | 7 | \$525,000 |
| \$10,000,001 + | \$112,500 | 2 | \$225,000 |
| Total | | 2,000 | \$29,017,500 |

We next consider a distribution of relatively more larger firms. There are at least three reasons why a greater number of larger firms might seek licenses than we have assumed. First, we suspect there will be some degree of consolidation in the industry as manufacturer size grows to achieve economies of scale, although we have little way to guess what the distribution by size will look like. Second, Type 6 and Type 7 licenses, in the adult-use and medicinal segments, will be able to produce edibles and topicals in their respective segments. The distribution of firms that both extract and produce edibles and topicals is unknown. We have assumed that manufacturers specialize and remain in distinct areas of production. To the degree that manufacturers are now more likely to extract oil as well as produce edibles and topicals, we would expect relatively bigger firms to apply for Type 6 and 7 licenses. Third, smaller firms may be more likely to remain unlicensed due to compliance costs being relatively greater for them compared to sales.

Assuming that total sales stays constant even if the distribution of firm size shifts, there will be about 25 percent fewer businesses in total if the number of larger firms increases. Annual fees need to rise by ten percent at all tiers in order to reach the same collected revenue.

**Table 22: Ongoing Annual Fees by Tier and Projected Revenue,
Alternative Scenario: Relatively More Large Firms**

| Tier Based on Gross Revenue | Alternative Annual Fee | Estimated Number of Licensees | Projected Revenue Ongoing |
|------------------------------------|-------------------------------|--------------------------------------|----------------------------------|
| \$0-100,000 | \$2,200 | 688 | \$1,513,600 |
| \$100,001 - 500,000 | \$8,250 | 662 | \$5,461,500 |
| \$500,001- 1,500,000 | \$16,500 | 527 | \$8,695,500 |
| \$1,500,001 – 3,000,000 | \$27,500 | 296 | \$8,140,000 |
| \$3,000,001 – 5,000,000 | \$38,500 | 92 | \$3,542,000 |
| \$5,000,001 – 10,000,000 | \$55,000 | 21 | \$1,155,000 |
| \$10,000,001 + | \$82,500 | 7 | \$577,500 |
| Total | | 2,293 | \$29,085,100 |

Fiscal Impacts

Local Government

MAUCRSA requires all license applicants show proof of compliance with local laws as a condition to receiving their state licenses. Local jurisdictions are authorized to develop a permitting process for cannabis businesses, but are not required to do so. In the absence of a cannabis-specific permit, a simple letter of authorization will suffice. This workload is expected to be absorbed by existing local government personnel and resources or expected to be covered by local license fees and taxes. We estimate local fees, taxes, and regulatory costs as part of the CDPH regulatory costs.

State Government

CDPH is appropriated \$12.8 million dollars in expenditure authority in State Fiscal Year 2017-18. The department will use these funds to promulgate regulations, employ staff to conduct licensing and inspection activities, and to develop a licensing system to receive and review

applications. There are also anticipated legal costs that CDPH will incur to enforce the provisions of MAUCRSA, specially related to license denials and administrative actions.

An unknown number of license applications will be denied by CDPH. We assume that a high percentage of those denials will be appealed. Most appeals will take place at the administrative level, a smaller percentage will appeal to the Cannabis Appeals Board, and an even smaller number will continue appeals through the courts.

CDPH also anticipates that some licensees will be subject to some form of corrective action or enforcement action. In the event CDPH must embargo cannabis products or issue an administrative fine, some licensees will seek to appeal that decision. CDPH does not anticipate there will be a large number of such cases as most licensees will work with the Department to correct any deficiencies. CDPH estimates that there will be no more than ten administrative appeals per year. The costs of administrative appeals from any enforcement actions will include: (a) staff time, including approximately .5 PY of an Administrative Litigation Attorney III (\$99,920); .5 PY of a House Counsel Attorney (\$99,920); .2 PY of an Associate Governmental Program Analyst (\$25,820); and, .1 PY of an Assistant Counsel (\$23,825); and (b) charges from the Office of Administrative Appeals, at approximately \$14,500 per appeal, or \$145,000 total. If the licensee continues to appeal the decision to the Superior Court, CDPH would incur approximately \$50,000 per each appeal for Attorney General Representation. CDPH does not anticipate more than one such appeal to the Superior Court per year. It should be noted that the costs for an administrative appeal to either OAHA or the Superior Court can vary greatly depending on the specific facts of each case, and can be significantly higher than estimated.

CDPH does not expect the proposed regulations will generate any lawsuits independent of a challenge to the underlying statutes themselves, however, if the requirements set forth in statute as implemented by the regulations are challenged, CDPH estimates the costs of defending one such lawsuit as follows: \$100,000 for trial court litigation, plus \$110,000 for any appeals, over the course of three years, for an average of \$70,000 per year. As indicated above, actual litigation costs are always dependent on the specific facts of each case, could vary greatly, and could be significantly more costly than estimated above.

Other State Agencies

CDPH will carry out enforcement of the licensing program. It will also consult and coordinate with the other agencies identified in MAUCRSA and elsewhere to carry out administration and crafting policy. No other significant direct or indirect impacts on other state agencies due to MAUCRSA regulations have been identified.

Appendix 1: Financial Survey

Scope

We limited our study exclusively to cannabis manufacturing activities. Cannabis manufacturing activities are typically characterized as relying heavily upon cannabis or cannabis extracts as a raw material. Marijuana is essentially converted into either a standard (homogenous) or boutique product. The process of converting this raw material into a usable form typically involves either pressurizing or utilizing chemicals (most commonly CO₂ or butane, although other extractions methods are used) to convert an inactive substance into an active ingredient. The product is then typically further refined, packaged, and distributed. We identified six possible categories of cannabis manufacturing that appear to be most prolific: edibles, concentrates, vapor pens, beverages, topicals, and capsules. We also considered flowers and pre-rolled cannabis cigarettes, which are not subject to CDPH regulations.

Data Collection

A written questionnaire of 29 questions, as well as an Excel template containing a chart of accounts appropriate for the cannabis industry, was sent to each participant to help facilitate the data collection process. As an additional measure, a sociologist and an anthropologist were deployed within the field to build rapport, answer questions, and verify the accuracy of disclosures of research participants. After the interview was conducted, an accounting expert compiled and benchmarked the data. If any obvious errors or omissions became apparent, efforts were undertaken to ask follow-up questions of the research participant. In most cases, participants were willing to help clarify their responses.

Since industry accounting standards are yet to have been developed for the cannabis industry, the data provided by particular organizations had to be standardized before the information could be compared to another business. In this process, the research team had to make certain assumptions about the appropriate classification of costs. For instance, did labor relate to the production of goods or back-office administrative functions? In making these judgments, we relied upon the informant's response to our questionnaire. While these applied assumptions do have an effect on the presentation of the financial statements and corresponding analytics, we attempted to be consistent in the application of these assumptions and disclose all alterations where appropriate.

Limitations

The organizations that participated in this study differ from traditional business enterprises in several important respects. First, few withhold income tax, payroll tax, or worker's compensation and there is little incentive to adhere to standard record retention practices.

Second, none of the organizations directly rely on traditional banking institutions.¹³⁶ Therefore, these entities have not been subject to audits or similar reviews. Third, the industry is still emerging and generally accepted accounting procedures within the cannabis industry are lacking.¹³⁷ Given the absence of any suitable standards, our research team did not take any action to independently verify or audit the information furnished, nor did the accountant serving on the research team actively participate in the site interview. Only obvious errors or omissions were pursued for resolution. Furthermore, we only received three completed surveys, and a sample of three should not be considered representative of an entire population. Given these constraints, the information represented in this study is our best attempt to create a picture of where the industry stands today, but should be viewed with a degree of caution due to data limitations.

Participant Characteristics

Many cannabis enterprises are small to medium operations. As such, our sample group was dominated by businesses with gross revenues and total assets ranging from \$500,000 to \$1,500,000. Although we were targeting a broad range of cannabis manufacturing activities, our sample essentially consisted of businesses focusing on extraction and concentrate processing. In fact, about 90% of all sales of our sample group focused on these manufacturing activities. Survey participants produced approximately 150,000 grams of extracts/distilled oil annually. Although our sample was dominated by concentrate manufacturers, this segment appears to be the biggest category of manufacturing activity in California. The University of Pacific's Center for Business and Policy Research (CBPR) estimates Cannabis processing market within Sacramento to be 62% extractor activity and 38% product activity. The vast majority of output from extractors (90%) is sold to retailing operations.¹³⁸ The remaining 10% of extractors' output is assumed to be sold to product manufacturers (CBPR, p. 24). Consequently, similar findings were observed in our study. With that said, one participant also produced edibles, topicals, and other cannabis products, but these activities represented a much smaller segment of their overall sales activity (less than 10%). Some industry experts believe infused products are capturing between 10% and 12% of the market currently (Zamarra, 2013, p. 10).¹³⁹ The businesses surveyed in this study would most likely be classified as Type 6 or 7 licensees as contemplated under proposed CDPH regulations.

Before requesting financial data, our survey participants were asked to describe the general characteristics of their financial control and reporting environment. All of the participants utilized QuickBooks as their primary accounting system. Often, QuickBooks was supplemented with a

¹³⁶ Most held bank accounts through credit unions vis-a-vi a nonprofit "pass-through" entity.

¹³⁷ The Financial Accounting Standards Board, AICPA, and California Board of Accountancy have yet to issue any formal guidance relating to specific industry-specific standards.

¹³⁸ http://www.pacific.edu/Documents/school-business/BFC/CannabisStudy/Sacramento%20Area%20Legal%20Cannabis%20Sector%20Impact%20Study_2016_10_12.pdf

¹³⁹ <http://lcb.wa.gov/publications/Marijuana/BOTEC%20reports/5b-Modelling-Marijuana-Businesses-Final.pdf>

secondary system, like Excel, SOS Inventory, or Insightly, for specialized recordkeeping activities. Some enterprises had attempted to integrate these traditional financial applications with specialized cannabis or extraction software. While none of the enterprises prepared operating budgets, all enterprises had attempted to deploy cost accounting best practices, such as activity-based or process costing. All of the businesses operated on a standard calendar year basis and relied on pass-through entities with accounts at local credit unions to manage cash.

The enterprises participating in our study appeared to be making a good faith attempt to maintain and improve their accounting records. For example, all of the businesses relied on the service a professional bookkeeper and had attempted to apply full accrual accounting principles. For these reasons, all of the business felt their financial data was “reliable” or, in some cases, “very reliable.” With that said, our research team discovered a disconnect between the perceived quality of the research participant’s data and actual adherence to U.S. GAAP. For example, the following deficiencies were observed: capital assets were not depreciated, manufacturing overhead was not allocated to products, direct labor accounted for outside of cost of goods sold, and owner’s distributions were not accounted for properly. We attribute these reporting deficiencies to a general lack of awareness to accounting standards and the absence of a certified public accountant in auditing or reviewing business records. As a consequence, several adjustments had to be made to properly classify financial data before disclosing the information contained in this report.

Qualitative Responses

In addition to supplying financial data, our survey participants were asked a series of questions about the effect Proposition 64 will have on their firm. The following highlights some of the key observations derived from this activity. With respect to the number of cannabis manufacturers, one respondent answered that the measure will encourage clients to get distribution licensing to build their own brands, but this will also have the effect of reducing manufacturing competition within the market. Another participant concurred that the measure will reduce the number of legal producers and, in some cases, turn cannabis manufacturers toward the illicit market, due to the higher operating costs stemming from taxes and regulations.

Respondents felt that Proposition 64 will increase industry production due to opening new products and markets. However, they cautioned that lots of venture investor capital will enter into the market based on speculation, which could lead to irresponsible production and market bubbles. Some feared large corporations are likely to take over many of the smaller operators. With respect to manufactured product prices, the participants felt taxes and regulations will drive prices up, regardless of whether the price of raw cannabis goes down. However, the extent to which prices climb will be largely influenced by the nature of the regulations. One participant indicated a preference of encouraging the grower to a pay a cultivation tax and allow the manufacturer to take the untrimmed plant, in essence flowers plus shake, tax-free. Several cautioned against the state setting tax rates too high or allowing counties, municipalities, and

special districts to impose additional excise taxes.

Financial or tax compliance regulations that the manufacturers expect having the most difficulty complying with included fire and food safety standards. Participants felt many safety upgrades would be needed for solvent-based extraction activities and to comply with FDA standards. Several business owners feared the health regulations may be too strictly enforced, thereby limiting producer ability to offer other suitable by-product alternatives like soft-drinks that water-down cannabis infusion. One respondent intended to stay on the medicinal side of the dual system stating "Prop 64 will support 215 rights, but does not protect 420 dispensary rights." Despite these reservations, survey participants were cautiously optimistic about the future.

Outside of Proposition 64 concerns, manufacturers also commented on their recordkeeping concerns. The most significant self-identified accounting challenges these businesses faced included dealing with contaminated or spoiled product that did not meet quality standards. Many businesses felt this could lead to significant business losses. Several respondents cited inventory control, chain of custody, and related tracking issues as being a significant challenge. Other basic internal control deficiencies included problems with cash collection and control. Respondents also noted the manufacturer's dual entity structure makes basic bookkeeping activities quite difficult.

Findings

While financial statements are critical towards any effort to **assess** the financial condition and viability of a business enterprise, they do not lend insights into where the businesses are specifically allocating resources. With this aim in mind, we attempted to break down material, labor, and overhead costs. The table below compares the distribution of material and overhead costs of our sample with the findings of a similar study analyzing California cannabis manufacturing costs conducted by the CBPR. Our study and CBPR find, outside of labor costs, Cannabis extracts are the most significant direct expense of Cannabis manufacturing activities. In fact, our study finds that acquiring trim, cannabis oil, and similar raw materials derived from marijuana plants to be even more costly than originally forecasted, as much as 45% of all operating costs within this segment of expense categories. If shake is used, material costs tend to be slightly lower. Other supplies and materials, such as solvents or CO2, also represent a significant cost driver. Our research sample appeared to more heavily depend on cannabis inputs into their manufacturing activities and spent a greater share of resources on testing, utilities, and equipment when compared to the CBPR sample.¹⁴⁰

Table A1: Allocation of Direct Material and Overhead Costs

¹⁴⁰ The CBPR study suggests their sample of cannabis manufacturers spent more resources on packaging activities and management consulting services.

| | <i>CBPR</i> | | |
|---|----------------------|-------------------|-------------------|
| | <i>Manufacturers</i> | <i>Extractors</i> | <i>This Study</i> |
| <i>Cannabis sector inputs</i> | | | |
| Cannabis/Cannabis extracts | 18% | 53% | 45% |
| Other cannabis products | 1% | 0% | 0% |
| <i>Cannabis sector services</i> | | | |
| Cannabis testing | 0% | 4% | 2% |
| Cannabis transportation | 7% | 6% | 1% |
| <i>Advertising / Promotion</i> | | | |
| Advertising, public relations, and related services | 2% | 5% | 0% |
| <i>Costs of premises</i> | | | |
| Newly constructed commercial structures | 0% | 1% | 0% |
| Maintained and repaired nonresidential structures | 1% | 0% | 7% |
| <i>Equipment</i> | | | |
| Valve and fittings, other than plumbing | 1% | 1% | 6% |
| Air conditioning, refrigeration, and warm air heating equipment | 0% | 1% | 0% |
| <i>Insurance services</i> | | | |
| Insurance | 1% | 1% | 0% |
| <i>Packaging</i> | | | |
| Packaging | 9% | 15% | 1% |
| <i>Professional services</i> | | | |
| Management consulting | 6% | 1% | 3% |
| Legal services | 0% | 1% | 0% |
| <i>Security</i> | | | |
| Investigation and security services | 1% | 1% | 0% |
| <i>Utilities</i> | | | |
| Electricity transmission and distribution | 1% | 1% | 1% |
| Natural gas distribution | 1% | 0% | 1% |
| <i>Other Operational Expenses</i> | | | |
| Other operational expenses | 52% | 9% | 30% |

In addition to examining material and overhead costs, we closely examined labor spending. Our survey results suggest that labor continues to dominate manufacturing activities within the cannabis sector. In relation to labor, material costs are relatively insignificant. The table below reflects the jobs our sample hired for in 2016, as well as the hourly pay rate of an employee within this job class. We compare our results to similar labor rate studies, which appeared to show consistency. Our results suggest a cannabis manufacturing worker can expect to earn between \$41,600 to \$83,200 depending upon experience, specialization, and responsibility. These results appear generally consistent with the CBPR forecast of labor income ranging between \$60,151 and \$72,182 in the Sacramento market. However, we find that some employees may be earning slightly less. Likewise, if an employee is not directly involved in manufacturing activities (e.g., clerical activities), they also tend to earn less money.

Table A2: Hourly pay rates by job class

| | Previous Studies* | This Study |
|---|-------------------|---------------|
| Management | \$41.79 | \$35.00–40.00 |
| Extraction/Lab Technician | N/A | \$20.00–25.00 |
| Operations Manager/Assistant | N/A | \$20.00–25.00 |
| Cleaning Technician | \$13.12 | \$25.00 |
| Chemist | N/A | \$27.50 |
| Agricultural worker | \$10.60–25.00 | N/A |
| Office Manager | N/A | \$27.50 |
| Office Assistant | N/A | \$17.50 |
| *Source Caulkins (2013) ¹⁴¹ and Hawken and Prieger (2014) ¹⁴² | | |

Given the research limitations previously stated and possibility that the small sample of data collected would not be generalizable, we attempted to triangulate our findings with industry benchmarks. We further extrapolated this data to predict profit margins of cannabis manufacturers involved in other manufacturing activities outside of those activities carried out by our research participants. To benchmark our findings we relied on two sources of data: 1) the business almanac of business and financial ratios; and 2) the financial statements of publicly-traded medicinal marijuana manufacturers. The almanac's results are computed from the Department of Treasury, Internal Revenue Service (IRS) statistical sampling of tax returns of all corporations. The advantage of this benchmarking exercise is the ability to compare performance within industry and asset size group of business enterprises across the United States. Two levels of data are presented within the almanac: corporations with and without net income (that is, the entire universe of active reporting corporations) and corporations with net income, a subset of this universe. We elected to utilize the with and without net income sample pool given it was larger and more representative of the current state of the cannabis industry in that many startups are not generating income. Meanwhile, the financial statements of the publicly-traded cannabis companies were downloaded from Mergent.

Due to the uncertain legal status of cannabis products, other products were considered to be better guides as to the appropriate margins one may expect to observe within a regulated cannabis manufacturing financial metrics. Since margins vary widely across standard industry,

¹⁴¹

http://lcb.wa.gov/publications/Marijuana/BOTEC%20reports/8a_Impact_of_tax_scheme_on_price_of_regulated_cannabis-Final.pdf

¹⁴² https://daggacouple.co.za/wp-content/uploads/2014/07/Economies_Scale_Production_Cannabis_Oct-22-20131.pdf

only specific clusters most closely aligned to cannabis manufacturing activities were selected for the analysis. We assessed that concentrates, capsules, and topicals would be most closely aligned to the following three industries: tobacco manufacturing, chemical product and preparation, and pharmaceuticals and medicine. Of the industries examined, pharmaceuticals had very high gross profits; whereas, tobacco and beverage had relatively low margins. Segments with low margins tend to be homogenous commodity items that are relatively simple to produce. In essence, there is large variability across industries. As this subset of cannabis products represented a hybrid of traditional product, a weighted average of all three industry averages was used. Meanwhile, edibles were aligned with bakeries and other foods. Beverages aligned with breweries and flowers, pre-rolls, flowers, and vapor-pens with the tobacco industry. Tobacco, like marijuana, loses weight when dried, but less dramatically. Several scholars have suggested beer, wine, tobacco, and food supplements make good comparators to cannabis manufacturing activities.

The tables below highlight how our research sample compares in terms of financial performance to its comparators within similar industries. The tables illustrate the common financial positions of entities within a particular total asset strata (expressed in thousands of dollars), as well as the corresponding financial ratios for that industry (e.g., current, equity, interest turnover ratio, etc.). When examining comparators, one must keep in mind that relatively few companies specialize in just one type of product. Financial statements do not break the margins by product. As such, any attempt to standardize data must require the application of judgment and multiple pairing techniques.

As reflected in the following table, the operating margins of the firms used in our study far exceed the industry norm. However, the operating margins of our sample were lower than the medicinal cannabis manufacturing peer group (see the next table) thereby suggesting larger firms may benefit from higher levels of operating and financial leverage. Another interesting observation is that large firms generate more net income. Therefore, owners demand a smaller share of the pool of existing resources.

Table A3: Operating Results for Similar “Regulated” Firms with Total Assets Ranging from \$500k - \$100 million

| Operating Costs / Operating Revenue | This Study < 500,000 | <1,000,000 | <10,000,000 | <100,000,000 | Industry Average |
|---------------------------------------|----------------------|------------|-------------|--------------|------------------|
| Cost of Operations | 65 | 61 | 58 | 58 | 59 |
| Taxes Paid | 1 | 16 | 16 | 12 | 15 |
| Other Expenses | 36 | 16 | 18 | 21 | 18 |
| Officers Compensation | 9 | 5 | 2 | 1 | 3 |
| Operating Margin | 28 | 4 | 6 | 7 | 6 |
| Operating Margin before Officer Comp. | 37 | 9 | 8 | 8 | 8 |

Table A4: Operating Results for Publicly-Traded Medicinal Marijuana Manufacturers with Total Assets Ranging from \$1 -\$500 million

| Operating Costs / Operating Revenue | This Study < 500,000 | <100,000,000 | <250,000,000 | <500,000,000 | Industry Average |
|-------------------------------------|----------------------|--------------|--------------|--------------|------------------|
| Product Costs | 65 | 90 | 42 | 54 | 62 |
| Operating Margin | 28 | 72 | 43 | 30 | 48 |

The next two tables compare and contrast the balance sheet structure of the firm's used in this study with that of similar regulated manufacturing firms, as well as the medicinal marijuana industry. We find that the cannabis industry maintains higher inventory levels and keeps less residual equity within the firm as a whole, especially smaller entities like those surveyed in this study.

Table A5: Balance Sheet Valuations of Similar "Regulated" Firms with Total Assets Ranging from \$500k - \$100 million

| Select Balance Sheet Accounts as a Percentage of Total Assets | This Study < 500,000 | <1,000,000 | <10,000,000 | <100,000,000 | Industry Average |
|---|----------------------|------------|-------------|--------------|------------------|
| Net Receivables | 7% | 4% | 9% | 5% | 6% |
| Inventories | 50% | 1% | 18% | 1% | 7% |
| Net Property, Plant, and Equipment | 23% | 16% | 6% | 6% | 9% |
| Notes and Loans Payable | 47% | 12% | 1% | 1% | 4% |
| All other liabilities | 31% | 19% | 19% | 13% | 17% |
| Net worth | 22% | 70% | 80% | 86% | 79% |

Table A6: Balance Sheet Valuations of Publicly-Traded Medicinal Marijuana Manufacturers with Total Assets Ranging from \$1 - \$500 million

| Select Balance Sheet Accounts as a Percentage of Total Assets | This Study < 500,000 | <1,000,000 | <10,000,000 | <100,000,000 | Industry Average |
|---|----------------------|------------|-------------|--------------|------------------|
| Net Receivables | 7% | 17% | 4% | 1% | 7% |
| Inventories | 50% | 4% | 13% | 3% | 7% |
| Net Property, Plant, and Equipment | 23% | 1% | 28% | 14% | 14% |
| Notes and Loans | 47% | 0% | 5% | 1% | 2% |

| | | | | | |
|-----------------------|-----|-----|-----|-----|-----|
| Payable | | | | | |
| All other liabilities | 31% | 33% | 5% | 30% | 23% |
| Net worth | 22% | 67% | 90% | 69% | 75% |

The next two tables compare common financial indicators of our sample to industry averages. We find that our sample maintained high levels of liquidity, not surprising given the industry's reliance on cash. Also, the firms tend to generate high returns relative to their capital assets, which is also not uncommon for labor intensive industries. Inventory turnovers appear higher than industry norms, as well as the debt burden. However, the most revealing finding is that profit margins and return on equity are much higher within the Cannabis industry than their "regulated" industry peer group. As stated previously, this is most likely attributed to the fact the "illicit" industry currently operates in a tax-free environment and can currently avoid other regulatory costs.

Table A7: Financial Indicators (times to 1) for Similar "Regulated" Firms

| Financial Indicator (times to 1) | This Study | <1,000,000 | <10,000,000 | <100,000,000 | Industry Average |
|--|------------|------------|-------------|--------------|------------------|
| Current ratio | 3.3 | 1.4 | 2.1 | 1.8 | 1.8 |
| Quick ratio | 0.8 | 0.9 | 1.2 | 1.1 | 1.1 |
| Net sales to working capital | 13.3 | 8.3 | 2.6 | 3.1 | 4.7 |
| Coverage ratio | 0.0 | 19.1 | 15.1 | 5.6 | 13.3 |
| Total assets turnover ratio | 3.2 | 2.2 | 1.0 | 0.6 | 1.3 |
| Inventory turnover | 9.7 | 6.8 | 2.9 | 5.3 | 5.0 |
| Receivables turnover | 7.8 | 12.0 | 8.1 | 26.8 | 15.7 |
| Total liabilities to net worth | 5.0 | 2.3 | 0.7 | 1.0 | 1.3 |
| Current assets to working capital | 1.5 | 1.9 | 9.3 | 0.1 | 3.6 |
| Current liabilities to working capital | 0.5 | 1.0 | 0.6 | 0.7 | 0.8 |
| Working capital to net sales | 0.4 | 0.2 | 0.5 | 0.1 | 0.3 |
| Inventory to working capital | 1.1 | 0.6 | 0.4 | 1.4 | 0.8 |
| Total receipts to cash flow | 0.0 | 8.6 | 6.3 | 5.4 | 6.8 |
| Cost of goods to cash flow | 0.0 | 4.5 | 3.4 | 2.7 | 3.5 |
| Cash flow to total debt | 0.0 | 0.6 | 0.4 | 0.3 | 0.4 |

Table A8: Financial Indicators (in percentages) for Similar “Regulated” Firms

| Financial Indicator (in percentages) | This Study | <1,000,000 | <10,000,000 | <100,000,000 | Industry Average |
|--------------------------------------|------------|------------|-------------|--------------|------------------|
| Debt ratio | 54.0 | 47.5 | 46.0 | 40.1 | 44.5 |
| Return on total assets | 31.0 | 12.6 | 12.4 | 7.0 | 10.7 |
| Return on equity before taxes | 58.0 | 24.4 | 22.8 | 11.8 | 19.7 |
| Return on equity after taxes | 53.0 | 22.6 | 18.7 | 8.4 | 16.6 |
| Profit margin (before taxes) | 24.0 | 5.6 | 12.1 | 8.3 | 8.7 |
| Profit margin (after taxes) | 21.0 | 4.3 | 8.8 | 5.9 | 6.3 |

While we have fixed on gross profit margins, some studies express ratios in terms of markup.¹⁴³ Likewise, although our study focused on concentrates, the following tables highlight industry ratios for other comparable cannabis manufacturing activities.¹⁴⁴ One may want to compare the aforementioned variances to convert ratios to the cannabis industry. For instance, we might estimate margins for edibles would be about 20.1% (16.7% + 3.4%) using a similar risk premium.

¹⁴³ Some scholars argue the difference between variable and fixed costs is blurred and therefore gross margin percentages are less helpful. If one wishes to convert figures to a markup percentage, they can divide the gross margin percent by cost of goods sold percent. However, there is wide variation in the final retail price among states. Nationally, overall markup is about 75%.

¹⁴⁴ Data from Troy, P. (2015). *Almanac of Business and Industrial Financial Ratios*. Chicago, IL: Wolters Kluwer.

Figure A10: Financial Indicators of Industries Engaged in Similar Manufacturing Activities as the Cannabis Industry

| Financial Indicator | 2. BEVAGE | | 3. FOOD | | 6. BAKERY | | Tobacco Manufacturing | | 4. Chemical Product and Preparation | | | | 5. Pharmaceutical and Medicine | | |
|-----------------------------------|-----------|-------|---------|-------|-----------|-------|-----------------------|--------|-------------------------------------|-----------|-------------|----------------|--------------------------------|-----------|-----------|
| | 500 | 1,000 | 500 | 1,000 | 500 | 1,000 | 10,000 | 50,000 | Under 500 | 500-1,000 | 1,000-5,000 | 50,000-100,000 | 100,000-500,000 | Under 500 | 500-1,000 |
| Total Assets (in 000's) | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 |
| Current ratio | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 |
| Debt to equity | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 |
| Fixed assets to net worth | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| Inventory to working capital | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Capital assets to working capital | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Fixed assets to net worth | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| Inventory to working capital | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Capital assets to working capital | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Fixed assets to net worth | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| Inventory to working capital | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Capital assets to working capital | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Fixed assets to net worth | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| Inventory to working capital | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Capital assets to working capital | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Fixed assets to net worth | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| Inventory to working capital | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Capital assets to working capital | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Fixed assets to net worth | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| Inventory to working capital | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Capital assets to working capital | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Fixed assets to net worth | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |

Source: Troy (2015)

Appendix 2: MAUCRSA Impact by Market and Segment

The tables below show the impact of MAUCRSA on the three manufactured cannabis markets in our simulations. The sum total impact across all markets and segments was presented earlier. For each market, the adult-use, medicinal, and unlicensed segments are shown at four different points, including the current segment conditions, as described above. The last two columns of each table show the percentage changes. The “Baseline to CDPH Change” is the most relevant to this SRIA, as it shows the marginal impact of CDPH regulations compared to the baseline. Consider the medicinal segment in the concentrate market. We expect (after-tax) prices to rise by 5.9 percent due to CDPH regulations and the quantity of oil grams to rise by 3.1 percent. Overall, we expect medicinal concentrate retail dollar sales to rise by 9.1 percent due to the CDPH regulations.¹⁴⁵ The other markets and segments are also shown.¹⁴⁶ The intuition here is that CDPH regulations raise costs at the same time that they lead to a decline in the risk premium in the adult-use and medicinal segments, and the net supply impact is mild. The increased demand coming from increased perceptions of safety are the key influence on these results.

The “Current to CDPH Change” is relevant to understanding how the markets may look post regulation compared to today. In the medicinal segment, there are hardly any changes to quantities, but prices (after taxes) rise quite a bit and thus overall retail sales rise. In the unlicensed segment, prices rise as well, but there is a large drop in quantities sold, which leads to a significant drop in retail sales.

¹⁴⁵ Manufacturer sales to retailers also rise by the same percent, since we are assuming a constant retailer margin.

¹⁴⁶ The adult-use segments do not have a “current” value since there is no adult-use manufacturing in 2017.

Table A11: Impact of MAUCRSA Regulations on the Adult-use, Medicinal, and Unlicensed Segments in the Cannabis Concentrates Market

| Concentrates, Adult-Use | | | | | | |
|---------------------------------|-----------------------|-------------------|-----------------|-------------------------|--------------------------------|-------------------------------|
| | Current (2017) | Split 2018 | Baseline | CDPH Regulations | Baseline to CDPH Change | Current to CDPH Change |
| Price | N/A | \$60 | \$72.66 | \$76.94 | 5.9% | N/A |
| Grams of oil | N/A | 5,701,254 | 5,372,247 | 5,536,730 | 3.1% | N/A |
| Retail Sales | N/A | \$342,075,240 | \$390,365,642 | \$425,982,904 | 9.1% | N/A |
| Concentrates, Medicinal | | | | | | |
| | Current (2017) | Split 2018 | Baseline | CDPH Regulations | Baseline to CDPH Change | Current to CDPH Change |
| Price | \$60 | \$60 | \$72.43 | \$76.94 | 6.2% | 28.2% |
| Grams of oil | 5,583,991 | 5,701,254 | 5,518,453 | 5,701,202 | 3.3% | 2.1% |
| Retail Sales | \$335,039,460 | \$342,075,240 | \$399,728,761 | \$438,633,967 | 9.7% | 30.9% |
| Concentrates, Unlicensed | | | | | | |
| | Current (2017) | Split 2018 | Baseline | CDPH Regulations | Baseline to CDPH Change | Current to CDPH Change |
| Price | \$51 | \$51 | \$59.03 | \$62.18 | 5.4% | 21.9% |
| Grams of oil | 16,751,972 | 11,402,509 | 12,320,684 | 12,353,102 | 0.3% | -26.3% |
| Retail Sales | \$854,350,572 | \$581,527,959 | \$727,236,143 | \$768,165,084 | 5.6% | -10.1% |

Table A12: Impact of MAUCRSA Regulations on the Adult-use, Medicinal, and Unlicensed Segments in the Cannabis Edibles Market

| <i>Edibles, Adult-Use</i> | | | | | | |
|----------------------------|-----------------------|-------------------|-----------------|-------------------------|--------------------------------|-------------------------------|
| | Current (2017) | Split 2018 | Baseline | CDPH Regulations | Baseline to CDPH Change | Current to CDPH Change |
| Price | N/A | \$180 | \$232 | \$251 | 8.2% | N/A |
| Grams of oil | N/A | 1,710,376 | 1,712,990 | 1,766,727 | 3.1% | N/A |
| Retail Sales | N/A | \$307,867,680 | \$398,081,871 | \$444,130,404 | 11.6% | N/A |
| <i>Edibles, Medicinal</i> | | | | | | |
| | Current (2017) | Split 2018 | Baseline | CDPH Regulations | Baseline to CDPH Change | Current to CDPH Change |
| Price | \$180 | \$180 | \$228 | \$247 | 8.2% | 37.3% |
| Grams of oil | 1,675,197 | 1,710,376 | 1,726,521 | 1,780,683 | 3.1% | 6.3% |
| Retail Sales | \$301,535,460 | \$307,867,680 | \$394,334,301 | \$439,949,329 | 11.6% | 45.9% |
| <i>Edibles, Unlicensed</i> | | | | | | |
| | Current (2017) | Split 2018 | Baseline | CDPH Regulations | Baseline to CDPH Change | Current to CDPH Change |
| Price | \$153 | \$153 | \$171 | \$180 | 5.1% | 17.5% |
| Grams of oil | 16,752 | 11,403 | 11,790 | 11,799 | 0.1% | -29.6% |
| Retail Sales | \$2,563,056 | \$1,744,659 | \$2,016,642 | \$2,121,908 | 5.2% | -17.2% |

Table A13: Impact of MAUCRSA Regulations on the Adult-use, Medicinal, and Unlicensed Segments in the Cannabis Topicals Market

| <i>Topicals, Adult-Use</i> | | | | | | |
|-----------------------------|-----------------------|-------------------|-----------------|-------------------------|--------------------------------|-------------------------------|
| | Current (2017) | Split 2018 | Baseline | CDPH Regulations | Baseline to CDPH Change | Current to CDPH Change |
| Price | N/A | \$180 | \$232 | \$252 | 8.2% | N/A |
| Grams of oil | N/A | 190,042 | 190,332 | 196,271 | 3.1% | N/A |
| Retail Sales | N/A | \$34,207,560 | \$44,231,371 | \$49,369,902 | 11.6% | N/A |
| <i>Topicals, Medicinal</i> | | | | | | |
| | Current (2017) | Split 2018 | Baseline | CDPH Regulations | Baseline to CDPH Change | Current to CDPH Change |
| Price | \$180 | \$180 | \$228 | \$247 | 8.2% | 37.3% |
| Grams of oil | 186,133 | 190,042 | 191,836 | 197,821 | 3.1% | 6.3% |
| Retail Sales | \$33,503,940 | \$34,207,560 | \$43,814,974 | \$48,905,131 | 11.6% | 46.0% |
| <i>Topicals, Unlicensed</i> | | | | | | |
| | Current (2017) | Split 2018 | Baseline | CDPH Regulations | Baseline to CDPH Change | Current to CDPH Change |
| Price | \$153 | \$153 | \$171 | \$180 | 5.2% | 17.6% |
| Grams of oil | 1,861 | 1,267 | 1,310 | 1,311 | 0.1% | -29.5% |
| Retail Sales | \$284,733 | \$193,851 | \$224,071 | \$235,843 | 5.3% | -17.2% |