



Cannabis Potency Tax Feasibility Study

A report for the Washington State Liquor & Cannabis Board

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1. Executive Summary

This report investigates the feasibility of implementing a potency tax on cannabis products in Washington State. Attention is given to the theoretical and technical considerations of replacing the current 37% ad valorem tax basis, in whole or in part, with a tax based on the concentration or amount of THC within a given product. For practical considerations we use the term "potency tax" synonymously with "a tax on THC concentration."

Interviews were conducted with a broad range of stakeholders including the Departments of Revenue and Ecology, cannabis regulators in California, Canada and Illinois, Tier 1, 2 and 3 producers and processors, medical and non-medical retailers, medical cannabis consumers, testing laboratories, point-of-sale-systems operators, stakeholders in the medical sector, and industry investors, to articulate their estimated costs for adaptation and compliance cost faced in response to a hypothetical tax on potency.

A literature review illuminates the history of cannabis taxation in Washington, and explores taxation in Illinois, and Canada, which have taxed cannabis based on THC concentration. The origins of the concept of a potency tax are discussed and an overview of the case for taxing cannabis by potency is presented. We find two broad arguments in favor of the potency tax:

As the market matures, efficiencies of scale and the increased competition tend to decrease product prices. If cannabis is taxed only on an ad valorem basis, lower prices may reduce public revenues. Increased sales might offset the impact of declining prices, but increased consumption resulting from lower prices will likely increase the costs of consumption faced by the state. Thus if consumption costs increase faster than revenues, then the state's budget may be threatened even while revenues rise. A potency tax would therefore aim to protect the balance in the state's budget by tethering (if somewhat imperfectly) revenue to THC with the goal of meeting any rise in consumption costs due to increased THC consumption with a proportionate increase in revenue.

A small but increasing body of evidence suggests that the public health harms of cannabis consumption are more strongly associated with products at the higher end of the potency curve. Concerns have been raised about adulterants including pesticide residue and heavy metals appearing in concentrates. Anecdotal evidence suggests an increasing number of hospital admissions for THC toxicity involving uncontrolled vomiting. And, at the time of writing, significant media attention is being given to the morbidity and mortality associated with vaping. The Center for Disease Control has publicly associated several hundred reported incidents of respiratory failure to the vaping of products containing THC. Advocates hope that a tax on THC products could encourage consumers to select lower potency products thus slowing the trend towards higher potency and avoiding associated public health harms.

Several models of taxing potency are identified, along with their potential drawbacks.

- A direct potency tax that establishes a dollar value per milligram of THC.
- A tax that creates different tax brackets for different types of cannabis products (for example establishing a distinct tax rate for flower, another for concentrates, and another for edibles).
- A tax based on ranges of THC concentration, that identifies different ranges of THC amounts and establishes corresponding tax rates for those ranges.
- A combination; maintaining a stable excise tax and adding one of the aforementioned THC taxes listed above as a supplement.

A brief econometric analysis demonstrates that the effectiveness of a potency tax is difficult to estimate at this time due to scarcity of academic research and practical experience. Specifically, we do not know enough about cross elasticities of demand between the licit and illicit markets and between products of different potencies making it difficult, if not impossible, to predict how consumers would respond to a potency tax. Additionally, imperfect evidence regarding the

marginal harms of various levels or forms of THC consumption make it impossible to guarantee that a tax on THC would be successful in reducing public health harms related to THC consumption. Thus, the legitimacy of the arguments in favor of a potency tax is unstable. Given the interests vested in Washington State's current regulatory structure that might be threatened by the adoption of any of the models presented, a discussion of the legitimacy of the arguments in favor of a tax on THC is an integral component in any determination of the feasibility of a potency tax.

Furthermore, several specific features of Washington's regulatory and enforcement infrastructure limit the effectiveness of any potency tax implemented at this time: confidence in Washington's laboratory testing regime is already low, with no standardized testing procedure and ample opportunity for gaming leading to variation in test results. The imposition of a THC tax may put additional stress on that system, requiring the LCB to invest in additional enforcement capacity at the expense of any potential revenue gains. Second, the reduced scope of the current traceability system and the persistence of bugs and malfunctions have limited the state's ability to use the system to monitor and enforce compliance among licensees. Changes to the Leaf Data System would require a comprehensive overhaul of the current database, which would be likely both costly and time consuming. Any change to reporting requirements or the traceability system would require corresponding changes to integrators and point-of-sale software providers which would also likely be both costly and time consuming.

In summary, a potency tax is likely to affect consumer purchasing habits to an unknown extent, and it is currently impossible to quantify any public health gains resulting from those effects. It is not feasible to estimate the potential long-term revenue changes afforded by a switch from ad valorem to a potency tax. However, the considerable costs relating to the implementation of a cannabis potency tax in Washington State, as well as both theoretical and practical challenges in doing so, are better known. Therefore, at present, any change in the tax structure would require embracing large known costs and additional unknown costs in exchange for unknown benefits.

2. Introduction

In May of 2019, the Washington Legislature asked the LCB to solicit a study investigating the feasibility of a potency tax for cannabis products. There is currently a 37% ad valorem excise tax on cannabis products in addition to the state sales tax, both of which are collected at the retail point of sale. A potency tax would replace the ad valorem one, either wholly or in part, with taxes based on the THC content of the product.

BOTEC's principals and senior researchers, including the late Mark Kleiman and Beau Kilmer, are widely considered along with Robert MacCoun to be the conceptual architects behind the notion of taxing cannabis by potency. These authors believed a THC tax could protect public revenues against losses in the event of falling prices, provide additional tax revenue from innovations in the legalized industry, and protect public health against the exposure associated with the more potent cannabis products.

As in other states, Washington's maturing cannabis market saw efficiencies in production and economies of scale, leading to a new supply-demand equilibrium that caused prices to fall significantly in the first years of the market. Greatly increased supply by cultivators and, to some extent, retailer market power allowed retailers to be highly selective about which products to offer consumers. An initial lack of knowledge about the characteristics of newly legal cannabis products led many consumers to choose products based largely, if not wholly, on price and concentration of THC. Consequently, many retailers found it profitable to populate their inventory with less costly, highly concentrated products. Producers with unsalable plant matter recouped a portion of the loss by selling in bulk to extractors for conversion to durable and high potency concentrates. As concentrates became cheaper and more available, the more potent modalities of administering the drug, such as flash vaporization (dabbing), increased in popularity. In 2014, ready-to-use flower accounted for 80% of the market; fast forward to 2019 and concentrates account for nearly 40% of the overall market. Flash vaporization of concentrates is now the most common mode of using concentrates after vaping. This flash vaporization of concentrated cannabis products exposes the consumer to quantities of THC that would be nearly impossible to achieve by inhalation of burned plant matter, which is the most common mode of administration.

This trend toward higher potency alarmed many in the public health community who saw an association between increased potency and public health harms. National Public Radio interviewed Nora Volkow, director of the National Institute on Drug Abuse on this topic. Volkow explained, "THC can have opposite effects on our bodies at high and low doses." For example, consuming lower potency cannabis can aid "relaxation and decrease anxiety" but high concentrations can cause panic attacks and "if someone consumes high-enough levels of THC, [one may become] psychotic and paranoid." Low doses of THC "increase blood flow, but high content [THC] can produce massive vasoconstriction." In low concentration[s], THC can be used to treat nausea ... but chronic consumption of high content THC has brought consumers "to the emergency department with a syndrome where they couldn't stop vomiting and with intense abdominal pain."¹

Advocates of taxing cannabis according to potency hope to protect the balance between cannabis tax revenues and the costs of cannabis consumption which can be disturbed in the event of falling product prices. A potency tax might also promote public health goals by nudging consumers to select less potent products.

There are four options for taxing potency.

- Establish a fixed tax rate per milligram of THC with an option for an increase as potency rises, thus making the highest risk products the most expensive.

¹ Highly Potent Weed Has Swept the Market, Raising Concerns About Health Risks, radio program "All Things Considered," May 15, 2019. Available at: <https://www.npr.org/sections/health-shots/2019/05/15/723656629/highly-potent-weed-has-swept-the-market-raising-concerns-about-health-risks> Accessed 10/1/2019

- Establish potency ranges with fixed tax rates for THC concentration falling within the range, and step raises at the margins.
- Establish different tax rates for different products, for example: taxing useable plant material (flower, bud, trim, kief) on one basis, and other categories of product such as edibles, extracts, and concentrates on another.
- Establish a hybrid system designed to incorporate two or more of the above or pairing one or more of the above with an ad valorem or specific excise tax.

Ultimately, the feasibility of any tax proposal would depend on the adaptation activities and costs that stakeholders would face. However, in something of a chicken-and-egg problem, the precise adaptations and costs will depend on the details of the structure under consideration.

In order to better understand the full range of these costs, researchers from BOTEC Analysis surveyed a wide range of stakeholders, including the Departments of Revenue and Ecology, out-of-state regulators in California, Canada and Illinois (the latter two of which have already implemented tax structures that focus on potency), Tier 1, 2 and 3 producers and processors, medical and non-medical retailers, medical cannabis consumers, testing laboratories, point-of-sale-systems operators, stakeholders representing medical consumers, and industry investors.

The question of feasibility touches on a few separate spheres: first, there are theoretical questions about whether a potency tax can achieve the stated goals, and if so, in what form. Then there are technical questions about whether such a potency tax is viable in the current economic climate and under the current regulatory structure.

Serious theoretical questions affecting the conceptual basis for a potency tax will remain unanswered until scientific and medical research can establish the association between THC and public health harm. Further, we find that significant technical and administrative obstacles are likely to prevent an effective potency tax from being implemented at this point. Until these obstacles are addressed, a potency tax would likely risk exposing the public to harms that exceed any possible benefit. While a potency tax has merit in theory, the specifics of the still-maturing Washington cannabis market—in particular the price recovery in 2019, traceability data in flux, point-of-sale limitations, and a lack of standardization across testing laboratories—may work together to make a potency tax an unreasonable goal at present.

A note on the use of the word “potency”: This term has been widely used to describe the propensity of a product to produce an effect on the part of the consumer, but it is a mistake to assume (as many do) that cannabis potency is as simple as alcohol. Unlike alcoholic beverages, the impairment caused by consuming cannabis is not solely dependent upon one chemical compound, but on the interaction of a multitude of different cannabinoids interacting in different ways over time. Indeed, many cannabinoids counteract the effects of others in ways that we are only just beginning to understand. In some doses, CBD may counteract the effect of THC while it may compound the effect in others. Thus, while THC plays an important role in determining impairment, it is far from the only relevant factor influencing impairment; a fact which belies the association between THC concentration and ‘potency’. This feature of cannabis products has important implications on the legitimacy and efficacy of a tax on THC which will be discussed in this study. For the purposes of this study ‘potency’ is taken to be synonymous with concentration. Thus, a potency tax for cannabis products is a tax based on the concentration of THC within a cannabis product.

3. Methods

A feasibility study is the examination of a hypothetical project or system which aims to identify the strengths, weaknesses, opportunities and threats associated with a defined undertaking. In its simplest form, a feasibility study surveys just two criteria -- anticipated value and anticipated costs -- but the strength of the study depends upon the inclusion of all relevant available data. Feasibility itself takes into consideration the technical, legal, political, operational, temporal, and financial aspects of the proposed plan. Our goal is to provide the working group with the information needed to inform their process.

Literature review

We conducted a literature review to illuminate the history of Washington's current cannabis tax rate of 37%; an overview of the methods used by other jurisdictions to tax cannabis based on potency; and a summary of existing research on cannabis taxation in general and elasticity of demand for cannabis products specifically. The result of the literature review will inform a discussion of the adverse health effects sometimes associated with cannabis potency, the varying impacts of different product types on THC absorption and health, the case for taxing cannabis products by potency, and the options by which this might be achieved.

Identify the impact of the adoption of a potency tax on businesses

The costs imposed are a major consideration in determining the feasibility of a proposed undertaking. In this analysis, costs must include more than those for the regulatory implementation of the new tax structure, which would be borne by regulators and ultimately the taxpayer. Costs also include those borne by industry stakeholders to adapt to the new structure; and for some stakeholders such costs are likely to be significant. Phone and in-person interviews were conducted with a wide range of stakeholders including the Departments of Revenue and Ecology, out of state regulators in Canada, California and Illinois, Tier 1, 2 and 3 producers and processors, medical and non-medical retailers, medical cannabis consumers, testing laboratories, Point-of-Sale (POS) Systems operators, industry investors, and stakeholder groups. Close to 40 interviews were conducted, with in-person interviews conducted in Olympia, Tacoma and Seattle from September 3–6, 2019, and telephone interviews conducted from August 26–September 13, 2019. Stakeholders were identified largely by word of mouth and referral, though public information was used to ensure that each category of stakeholders identified by the researchers was interviewed. The interviews were semi-structured, with a script of general questions leading to follow-up questions.

4. Background: Cannabis Taxation

History of the cannabis tax rate in Washington

From the outset of the movement to legalize cannabis in the US, the topic of taxing cannabis has been of central importance. As with the laws covering gambling, liquor and tobacco, revenue arguments featured prominently in the liberalization of cannabis laws, and these ‘sin taxes’ are recognized as powerful tools for advancing public health interests, even apart from their fiscal benefits.² Legalizing cannabis was never solely about expanding civil liberties and correcting some of the historic injustices for which prohibition was responsible. The promise that a tax could be placed on cannabis products sold in a regulated market was a motivating factor for many who imagined that the additional revenue from cannabis sales could more than pay for the additional regulatory burden necessitated by an adult use system. Cannabis taxation, it was imagined, could fund education and research, support states’ General Funds, and prop up struggling social benefit systems. Cannabis taxes in Washington state in 2018 topped \$365 million - \$50 million more than in the previous year and more than \$155 million more than the revenues from liquor. This money supports the General Fund (\$198.9 million), Basic Health (\$117.4 million), Cities, Counties (\$15.0 million), Education and Prevention (\$36.2 million), Research (\$1.1 million) and provided \$20.8 million for other programs and initiatives benefitting the residents of Washington State. Initial projections for financial year 2019 also look good with further gains credited to the rebound in farm-gate prices resulting from some former producers leaving the industry, reducing the former supply-demand imbalance. Stakeholders we interviewed were overwhelmingly optimistic about the future of prices for cannabis in Washington State, though it remains to be seen whether the rebound is permanent and product prices have hit a natural floor.

However, despite increasing revenue from cannabis taxation, the price drop for cannabis products remains a cause for concern: Since 2013, increased producer efficiencies and supply have driven prices downward, including a precipitous drop in the fall of 2017. Though prices have stabilized somewhat since then, as the industry continues to mature and adopt more efficient technologies and business practices, further drops in the future are not impossible. When tax revenue is a function of price, the lower prices would produce less revenue unless a corresponding increase in sales offset the sales price discount.³ However, tax revenues do not need to decrease in order for fiscal concerns to be valid. If the costs of cannabis consumption increase faster than the gross revenues, the state’s capacity to regulate can be diminished even while tax revenues increase, and the fiscal benefits of cannabis legalization are reduced.

When I-502 went into effect, cannabis was taxed with three cascading ad valorem excise taxes, each 25%. The tax was levied at the point of sale (1) from producers to processors or other producers; (2) from processors to retailers; and (3) from retailers to customers. In each instance, the buyer paid the tax to the seller, who was responsible for reporting the sale and passing the tax on to the state. Holding producer-processor licenses allowed the licensee to avoid the initial 25% tax. The state continued to prohibit full vertical integration and to this day neither producers nor processors may be retailers.

On July 1, 2015,⁴ the three levels of tax were rolled into the single 37% excise tax, paid by the consumer and collected

² Chaloupka, Frank J., et al., “Tobacco Taxes as a Tobacco Control Strategy,” 21 *Tobacco Control* 172, 179 (2012); Wagenaar, Alexander C., et al., “Effects of Alcohol Tax and Price Policies on Morbidity and Mortality: A Systematic Review,” 100 *American Journal of Public Health* 2270, 2277 (2010).

³ A similar trend is evident in other legalized states, especially Oregon. “Lower prices should entice more consumption, but it’s not necessarily a one-to-one tradeoff,” said Josh Lehner, senior economist with Oregon’s Office of Economic Analysis in an interview for Pew Trusts. (The Pew Charitable Trusts, 2019. *Forecasts Hazy for State Marijuana Revenue*. Retrieved from: https://www.pewtrusts.org/-/media/assets/2019/08/marijuana-brief_v2.pdf)

⁴ Materials relating to the legislative history of the change can be found at <https://app.leg.wa.gov/billssummary?BillNumber=2136&Year=2015>. See, e.g., <https://app.leg.wa.gov/committeeschedules/Home/Document/110818#toolbar=0&navpanes=0>

by retailer at the point of sale.⁵ Producers and processors pay no excise tax, but are still subject to the state business and occupation tax on gross receipts like other businesses.⁶

The 2015 tax change made it clear that the new Washington cannabis excise tax was to be paid by the purchaser, not the seller. The seller was simply collecting the tax amount, so it could never be counted as the seller's income under federal tax code section 280E. The change made it clear for the first time that the seller did not pay federal income tax on the amount of the state tax.⁷

However, revenue gain or loss does not appear to have spurred the change. "The 37 percent marijuana tax rate was selected as a revenue-neutral level compared to the earlier taxes."⁸ Because the first 25% tax was collected on a lower tax base than the second (wholesale price rather than retail price), a 37% retail tax matched the revenue projections for the cascading taxes it replaced. The Fiscal Note for the change projected annual revenue gains so low (topping out at \$1,238,708 in the final out year) that 36% was projected to be a revenue-losing rate.⁹ A recent academic study concluded, "The tax changes that were implemented on July 1, 2015 were designed to be approximately revenue neutral, and, in practice, they were not too far off from this."¹⁰

Taxation in other jurisdictions of note

At the time of writing, the sale of cannabis for adult use is legal in eleven states and Canada, Uruguay, Guam, and the Northern Mariana Islands. Medical cannabis sales are legal in 33 states. However, while taxing potency is not a new idea, only Illinois and Canada have implemented tax structures that seek to tax cannabis based on THC content.

Illinois

As discussed in Part 6 (c), beginning in 2020 Illinois will tax recreational cannabis differently depending on the types of product and, in some instances, the THC content.¹¹ Producers selling to retailers will pay a 7% tax, but a more complex system will be imposed at retail.¹² Cannabis products "not intended to be smoked" (e.g., beverage, food, oil, ointment, tincture, topical formulation) will carry a 20% tax rate regardless of THC content, while those products intended to be smoked (dabs, vaping cartridges, and flower or bud) will be taxed either at 10% or 25%, depending on THC content. If THC content is below 35%, a tax of 10% will apply, while products at or above 35% will be taxed at 25%. Since

⁵ A special rule addresses price in bundled transactions, like free-pot-with-pipe deals. Section 210 of

<http://lawfilesexternal.wa.gov/biennium/2015-16/Pdf/Bills/House%20Passed%20Legislature/2136-S2.PL.pdf>.

⁶ Farmers selling agricultural products to wholesalers are exempt from the B&O tax in Washington, but cannabis and cannabis products are specifically excluded from the state's definition of an "agricultural product" (RCW 82.04.213) and thus cannabis producers are not considered to be farmers for tax purposes (https://dor.wa.gov/sites/default/files/legacy/Docs/Pubs/Marijuana/FS_I-502_MarijuanaProducers.pdf).

⁷ <https://www.irs.gov/pub/irs-wd/201531016.pdf>; Lerch, S. (2019, August 7). Cannabis Forecasting in Washington State. Retrieved from: https://comm.ncsl.org/productfiles/126218130/Presentation_by_Steve_Lerch.pdf: "Because tax [is] imposed on consumer, cannabis tax [is] no longer 'income' for Federal tax purposes." See also <https://www.thecannabist.co/2015/07/01/washington-state-pot-law-overhaul-marijuana-tax-reset-at-37-percent/37238/>; <https://taxfoundation.org/marijuana-taxes-lessons-colorado-washington/> (the new tax's "structure as an excise tax also ensures that retailers will not have collections included as gross income for federal income tax purposes").

⁸ <https://taxfoundation.org/marijuana-taxes-lessons-colorado-washington/>

⁹ Annual revenue gains from the tax change for recreational marijuana were projected to be: FY 2016 \$572,685; FY 2017 \$816,155; FY 2018 \$1,053,723; FY 2019 \$1,238,708; FY 2020 \$1,238,708; FY 2021 \$1,238,708
<https://fortress.wa.gov/FNSPublicSearch/GetPDF?packageID=42225>. An earlier version of the bill set the new retail rate at 30% rather than the ultimately enacted 37%.

<https://app.leg.wa.gov/committeeschedules/Home/Document/110818#toolbar=0&navpanes=0>.

¹⁰ <https://www.nber.org/papers/w23632.pdf>.

¹¹ Medical cannabis sales will be taxed at 1% of retail price.

¹² 10% tax will apply to cannabis flower or other product "not intended to be smoked" with less than 35% THC, 20% tax will be applied to cannabis products infused with cannabis such as edible products, and 25% tax will be applied to any product "not intended to be smoked" with a THC concentration higher than 35%. Cannabis Regulation and Tax Act HB1438.

virtually no flower or bud tests above 35%, the tax could equalize or better balance the cost of intoxication by raising the price of the intensely potent extracts and concentrates intended to be inhaled. The literature offers no evidence that the 35% threshold is significant in public health terms, and indeed, our communications with Illinois government, did not reveal any direct or specific health related evidence that drove the choice of 35% as the threshold.

It may be helpful to think of the Illinois tax structure tiers as proxies: The low taxed tier (<35%) would typically contain flower, solvent-free concentrates like hash, kief, and other raw plant material; the high-tax tier (\geq 35%) would typically apply to dabs and other concentrated cannabis intended to be smoked or vaped.

The Illinois system seems designed to discourage high-risk patterns of use. The system is not perfect; for example gels-caps containing cannabis extract will be treated as edibles even though they are technically distillates; the product's effect will be felt within 15 to 20 minutes.¹³ Even highly potent cannabis products will be taxed at a favorable 20% rate if they are to be swallowed or absorbed through skin or mucous membranes. Relying on stated intent for method of use allows gaming when products have ambiguous uses, e.g., with Rick Simpson Oil, which may be applied topically, baked into an edible, vaporized, or dabbed. To dodge higher tax rates associated with a product intended to be smoked, high-THC Rick Simpson Oil could be labeled "not intended for smoking" and taxed at the 20% rate that applies to edibles. This method would not prevent dab-seeking customers from evading the 25% higher tax rate by purchasing and smoking RSO labeled non-smoking rather than other concentrates intended for smoking. To some extent, gaming of this sort already occurs. Indeed, one Washington retailer told us that selling RSO in a 600-milligram bottle was a method to get around the state's 100 milligrams per-product limit on THC in sublinguals.

Canada

The Canadian government elected to break legalization into two phases and develop separate regulations for products legalized during each phase. Cannabis flower, seeds, plants, and derived oils became legal to produce, sell, and buy in 2018. In fall of 2019, manufactured cannabis products including edibles, extracts, and topicals become legal. The Cannabis Act relied upon coordination between Health Canada, the Department of Finance Canada, and the Canada Revenue Agency for rulemaking.

For fresh and dried cannabis, Canada applies the greater of two taxes. The first tax is an ad valorem (percentage) tax of 10 percent of price (or the value of the plant matter that went into creating the products). The second tax is a specific or flat-rate tax of \$1 per gram for flower and \$.25 per gram for trim. The taxpayer simply pays whichever of those two amounts is greater.¹⁴

Take for example, a 2-gram package of flower selling for \$15 pre-tax at wholesale. The Canadian tax would be \$2, the greater of \$1.50 (10% of \$15) and \$2 (one dollar per gram). If instead a 2-gram package of flower sells for \$25 pre-tax at wholesale, the Canadian tax would be \$2.50; that's the greater of \$2.50 (10% of \$25) and \$2 (one dollar per gram).

This tax is collected at the time of sale to a retailer or, in the case of medical cannabis, directly to a consumer. Oils are taxed not as a percentage of the wholesale value or weight, but only according to their THC content, generally at one cent per milligram. Products to be legalized this fall will also be taxed only according to their THC content, at the same one-cent rate.

The Canada Revenue Agency (CRA) reported that the decision to tax manufactured products by THC was made in order to simplify excise duty calculations and ease compliance issues that producers have encountered operating under a system that required them to measure the original weight of the cannabis biomass used to manufacture the product. The lack of a standardized system for accounting for product input weights presented operational and auditing challenges and made

¹³ <https://medium.com/trykecultivator/concentrates-deliver-the-cleanest-cannabis-and-the-highest-potency-bc87795b1e00>

¹⁴ The tax rates in Manitoba are lower. Other provinces add surtaxes. <https://www.canada.ca/en/revenue-agency/services/tax/businesses/topics/excise-duties-levies/collecting-cannabis.html>.

for burdensome recordkeeping. The Task Force on Cannabis Legalization and Regulation recommended that the government “develop strategies to encourage consumption of less potent cannabis, including a price and tax scheme based on potency to discourage purchase of high-potency products.” Regulators started taxing some oils by potency in May 2019, making Canada the first jurisdiction to tax cannabis on a per-milligram-of-THC basis. This fall, Canada will allow the sale of edible cannabis, cannabis extracts and cannabis topicals. When sold, these products will be taxed by milligram of THC.¹⁵

CRA has published lengthy instructions on how to calculate, collect, and remit the potency tax. Health Canada already requires producers to test each batch or lot of cannabis for potency of THC and CBD and report these on the product packaging. Labs must hold a license for analytical testing, and though the methods and procedures used by licensed labs are not prescribed, Health Canada may audit test results up to nine times per year. There are currently sixty-nine labs licensed to test cannabis. The potency of THC indicated by the lab and placed on product is then used to determine the duty. There is a base tax of \$0.0025 per milligram of THC found in a given product unit, which must be paid by the licensed supplier at the time of delivery to a purchaser. There is also a \$0.0075 per milligram THC “additional tax.” Added to this flat \$0.01 per milligram tax is an “adjustment” that varies by province. CRA has published a formula by which this adjustment is to be applied. Both the additional tax and adjustment are to be paid by the licensee who packages the product. So, the tax on a gram of oil that contains 700 milligrams of THC would be \$7 – regardless of the pre-tax price.

Canada’s potency tax could lead to unintended consequences. Creating incentives for low-THC products in a marketplace that demands high potency products might encourage a return to the illicit market. A resurgent illicit market would diminish state revenues and pull business from licensed market suppliers.

Determining THC concentration is not straightforward. The scientific approach yields a range rather than an exact figure; using high-quality methods, labs in Canada still regularly report relative standard deviations of 10-15%.¹⁶ Health Canada auditors have discretion over what range is acceptable and what part of the range labs will report. The uncertainty in the tested potency results translates to an equally sized uncertainty in terms of tax obligations. As such, a degree of gamesmanship should be anticipated, complicating the task of regulators. Canada’s regulator’s appetite for this challenge should not necessarily be taken as an indication that Washington State should follow suit. Canada’s enforcement capacity is significantly greater than that of Washington State, as evidenced by the fact that Canadian licensees (fewer than 300) are visited by regulators on a monthly basis and audited annually. Testing labs are subject to the scrutiny of the federal revenue authorities. Given these key differences between Canada and Washington State, it is reasonable to suspect that attempted violation in Washington might be significantly more common (unless the penalty for noncompliance could be raised sufficiently to counterbalance the decreased risk of detection), putting tax revenues at risk.

At the time of writing, the roll out of Canada’s potency-based tax policy has not been implemented for edibles, topicals, and the like (though it was initiated for oil May 2019). Non-oil products taxed by potency will likely not reach retail shelves until December 2019 or January 2020. There will be much to learn from observations of the Canadian market. The Canada Revenue Authority and Health Canada have based their potency tax policies on good research, but the effects on the market are difficult to predict and likely to cause them to change their policies over time.

Existing research on cannabis demand and taxation

General issues

The basic considerations when setting tax rates for cannabis include tax revenues, regressivity, problem use and health

¹⁵ Again, the tax rates in Manitoba are lower, and other provinces add surtaxes. <https://www.canada.ca/en/revenue-agency/services/forms-publications/publications/edn60/calculation-cannabis-duty-additional-cannabis-duty-cannabis-oil-cannabis-edibles-extracts-topicals.html>.

¹⁶ It is unclear whether the wide range is due to the imprecision in measurement of a single sample or variation between samples from the same batch.

risks, the illicit market, and negative externalities (i.e., harms to nonusers) (Caulkins et al., 2015). The tax rate and structure obviously drive revenue; this is discussed below in this section regarding demand elasticity (i.e., the sensitivity of demand with respect to increases in price) and in section 10 on revenue estimation. Excise taxes in general are regressive;¹⁷ such taxes on cannabis raise no new issues apart from how the potential for dependence may influence and be influenced by income. Unlike most taxed commodities, however, cannabis raises issues involving health, the relationship to illicit markets, and negative externalities, which require further thought.

High tax rates on cannabis may discourage use and, if THC concentration is taxed, discourage high potency use in particular. Risk reduction from discouraging use of high concentration products may be countered (discussed in Part 4) by the potential for increased smoking of lower-concentration cannabis. Based on our conversations with regulators in Canada and Illinois, however, it appears that the health risks of high THC concentration and consumption outweigh any additional harms from increased smoking in the minds of some policymakers who have explicitly considered the issue. For example, in 2016, Canada's Task Force on Cannabis Legalization and Regulation recommended the design of "a tax scheme based on THC potency to discourage purchase of high-potency products," which was later implemented.

The impacts on illicit markets could be manifold. Caulkins et al. (2015) point out that by making product expensive, a high tax rate decreases the likelihood of diversion to other states, but it also creates a reason for consumers to resort to the illicit market, which could include cannabis diverted from licensed producers as well as illegally produced product. The same considerations apply, though perhaps to a lesser extent, to high taxes on subsets of cannabis products (e.g., edibles, concentrates, or other high-potency products), as long as enough consumers do not see lower-THC alternatives as good substitutes. For a licit cannabis market to thrive, consumers must be lured away from (or find unattractive) illicit suppliers, and those suppliers must be unable to compete with the lawful retailers.

The economic concept of a negative externality is often confused with negative personal consequences to the cannabis user. True negative externalities for the cannabis market are those suffered by parties other than the purchaser/user and might include harms to other people and their property for example from traffic accidents caused by intoxication or harm from second-hand smoke. The Pigouvian taxation theory (justifying taxation for products when the untaxed price is too low to reflect the full marginal cost to society) might also be used to justify potency taxes. But, while externalities are always difficult to estimate, research suggests that the external costs of cannabis use are only one-fifth to one-eighth as high as for alcohol.¹⁸ Those rough calculations indicate that taxes based solely on the intent to correct for the presence of negative externalities would lead to relatively low tax rates, and thus externalities probably cannot be considered a main driver of Washington's tax structure.

Econometric studies of taxation in Washington

Given the relative novelty of legalization in Washington, there are only a few econometric studies of cannabis taxation in the state, and none that have undergone peer review.

Hansen, Miller, and Weber (2017) study the "seed-to-sale" administrative records around the time of the tax restructuring on July 1, 2015. Given the study design, it is important to note that these results pertain specifically to how the market responded to a sudden and relatively unanticipated one-time change in the tax structure. Their findings include:

- The original tax regime encouraged vertical integration between cultivators and processors, since an integrated firm could avoid multiple taxation.
- In part because the tax reform eliminated the chain of taxation, it eliminated 28 cents of tax per gram overall. The excise and sales taxes collected before the tax change totaled \$4.51 per gram, whereas they were \$4.23

¹⁷ Regressive taxes place a greater burden on low-income households or individuals than on their higher-income counterparts.

¹⁸ Gravelle and Lowry, 2014.

afterward.¹⁹

- There was a small but significant decrease in the THC concentration among products sold after the reform, but not in production.
- The tax-inclusive price faced by consumers for identical products increased by 2.3%.
- About 44% of the tax is passed through to consumers.

Given the study design, it is unclear whether these findings pertain to other potential changes in the tax structure or time periods. The specific results for demand elasticity are covered in a later section below.

Hollenbeck and Uetake (2019) studied data on every legal cannabis transaction in Washington from November 2014 to September 2017. They group the 80 million transactions into product categories (usable marijuana, sold edibles, liquid edibles, extracts, and other products) and create 31,502 observations at the product-retailer-month level. Using these data, they estimate a model for demand for product from a retailer as a function of average price that month, the type of product, and income in the local area around the retailer. With the results of the estimation and data on wholesale prices, and for some parts of the analysis coupling these to a model of competition among retailers, they reached conclusions differing markedly from those of Hansen et al. (2017). (Their specific results for demand elasticity are covered in a later section below.)

- The evidence points to a high degree of market power among retailers. Due to entry restrictions from licensing, retailers are able to charge high markups over wholesale prices.
- Producers have little market power; the evidence suggests that they are essentially selling at their cost of production as in a competitive market.
- Retailers pass taxes through to consumers more than fully; a \$1 increase in the wholesale cost of product (as, for example, created by the cannabis tax) is associated with retail prices rising by \$1.64 to \$1.72. The economic theory of tax pass-through shows that such large pass-through rates suggest that there is a high degree of market power among retailers.
- The state is still on the upward sloping part of the tax yield curve. When plotted against tax rates, the tax revenue curve is hill shaped; increasing tax rates when they are low increases revenue, but after some threshold further increases in rates decrease revenue because too much economic activity is made uneconomic.²⁰ Despite having the highest cannabis taxes in the U.S., the evidence suggests that raising taxes would bring in additional tax revenue.
- The evidence suggests that diversion to illicit markets (either of product or consumers) is not a large problem.

The final point requires comment. The authors state that “there is not a widely available black [sic] market where consumers may find substitute products” based solely on the finding that the demand elasticity for cannabis as a whole market is roughly unit elastic (around -1.0). They argue that such demand is “fairly inelastic,” meaning that when the price of licit product rises, consumers do not all turn to illicit sources of supply. This argument is overstated, as demonstrated by reference to tobacco markets. Canada in the late 1980s and early 1990s had a thriving illicit market in cigarettes supported by high excise taxes on tobacco. Gruber, Sen, and Stabile (2003) report that smuggled cigarettes made up about one-third of all Canadian cigarette consumption at the height of the illicit market. Nevertheless, these authors estimate that the elasticity of legally sold cigarettes with respect to fully taxed price, without accounting for the

¹⁹ Part of the difference is because the sales tax was applied to the excise-tax-inclusive price before the change and to the tax-exclusive price afterward.

²⁰ In the context of macroeconomics, the tax revenue hill is known as the Laffer curve.

presence of the illicit market (i.e., the same setup as in Hollenbeck and Uetake (2019)), is -0.72. Although the Hollenbeck and Uetake (2019) study shows that price elasticities much lower than unit elastic can coexist with thriving illicit markets, the research is limited due to difficulty gathering data from the illicit market.

The conclusions of Hollenbeck and Uetake (HU; 2019) differ from those of Hansen et al. (HMW; 2017) in several regards: does market power reside with producers (HMW) or retailers (HU)? Is tax pass-through closer to 45% or 165%? Would increases in the tax rate bring in additional revenue (HU) or not (HMW)?²¹ In part these differences may stem from the quite different nature of variation in the data. The HMW study looked at activity a few days before and after a one-time change in prices, whereas the HE researchers identified their estimates using variation across the entire period of the legal market in the state. However, methodology and treatment of the data also differ, and it will be important to study the Washington experience further to reconcile these results.

Price elasticity of demand for cannabis

Price elasticity is a unit-free measure of how demand for a product responds to changes in its price; a price elasticity of a means that for every 1% increase in price, the quantity demanded increases by $a\%$. For cannabis purchased in illicit markets, when the price of the illicit good rises a consumer may purchase less because of income constraints, switching some or all consumption to substitute drugs (e.g., alcohol). For licit cannabis, when the price of the regulated and taxed product rises, a consumer has an additional consideration: whether to switch some or all purchases to the illicit market. For any one consumer, the decision to switch away from the legal market may be a discrete choice (all demand is shifted) or gradual and progressive. In the former case, the individual's participation elasticity of demand for the legal good is interpreted as the percentage change in the *probability* that the choice is made to switch to the illicit market. Key factors for each consumer facing this decision include the quality assurances, perceived avoided negative health consequences, and legal protections offered by the legal market as opposed to illicit products. Aggregating to the market level smooths out the impact of individual consumers' triggering price points, and the total quantity demanded responds essentially smoothly to changes in price.

Given the nature of the data available from illicit cannabis markets, the most common elasticity to be estimated is the participation elasticity. As with other products such as tobacco, there are at least two relevant margins for the demand function. On the *extensive* margin, a consumer decides *whether* to smoke (tobacco) or consume THC in some form (cannabis). At the *intensive* margin, a cannabis user decides *how much* to use. Some of the cannabis studies introduce an intermediate margin of conditional use in which a consumer who has already initiated cannabis use decides whether to use within a past given period (e.g., a week or month). Since data on initiation and yes-no questions on recent use are more commonly available from surveys than are data on the quantity of use, most published elasticity estimates for demand in illicit cannabis markets are for the extensive or intermediate margins.

Several studies from the early 2000s informed policy makers at the time of the legalization debates and policymaking. For example, in a report for Colorado in 2015 (Orens et al., 2015), all the studies cited regarding demand elasticity were from 2001 to 2005 (Farrelly et al., 2001, Pacula et al., 2001, 2003; and Jacobson 2005).

Initiation (often by youth) is typically found to be sensitive to prices. Early studies on the extensive margin find elasticities with respect to prices in the general range of -0.3 to -0.7,²² although some studies report some elasticities near zero (Pacula et al., 2001). As with any elasticity, these figures may be interpreted as the percentage change in quantity studied (here, the initiation rate) given a one percent increase in the driving factor (here, prices). Thus, the main range of estimates implies that a 10 percent increase in prices is associated with a 3 to 7 percent decline in initiation rates of

²¹ While HMW find that in the very short run of a week or less, the elasticity of demand is such that there are temporary increases in revenue from a tax hike, they also show that in as little as two weeks this result is reversed (Hansen et al., 2017, p.26).

²² See the review by Pacula and Lundberg (2013). Given the particular surveys employed, some of these studies appear to commingle the extensive and intermediate (conditional use) margins.

cannabis use. Later reviews of the literature come to similar conclusion. Gallet (2014) performed a meta-analysis on 13 cannabis studies and found participation elasticity (i.e., the probability of use with respect to price; the extensive margin) to be about -0.3 (which, incidentally, is about half that of other illegal drugs).

For studies looking specifically at conditional use (the intermediate margin), the review in Pacula and Lundberg (2013) shows that the 30-day participation elasticity is measured to be in the range of -0.24 to -1.0, with most studies in the range of -0.24 to -0.31.²³ Estimates of the total demand elasticity, which combines all margins to arrive at the sensitivity of the quantity of cannabis consumed to price, are rare since data on amount of consumption are less common than participation data. Pacula (2010) estimates the total demand elasticity to be -0.525, which can be broken down into an extensive margin of -0.3 and an intensive margin of -0.225. In some of the most recent work involving illicit cannabis markets, Jacobi and Sovinsky (2016) find an extensive margin elasticity of -0.2 and an intensive margin elasticity of -0.17, for a total demand elasticity of -0.37.

In summary, evidence from a few decades of studies on illicit market participation and consumption show that consumers respond to price on all margins. This necessarily implies that unless tax pass-through to consumers is zero or negligible, taxes will discourage initiation and use. However, none of those studies were able to address how raising the price of high concentration products might shift demand to lower concentration products. Furthermore, the uncertain nature of the data used in the studies makes administrative data from legal markets an attractive target of study.

Both of the econometric examinations of the Washington market estimated the price elasticity of demand. Hansen et al. (2017) were the first to study demand elasticity in a legal market for cannabis. They found that the very short-term (within a few days) price elasticity in response to the tax change in 2015 was -0.43, although the estimate is not statistically significant (i.e., an elasticity of zero lies within the 95% confidence interval, which is very wide). The elasticity at two weeks rises in magnitude to about -1.0. These estimates are for cannabis as a whole. Hollenbeck and Uetake (2019) find that the demand elasticity for individual retailer-product type combinations is more elastic, as would be expected. When a retailer unilaterally raises prices for a product type such as usable marijuana, many consumers may be expected to switch to other (cheaper) products or retailers. They find demand elasticities for cannabis products are on average between -2.8 and -3.5. Taking the cannabis market as an undifferentiated whole, they find that the average elasticity for marijuana products in aggregate is -1.1, which is strikingly similar to the medium-term estimate of -1.0 of Hansen et al. (2017).²⁴ The results of both studies thus lead to the conclusion that taxation could have significant effects on reducing total consumption of cannabis.

Taxing concentration

The idea of taxing cannabis by concentration was first discussed in the academic literature by Robert MacCoun (2010). Justifications proposed for a potency tax, whether directly on THC or on the THC:CBD ratio, mainly focus on discouraging heavy use and health harms by nudging users toward lower-potency product (MacCoun, 2010, 2014; Caulkins, et al., 2013, 2015; Kilmer, 2017). These authors refer to evidence that high-potency cannabis, especially when coupled with relatively low CBD concentrations, may increase the risk of psychosis and lower the age of onset of schizophrenia (Di Forti et al., 2009, 2014, 2015). There is also evidence that dependence on cannabis (in the clinical sense) has increased as potency has risen over time. Of course, such associations may not be causal in the direction of cannabis use to harm or higher potency to dependence, and researchers recognize that there is a need for further understanding of the mechanisms involved (WHO, 2016).

Taxes on THC concentration are often prompted by concerns that the potency of cannabis products is rising. The available evidence indicates that the THC concentration of cannabis sold in illicit markets has been rising for decades.

²³ The lone study outside that range, arriving at a unit-elastic participation estimate, is from the 1970s

²⁴ The Hansen et al. (2017) estimate pertains to a period of two weeks, whereas the estimate of Hollenbeck and Uetake (2019) is based on monthly data.

Ben Lakhdar et al. (2016) present figures from France and the U.S. showing marked upward trends in THC concentration in resin, herb, and all cannabis products. A comprehensive report by the World Health Organization (WHO, 2016) discusses several studies showing that average THC concentration levels of seized product in the U.S., beginning with 2% in 1980, rose steadily through the 1990s and 2000s until they were about 9% in 2008.

The same upward trend appears to hold in the newer legal markets for cannabis. “Washington’s legal cannabis market has trended towards higher-THC product.” Smart, et al. (2017). A few years after legalization, that study found that more than 92% of all cannabis flower sales had THC concentrations of 15% or higher. Of particular concern is the following comparison: “Compared to estimates from illicit cannabis markets, THC potency is strikingly high for flower (mean 20.6%) and extracts for inhalation (mean 68.7%).” This striking increase in THC concentration in domestically produced product is a change from the era before legalization, in which increasing potency in the U.S. was driven by imports instead of domestically cultivated product.²⁵

Given the concern about rising potency it is unfortunate that so little is known about how consumers might respond to differential taxes on cannabis products with different concentrations of THC or THC÷CBD. Some authors note that experience from similar markets show that tax changes can influence relative market shares of similar products. Caulkins, et al. (2013) mention the connections between demand for cigarettes and the demand for pipe and fine-cut tobacco, since the latter can be used to roll cigarettes at home. Experience in the U.S. and elsewhere has shown that when taxes are raised on cigarettes but not loose fine-cut tobacco, some consumers switch to the relatively cheaper good. A systematic review of the relevant literature found that there is a positive substitution effect between cigarette and such non-cigarette tobacco products (Jawad, et al., 2018). Usable marijuana that differs only in THC concentration may be expected to be even more closely related in users’ minds.

Available evidence, although sparse, suggests that consumers do consider concentration when selecting cannabis products. In Colorado, Orens et al., (2015) made broad comparisons across product classes (e.g., flower, concentrates, and edibles), noting that prices are very roughly proportional to THC content.

The two studies specific to Washington State are useful in this regard, as the following rough calculations demonstrate. Hansen et al. (2017) find that because of the tax change in 2015, quantity (sales) rose by 2.2% and THC content declined by 1.8%. Dividing the former by the latter (a calculation not explored in their paper) implies an elasticity of demand with respect to THC concentration of 1.2. Dividing this demand elasticity by the aforementioned price elasticity of demand from the same study (-0.43) yields the ratio 2.8, which implies that a 1% increase in price has the same impact on the quantity demanded as a 2.8% increase in THC concentration. This ratio thus speaks to how consumers viewed the tradeoff on average between price and potency at the time of the tax change in 2015. This result can be compared with that of Hollenbeck and Uetake (2019), that a one percentage point increase in THC concentration increases the monthly average retail price per gram of cannabis product by 0.8 to 1.0 cents. Assuming that THC of flower averaged about 20% in the state, as mentioned from another source above, and taking the average price per gram of usable marijuana of \$9.02 reported in the paper, these figures imply that a 1% increase²⁶ in THC concentration is associated with an increase in retail price of 0.1%. This figure is not directly comparable to the substitution ratio computed above since the quantity demanded is not being held constant here. However, both figures imply that consumers *do* respond to prices and concentrations and that there is therefore some degree of substitution between products of differing potencies to be expected.

Before leaving this topic, it is worth noting that one commentator in the field of tax policy, after discussing potential difficulties with testing concentration in a verifiable, non-gameable way, concluded that “the tax code’s approach to THC may have to more closely resemble its treatment of nicotine than of alcohol; although alcohol is frequently an important

²⁵ “The increase in cannabis potency in the USA was mainly due to the increased potency of imported rather than domestically-produced cannabis...” (section 2.1.3 of WHO (2016)).

²⁶ Note: not a one percentage point increase.

determinant of a product's tax rate, no jurisdiction in the world taxes tobacco by nicotine content" (Davis, Hill, & Phillips 2019).

5. Background: Potency and public health

Cannabis is a psychoactive drug, with behavioral and psychological changes that are correlated to short and long-term effects. The primary psychoactive ingredient in cannabis is delta-9 tetrahydrocannabinol (THC). In legal marketplaces, the amount of THC in a product is referred to as “potency” despite the pharmacological inaccuracy of the word for that purpose.²⁷ Typically, loose marijuana and pre-rolled joints contain, as labeled, between 20 and 30% THC. Edibles in Washington State can contain up to 10mg THC per serving. Concentrates used in flash vaporization range in potency between 80 – 95%, though some products have tested higher than that.

The method of administration affects THC “bioavailability,” defined as “the degree to which a drug or other substance becomes available to the target tissue after administration.”²⁸ Cannabis is most commonly smoked, in either pipes or cigarettes. A 2005 study found that smoked cannabis has an average of 30% bioavailability, though the product used for testing was of very low potency.²⁹ Vaping seems to increase bioavailability, with tests indicating it reaches as high as 50 – 80%.

The link between public health and the potency of cannabis products is therefore not straightforward. Potency is not the only determinant of health risk, so there is no established method for relativizing the risks or harms of different product types at this time. Notice must also be taken of other negative health consequences such as the inhalation of burned material or the unknown components of vape devices and cartridges. Furthermore, bioavailability, method of administration and frequency of use contribute to health assessment. For example, vaping cartridges tend to have higher potency and increased bioavailability than a joint, but the lack of combustion reduces the risk of damage to the lungs. Similarly, concentrates are typically high in potency, but may not be used as often as vaping or smoking.

Current Research

Most research on the impact of cannabis use on health has been conducted using cannabis much lower in potency relative to what is now available in the state-regulated market. Prior studies identifying health impacts of cannabis use may not be particularly relevant in understanding the health impact of today’s products. As Keith Humphreys writes,³⁰ “‘old cannabis,’ or product that was dominant in the U.S. throughout the 20th century, is unlike the cannabis we see today and most of what is understood regarding public health and cannabis use is based on research of ‘old cannabis.’” Further, as the higher-potency products are relatively new, their long-term impacts are not yet well studied or understood.

Impacts of Cannabis Use

Short-term impacts of cannabis use include “intoxication marked by disturbances in the level of consciousness, cognition, perception, affect or behavior, and other psychophysiological functions and responses.” Most commonly, cannabis use affects attention, concentration, memory, and motor skills for as long as 24 hours after use.³¹ Some users may experience anxiety, panic attacks, or hallucinations, especially first-time users, though this appears to be more associated with high-potency products.³² In a recent study, researchers found an association between cannabis use and schizophrenia, noting

²⁷ The pharmacological definition of potency is the expression of the activity of a drug in terms of the amount needed to produce a defined effect. Because the bioavailability of THC depends on more than just the concentration (as discussed next in the text), potency in the correct usage of the term cannot be measured only by THC concentration in a product. Nevertheless, given the common usage of the term in policy discussion, this report does not use the term “potency” only in its exact pharmacological meaning.

²⁸ American Heritage Medical Dictionary

²⁹ McGilveray, I. J., 2005.

³⁰ Marshall Project Virtual Roundtable with Maria McFarland Sánchez-Moreno, Keith Humphreys, Mark Kleiman, and Alex Berenson. (2019, January 14). How Dangerous is Marijuana, Really? Retrieved from: <https://www.themarshallproject.org/2019/01/14/how-dangerous-is-marijuana-really>

³¹ Crean, R. D., Crane, N. A., & Mason, B. J., 2011.

³² Crean, R. D., Crane, N. A., & Mason, B. J., 2011.

that individuals with a genetic risk for psychotic disorders may be more likely to engage in drug use.³³ Other evidence suggests that cannabis use is associated with lowered age of onset of schizophrenia, though the causal mechanisms are not well-understood.³⁴

In the long term, regular cannabis use may impair memory formation and learning ability and result in dependence or addiction.³⁵ Cannabis use disorder (CUD), which affects roughly 9% of users, is marked by continuous cannabis use despite negative consequences, including diminished quality of life via lost jobs, failing marriages, exacerbated mental-health problems, and an inability to quit cannabis use despite expressing the desire to do so.³⁶ The number of people presenting with CUD has increased substantially in recent years, though we do not know whether this is driven by more people engaging in problem use or by individuals being more willing to seek professional help.³⁷ In the long term, smoking cannabis can produce symptoms of chronic and acute bronchitis and may increase the risk of cancer and other respiratory diseases.³⁸ Other negative symptoms associated with long-term use include cognitive impairment, depression, and suicidal thoughts and behaviors.³⁹

Potency levels appear to affect the symptoms of cannabis use. A recent study in the United Kingdom found a three-fold increased risk of developing psychosis among users using high-potency products.⁴⁰ Further, the number of patients seeking emergency medical care for severe abdominal pain and uncontrollable vomiting after cannabis use is on the rise, though we do not yet know what potency threshold contributes to these symptoms. High-potency cannabis use is also associated with higher levels of dependence, negative impacts on cognitive ability, and increased paranoia.⁴¹

A study of emergency room visits in Colorado found that nearly 10% of cannabis related visits were related to consumption of edibles and that individuals were more likely to report acute psychiatric symptoms, intoxication, or cardiovascular symptoms due to edibles than visits attributed to inhaled cannabis.⁴² On the other hand, for visits attributed to inhaled cannabis, individuals are more likely to report severe vomiting. The bioavailability of edibles differs from that of inhaled cannabis, so there may be a perceived stronger “high” from edibles (Orens et al., 2015).

³³ National Academies of Science, Engineering, and Medicine, 2017.

³⁴ World Health Organization, 2016.

³⁵ World Health Organization, 2016.

³⁶ Lowrey, A., 2018 August 20, America’s Invisible Pot Addicts, Retrieved from:
<https://www.theatlantic.com/ideas/archive/2018/08/americas-invisible-pot-addicts/567886/>

³⁷ World Health Organization, 2016.

³⁸ Volkow, N. D., Baler, R. D., Compton, W. M., & Weiss, S. R., 2014.

³⁹ Volkow, N. D., Baler, R. D., Compton, W. M., & Weiss, S. R., 2014; Delfortherie, M. J., et. al, 2015.

⁴⁰ Stuyt, E., 2018.

⁴¹ Freeman, T. P., & Winstock, A. R., 2015.

⁴² Monte, A. A., Shelton, S. K., Mills, E., Saben, J., Hopkinson, A., Sonn, B., ... & Williamson, K., 2019.

Differential impacts of varying product types on THC absorption and health

Recent news articles are also causing alarm about the potential health consequences of vaping – which, in some circles, is considered (and indeed may still be) a safer alternative to inhaling smoke. At the time of writing, the DFA and Centers for Disease Control and Prevention have recorded over 1000 cases of vaping-related lung illnesses across 46 states and one US territory and 12 deaths from illnesses related to vaping THC-containing oil.⁴³ “The latest findings from the investigation into lung injuries associated with e-cigarette use, or vaping, suggest products containing THC play a role in the outbreak.”⁴⁴

Symptoms included chest pain, difficulty breathing, nausea, vomiting, and diarrhea. “Federal health officials have said they don’t know the exact cause, and are studying vapes and their contents in search of a common link among illnesses.”⁴⁵ It appears that the majority of these cases arise from illegally sold vaping material (which may contain substances that the regulated market has eliminated), but it is too early to attribute accurately the source of this morbidity and mortality. The recent outbreak has highlighted the fact that we do not fully understand the harms associated with vaping.

Public health experts are also alarmed about the rise in popularity of ‘dabbing’ or flash vaporization of concentrates such as wax, budder, or shatter. Dabbing puts a large amount of the psychoactive cannabinoid into the consumer’s body without necessarily allowing the same degree of titration that is afforded by other methods of consumption. Other than increasing exposure to THC, the long-term consequences of this method of cannabis consumption are not known.

⁴³ https://www.cdc.gov/tobacco/basic_information/e-cigarettes/severe-lung-disease.html

⁴⁴ Outbreak of Lung Injury Associated with E-Cigarette Use, or Vaping Available at https://www.cdc.gov/tobacco/basic_information/e-cigarettes/severe-lung-disease.html Accessed 10/1/2019

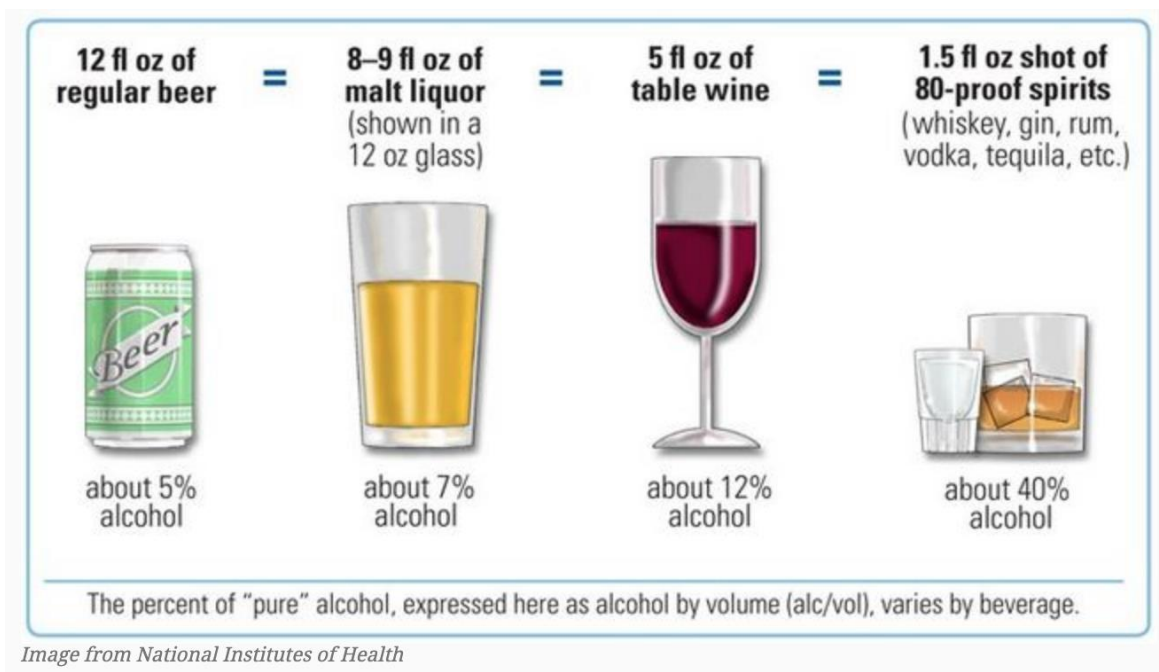
⁴⁵ Naftulin, J. and Court, E. (2019, September 23). Black market marijuana vapes containing substances like alcohol and caffeine may be to blame for spate of mysterious lung illnesses. Retrieved from: <https://www.businessinsider.com/vaping-lung-diseases-may-be-linked-black-market-marijuana-products-2019-9> Accessed 9/24/2019

6. Synthesis: Why tax cannabis by potency

Defining potency

One immediate issue facing any attempt to tax potency is identifying what it is that you are trying to tax. It seems intuitive that the goal of a potency tax is to tax the propensity of a product to cause impairment, in which case THC concentration is used as a proxy for a product's propensity to cause impairment. However, using THC concentration as a proxy in this manner is problematic for several reasons.

Online chatrooms and cannabis forums frequently see calls to "tax cannabis like alcohol," and in one sense alcohol does provide an archetype of a cannabis tax, with higher potency products taxed on a different basis than lower potency ones. The relationship between the concentration of ethanol in a product and the product's propensity to cause impairment is roughly linear.⁴⁶



Although the ability to metabolize alcohol varies according to a number of factors including body mass and tolerance, many drinking adults know that the average body can metabolize the ethanol in a standard serving alcoholic drink in approximately one hour. Cannabis does not have a linear relationship between consumption and intoxication, nor is it understood how cannabinoids are metabolized or tolerated. There is no evidence that cannabis intoxication or tolerance is related to body mass or sex as understood with alcohol.

Another issue with the notion of using THC concentration as a proxy for potency is that different modalities of administration differ widely in the portion of their THC that they deliver to the consumer's blood stream. Researchers at Johns Hopkins conducting a recent study on impairment found that vaping cannabis products of standardized 10% and 25% THC concentrations led to a statistically significantly greater degree of impairment compared with smoking cannabis products of the same concentrations.

⁴⁶ For example, Evans, et al. (1974) found that psychomotor performance deteriorated linearly with increasing blood alcohol content (BAC). Furthermore, BAC rises linearly with drinks consumed in standard blood alcohol charts for estimation (see <http://www.breathalyzeralcoholtester.com/alcohol-chart-estimation>).

Unlike alcohol, in which case a single chemical compound (ethanol) causes impairment, the impairment caused by cannabis consumption results from the interaction of a large number of cannabinoids. The most well understood cannabinoids are THC and cannabidiol (CBD) though there may be hundreds of other cannabinoids present in a single product. Ostensibly, similar products like two cannabis cigarettes with a stated THC concentration of 21% might intoxicate very differently based on the presence or ratios of other psychoactive compounds. The way in which different cannabinoids and terpenes interact synergistically with each other to produce a user's experience of a high is referred to as the "entourage effect."⁴⁷ It has been suggested that, if a potency tax is targeted to tax impairment, the taxing authority might offer some relief to products that matched THC with CBD, since CBD serves as something of an antagonist to THC. And, "since we are still learning about cannabinoids and how they interact, one may want to design a tax regime that can be easily amended to incorporate new insights."⁴⁸ But this dynamism comes at a price – as each time regulations change the adaptation and compliance costs favor larger better-capitalized firms, thus risking further concentration of the market.

Even at the most basic level, differences in individual smoking technique may lead to different levels of impairment. A smoker who inhales deeply or often is likely to achieve a significantly higher degree of impairment than a smoker who doesn't inhale or does so less frequently.

"Given how little we know about the effects of different cannabinoids and how legalization will actually play out, especially with respect to alcohol consumption and the federal response, at this point it may make sense to think of revenue regimes for legal marijuana as learning experiments rather than permanent fixtures and, as Oglesby argues, to design nimbleness into marijuana tax systems."⁴⁹

Reasons for taxing THC

According to Robert MacCoun, "there are fairly compelling reasons to consider taxing by THC content, and perhaps by the THC:CBD ratio," (see MacCoun 2010, Caulkins et al. 2012). Evidence now suggests that cannabis is considerably more potent than a generation ago (McLaren et al. 2008). Plausible evidence also suggests that users are limited in their willingness and ability to titrate their doses, and that increased THC consumption (and a rising THC:CBD ratio) bring increased risk of harmful health and safety consequences, including dependency (Di Forti et al. 2009, Hall & Degenhardt 2009). Taxing by weight can encourage this troubling trend toward higher potency; taxing by content could help to discourage it by pushing users back toward the "softer" products of earlier decades."⁵⁰

Caulkins et al. outlined the following goals for legalization that any successful tax structure would have to balance:

- Maximizing tax revenues,
- Battling the illicit market and violence by those involved in the drug trade,
- Limiting the increase in marijuana misuse and dependency,
- Minimizing the use of particularly risky and unhealthy forms of marijuana,
- Limiting gray-market tax evasion, and
- Minimizing the cost and complication of enforcing the marijuana tax structure.

On this basis, a potency tax is promising in at least three ways. First, taxing THC could protect public revenues in the event that prices declined without a commensurate rise in sales volume. This could be especially important in the event

⁴⁷ Ethan Russo has written extensively on the topic of the entourage effect.

⁴⁸ Caulkins, et al., 2013, at 1054.

⁴⁹ Caulkins, et al., 2013, at 1068.

⁵⁰ MacCoun, R., 2014, p. 42.

of federal legalization since states with mature markets would have to compete with each other. Interstate competition would likely bring a further reduction in prices, with consequent loss of tax revenue. Currently legal states that have become used to the revenues from cannabis taxes would have more to lose than newly legalizing states poised to create tax schemes from a blank slate. A potency tax is one mechanism by which states could protect their revenues (less, of course, unintended consequences such as smuggling from lower-tax states driven by tax differentials eroding revenues).

Second, a potency tax could create new revenues from higher potency products as the young market continues to innovate. If we see further price declines, even coupled with increases in gross sales, a tax on potency could ensure that the amount of THC sold would not increase in comparison to revenues. In these scenarios, a potency tax may in itself constitute a means to protect public health, but the feature of a potency tax that best serves public health is the fact that price increases are effective behavior changers for two vulnerable groups: youth and frequent/problem users. Thus, it is also hoped that a potency tax could encourage consumers to make less potent product selections the potency tax might reduce the harms to which they are exposed. Testing labs are already required to test all material going to retailers, and the technology exists to have the THC potency figure associated with a global product ID number, which could then be rung up in the store by the bud tender at the point of sale.

In summary, the main reasons to tax THC as opposed to sales price are as follows:

- Protect tax revenues in the event of declining product prices and create new revenue streams as new products come to market.
- Protect public health by nudging consumers to select less potent products.

7. Regulatory options and challenges

A well-designed tax should not only accomplish the primary goals of protecting revenues and public health, but also promote fairness, tax morale, and auditability.

We present four practicable models for taxing THC, each with advantages and disadvantages. These considerations should influence the assessment of which, if any, model for taxing cannabis by potency of THC is feasible. This section will consider design challenges related to imposing a potency tax in Washington State, followed by a discussion of specific tax approaches.

Challenges and Potential Responses

The design of a hypothetical potency tax should consider the logistical and theoretical challenges to its effectiveness and feasibility. Such challenges include the integrity of the cannabinoid testing system; the ability to use traceability systems to facilitate and audit compliance; the potential for licensees or consumers to creatively respond to a tax with attempts for tax avoidance (“gaming”); the lack of an extensive research knowledge base about the harms of various cannabis products; and the potential for a tax burden on medical users.

Precision and Integrity of Cannabinoid Testing System

In Washington State, there are concerns about the precision and accuracy of cannabinoid testing. A potency-based tax would place additional importance on the integrity of cannabinoid testing. Imprecision in cannabinoid testing risks tax obligations that are unpredictable or unfair. Accuracy could be either damaged or strengthened by a potency tax, depending on policy details. Both are important to facilitate tax planning and auditing. Therefore, a hypothetical potency tax should be imposed in a way that avoids placing additional stress on these known vulnerabilities.

Washington State’s sampling-based method of potency testing is expected to include some amount of imprecision due to sampling variation. When a number of different samples are randomly selected from a lot of heterogeneous cannabis, a range of potency results is generated. This problem is exacerbated by varying methods and standards across laboratories and potentially inconsistent procedures within individual laboratories. Lack of precision in sampling and testing could introduce an element of random chance into tax obligations, obstructing tax planning and reducing perceived fairness (at a cost to the regulator’s enforcement capacity).

The natural variation of cannabinoid concentration occurring across a cannabis plant is one cause of imprecise potency testing. The New Zealand Institute of Environmental Science and Research’s experimental cannabis harvest recorded “extreme variation in potency, not just between plants, but even between samples taken from the same plant.”⁵¹ Flower higher on the plant tends to be more potent than lower flower, and we are informed that the third node from the top tends to be the most potent. In 2018 BOTEC interviewed producers who reported that they sent two halves of one bud to different testing labs and received much different results.

Complicating this is the practice of allowing producers to collect their own samples. Given the price premium paid for products with higher posted THC content, producers may choose samples expected to have higher-than-typical THC content. One way to do this is by selecting flower from the parts of the plant that are known to receive favorable amounts of light or nutrition, e.g. from buds on the top of the plant.

The expected magnitude of variation from a random sample is smaller for products that are more easily homogenized. Even random samples from blended cannabis flower can generate inconsistent test results. Liquid concentrates are the

⁵¹ MythBusters: Cannabis potency. Here’s more: “‘Reliability and replicability of testing remain problematic,’ wrote Carl Davis, Misha E. Hill and Richard Phillips of the Institute on Taxation and Economic Policy in a 2019 policy paper. ‘Cannabis testing laboratories lack the regulation and oversight that most other public health and safety labs require. Thus, there is not yet an industry standard and testing results may vary.’”

easiest category of products from which ascertain THC content to tax, but not all concentrates are liquid. To the extent that solid concentrates such as shatter (and semi-solid dabbing materials like “wax” and “budder”) are less homogeneous than liquid concentrates, they are more difficult to sample. Concentrates that are infused or contained in other products for retail sale, such as those that go into edibles, sublinguals, tinctures, topicals, suppositories, and other processed cannabis products are additionally difficult to test accurately after being mixed with other ingredients.

Though the current level of precision may be adequate for the purposes for guiding consumer choices, it may not be sufficient as the basis for levying taxes. As RAND’s Vermont report noted, “The threshold for a potency tax base is whether it can provide replicable, auditable results, close enough for the government work of honest taxation. If the tax can be gamed, some taxpayers will try to beat it, and the state will try to stop them – at a cost, possibly a significant one... Ensuring representative samples would be critical for an auditable THC tax.”⁵²

Bias

Due to the premium paid for high-THC product, licensees are incentivized to attempt to inflate the reported amounts of THC and other cannabinoids in their products. Further, the ability to self-select tested samples and also choose the laboratory to perform their tests has allowed some licensees to follow that incentive, leading to systematic inflation of THC results. (In some cases, there have also been allegations of more egregious violations, such as diluting concentrate product after it has already been tested.)

Counter-intuitively, rather than putting additional stress on an already fragile testing regime, imposing a potency-based THC tax may actually *strengthen* the integrity of the current THC testing scheme. Because customers are generally willing to pay higher prices for more potent products, producers and processors are incentivized to take actions that will lead to higher tested cannabinoid content; for example, by modifying how they select the sample of a product or selecting a lab based on a tendency of the lab to overreport potency. However, the imposition of a tax based on THC content would introduce a countervailing pressure in the opposite direction, particularly if the tax were designed to impose a tax on each milligram of THC content. Imposing a THC tax could balance existing incentives in a way that would encourage accuracy in product potency testing.

Systems for tax compliance and reporting

Another challenge relates to data systems for tax compliance and auditing. A comprehensive traceability system would be one such system, though alternatives are also available.

Collecting tax at the cash register could be administered directly, on the basis of the amount of THC listed on the package label. However, it may be problematic to rely on bud tenders to calculate and add such a THC tax correctly based on package labeling in a busy retail environment without assistance. One option would be for this data to have been previously entered into a POS system before checkout; in that case, a modified POS system could automatically compute potency tax obligations. An alternative to pre-entering data into the POS system could require a bar code or QR code on each package reflecting the amount of THC tax, similar to how packages of cigarettes bear distinct state tax stamps. Once flower or concentrates were labeled and sealed by processors, the product could be affixed with a code linking to an electronic record of THC content, additional identifying information from the Certificate of Analysis (COA), and perhaps also the amount of tax due per product unit. Such a system would relieve the burden on the POS systems to calculate tax obligations. One advantage of this electronic system is that, as a check on tax avoidance, once the tax is calculated at the point product leaves the laboratory, the recipient could be asked to claim tax responsibility for the whole delivery, and proper tax payment could be audited based on POS records.

However, retailers may want to continue the present commercial practice of having after-tax prices end in round dollar numbers (an advantage when cash is frequently used in transactions). If so, they would need to include potency tax

⁵² RAND-Vermont, page 81

obligations tax in arriving at their final after-tax price, as they do now by including ad valorem excise and sales taxes. This would complicate the work of retailers – adding a step to their inventory management process before the point of sale to maintain their pricing method.

The requirement that labeled products show a bar or QR code would tend to impose greater burdens on small operators, since the cost of such a system might be relatively fixed, though one producer with whom we raised this option envisioned a case where codes (and other enforcement mechanisms less costly than traceability) would replace the current traceability system altogether, which together may lighten their compliance costs.

Given limitations of the current traceability system, such alternatives provide a more manageable approach to ensuring tax payment and auditing.

Gaming

There would remain some opportunities for producers to attempt to game the system. A per milligram THC tax could encourage sellers to state low THC for tax purposes but convey a message that their products are highly intoxicating, potentially through marketing and on-package messaging. Claims about terpenes, other cannabinoids, and other product characteristics might alert the consumer to the promise of an inaccurate tax declaration.

Product-type based potency taxes may have the advantage of making tax determinations simpler; it is harder to misrepresent a highly concentrated, highly taxed product, such as an extract, for a low-concentration, low-tax product, such as flower.

Taxing by product type makes gaming more difficult for licensees, but it leaves room for consumers to exploit the tax rules by using a product in a way other than as advertised. For example, distinguishing concentrate oil (e.g., RSO) as a sublingual extract as opposed to a “dabbable” extract might yield lower taxes. Stakeholders report that processors pitch RSO as something that may be consumed either orally or through flash vaporization, so the user might buy a product marketed for a lower-tax use and exploit its versatility. Similarly, they reported that infused coconut oil may be sold as a topical but can be consumed as an edible.

Incomplete evidence base

We lack the scientific knowledge to be able to determine the relative harms of THC consumption. The notion that >35% THC cannabis is more harmful than <35% THC cannabis rests on weak empirical ground. In order to be truly effective, a potency tax would have to go further, comparing harms of THC consumption not only in absolute terms, but also relative to the different modalities of consumption. We are a long way from knowing the comparative health risks of smoking 15% THC bud as opposed to vaping 15% THC oils or eating a 15% THC candy.

A product-based potency tax meant to protect public health would need to account for the relative trade-offs between THC-related harms and the product-type-specific harms. This early into the legalization experiment, and with federal law still forbidding most human-subject cannabis studies, we cannot answer this question. A host of factors beyond intoxication might be taken into account in taxing. Good factors would lead to less tax, bad factors to more. Smoked material may be bad for the lungs, but smoked material allows easier titration than edibles. Empty vape cartridges become non-biodegradable trash. Any harms could influence tax design, but very little definitive research about the relative harms of cannabis products exists.

Unpredictable consumer response

Microeconomic theory suggests that raising the price of a given product will cause consumers to respond by shifting some share of their consumption to a substitute. In the case of a cannabis potency tax, this could manifest in a number of ways depending on the structure of the tax: shifting from one product type to another; from products in one potency range to a lower range; from the licit market to a similar product produced in the illicit market or at home; from THC-heavy cannabis products to CBD- or terpene-based products; or finally to reduce their cannabis consumption altogether.

These propensities to do so are identified as price elasticities and cross-elasticities; however, these elasticities are not well known (see Chapter 4). Further, some of these shifts are likely to expose consumers to different harms which would count against any health benefits delivered by a tax on THC. For example, taxing edibles substantially more than flower would create an incentive for people to make edibles themselves. The risk is that homemade edibles are difficult to dose, which could lead to an increase in over-consumption of THC. Shifts to illicit sources would negatively impact public revenues and expose consumers of un-regulated products to possible health harms. According to the 2018 RAND BOTEC report, Washington State incorporated at least 50% of the state's demand for THC into the regulated marketplace, but the illicit market in Washington State has not disappeared.

Tax preferences for medical use cannabis

Because taxes tend to discourage consumption of the good or activity on which the tax is imposed, it is a common principle of tax design to avoid selecting a tax base that is inherently beneficial for the public good. Further, the burden of any tax will fall disproportionately on those who consume and purchase it in the largest amounts. This raises a complication with the tax treatment of individuals who use cannabis for wellness or medicinal purposes, who tend to use larger amounts of cannabis.

Registered medical marijuana patients in Washington State enjoy an exemption from sales tax, but not from cannabis excise taxes. There are roughly 14,000 registered medical marijuana patients in Washington State. Reportedly, many other users who use for medical intent are not registered, with some purchasing from the illicit market. Patients have voiced frustration about the stipulation that they be registered at all in order to avoid this tax on a medicine. Interviews with medical patients recorded frustrations and fears that participation in the registration system would seem to threaten consumers' second amendment rights. Patients also feared having their consumer status used to bias legal hearings in cases such as custody battles, employment tribunals or divorce settlements.

Medical cannabis patients have some special needs, e.g. higher-potency products in order to treat ailments despite high tolerance, and additional protections from potentially harmful adulterants resulting from compromised immune systems. In order to relieve the tax burden on the use of medical cannabis, it may be desirable to impose lower taxes on products that are disproportionately used by medical patients, e.g., suppositories, topicals, and Rick Simpson's Oil. The opportunity to do so would be an advantage of a product-based potency tax.

However, even a product-based potency tax would not very effectively distinguish between unregistered medical and non-medical cannabis users.⁵³

Tax Options

Below we consider four different regimes for a potency tax: a tax per milligram of THC, by product type, by range of THC content, and finally a hybridized model.

Tax by milligram of THC

One regulatory option would be to establish a tax per milligram of THC. The higher amount of THC in a package, the higher the product's tax burden. While this option is the most simplistic in theory, it would require converting the labels on all packages into a milligram measurement. Currently, most cannabis product's THC content is expressed as a percentage rather than a number of milligrams. This would likely change product labeling, as well as how products are displayed in the traceability system, presenting a potential feasibility challenge and cost to businesses.

Taxing by milligram of THC has a great deal of theoretical appeal. There is a distant precedent for this provided by the

⁵³ The consumption patterns of medical cannabis patients are difficult to distinguish from heavy users who use for non-medical purposes. Like non-medical users, many medical patients prefer to consume cannabinoids in the form of dabbing solid concentrates or vaporizing highly potent oil cartridges.

potency taxes New York State⁵⁴ and Delaware⁵⁵ have imposed on prescription opioids. Potency is measured in terms of morphine milligram equivalents (MMEs). In legal commerce, these opioids pass through a stage in which they are homogeneous enough for reliable potency taxation.

Plant matter and concentrates allow different levels of precision in testing. Selecting a representative sample of dried flower is difficult. Liquid concentrates, meanwhile, may be as homogenous as liquor, for which potency-based federal excise taxation is broadly accepted.⁵⁶

The relative difficulty of measuring THC in raw plant material as opposed to concentrates has led jurisdictions to adopt bifurcated potency tax systems. Canada taxes concentrates now, and will tax processed products when they become legal for sale after October 17, 2019, by THC, at 1 cent per milligram.⁵⁷ It taxes raw plant matter at the greater of (1) weight, at \$1 per gram of flower and \$0.25 per gram of trim, or (2) 10% of retail price. Similarly, a Congressional proposal by Oregon's Sen. Ron Wyden and Rep. Earl Blumenauer would tax concentrates by THC and plant matter by weight.⁵⁸ Illinois' decision to distinguish between cannabis products based on a 35% potency divide establishes a de facto bifurcated potency tax system because in practice unprocessed plant matter is seldom if ever in excess of 35% THC, and most concentrates and extracts exceed this level.

Product-based potency tax

The simplest product-based potency tax would give specific excise tax rates to a small number of product types. Cannabis can be inhaled (either as smoked or as a vapor), orally ingested, consumed in capsule form, applied topically or sublingually, and used in suppository form. Cannabis products for sale in Washington State's recreational market include dried flower, edibles, capsules, tinctures, and liquid and solid concentrates. Though dry flower remains the largest market segment, following legalization there has been a trend towards more potent forms of cannabis. Further, the use of concentrates, especially dabs, has increased and the price for such products has decreased significantly. The wide range of pharmacological differences between these products (especially between the organic plant matter and the more concentrated forms) and a concern about a range of harms associated with the more potent product types have led to the suggestion that a potency tax could be designed in the basis of product type.

Many modern states impose cannabis taxes that distinguish between product categories, but these are generally levied at wholesale and on intermediate products. Alaska, California, and Maine impose separate taxes on flower and trim, and Colorado and Nevada impose taxes in a very similar way. Retail products manufactured downstream are therefore taxed indirectly, without any distinction based on the final retail form.

The simplest product-based potency tax would give distinct excise tax rates to a small number of product types. Both Canada and Illinois' tax structures have such features: Canada imposes an ad valorem and weight-based excise tax on plant matter, with a price-per-milligram potency tax on edibles, concentrates and topicals; Illinois' tax structure makes a quasi-distinction between flower and other smokable material by imposing a cut-off point of 35% THC, above which Cannabis products are taxed at 25% and below at 10%. Since no organic plant matter ordinarily exhibits THC content

⁵⁴ New York State Tax Code Article 20-D, section 498. New York's tax is based on price ranges: "(1) a quarter of a cent per morphine milligram equivalent where the wholesale acquisition cost is less than fifty cents, or (2) one and one-half cents per morphine milligram equivalent where the wholesale acquisition cost is fifty cents or more."

⁵⁵ In Delaware, the tax is labeled an "impact fee" is \$0.01 and is per MME generally, but "\$0.0025 per MME for a prescription opioid that is a generic substitution." Minnesota, instead of taxing, imposes a \$250,000 fee on certain opioid sellers.

⁵⁶ The Federal liquor tax reaches \$13.50 per "proof gallon," which is a gallon containing 100-proof spirits. A gallon of spirits of 80 proof incurs 80% of the federal excise tax of a gallon of spirits of 100 proof.

⁵⁷ <https://www.leafly.com/news/politics/canadas-2019-budget-thc-based-taxation-excise-tax-medical-cannabis>. We say "generally" in this paragraph because cannabis sold in Manitoba bears less tax.

⁵⁸ <https://thehill.com/blogs/pundits-blog/economy-budget/327694-marijuana-legalization-grows-closer-with-senate-tax>. The bill transitions to those taxes after a 5-year period of price-based tax.

exceeding 35%, the tax aims to be essentially a product-type potency tax.

If a product-based potency tax were imposed, it would not be clear which products to consider more high risk than the others and therefore, it would be difficult to establish which products should carry higher tax rates. Each carries different types of risks that are not easily quantified and directly compared. Dried flower is almost always smoked, and therefore carries risks relating to smoke inhalation. Solid concentrates are generally dabbed, leading to rapid intakes of very large amounts of cannabinoids. Edibles are disproportionately responsible for visits to emergency departments.

User intention is also important. The tax in Illinois makes a distinction based on whether product is intended for smoking. Product not intended for smoking is taxed at 20%, a lesser rate than high-THC products intended for smoking (25%). Rules such as these can be difficult to administer, since it is impossible to know how the user intends to use a given product.

Tax by potency range

The state could establish tax brackets tied to potency ranges. For example, Illinois applies a 10% ad valorem tax on smoked cannabis with a THC content below 35% and a 25% tax on smoked cannabis with a THC content of 35% or greater. Considerations for designing a tax based on potency ranges include: the extent to which the THC content correlates to public health outcomes, the ability of tests to accurately place products in categories, and the room such a tax scheme leaves for licensees and consumers to exploit (game) the rules.

Taxing by range of THC content means that more potent materials bear heavier taxes. Depending on the taxes applied to each bracket, this tax design could make higher THC products disproportionately more expensive than lower THC products, which would make them less attractive to consumers. A progressively more burdensome tax on higher THC ranges promotes public health only so far as THC is a proxy for harm. Several interviewees expressed a hope that a THC tax would reduce the effective tax rate on lower potency products. It is possible that showing tax ranges would make consumers less THC-centric by “blinding” them to reported single-point THC content, in which case the consumer fixation with THC might lose intensity which would benefit suppliers of heirloom strains. But that hope seems ill-placed: Commercial free speech enjoys protection under the Washington Constitution,⁵⁹ so even in the event of a potency tax that used potency brackets, sellers would still seem to be free to display single-point THC testing results (in addition to the range).

In Illinois, different tiers or ranges of brackets for potencies create measurable cost distinctions between product classes whose respective effects on public health are difficult to measure.⁶⁰ Hard distinctions based on THC content create easily enforced tax categories but these categories risk exaggerating the difference in harm between differently taxed products. Cannabis with adjusted THC of 35% or less bears a much lower tax rate than cannabis testing over 35%. Some cannabis products, such as concentrate meant to be flash vaporized, appeal to consumers who exhibit problem use, but the correlation between these high-THC products and problem users does not prove that the harm these products cause has a linear relationship to THC. The relationship among potency, use, and harm of cannabis products is not straightforward. Indeed, method of ingestion may be even more important to public health outcomes than absolute amount of THC.

Room for gaming

Cliffs or discontinuities between tax classes encourage tax gaming. Producers and sellers may increase potency to a point just short of the threshold to the next tax bracket. If the tax cliff or discontinuity is at 35%, as in Illinois, the producer or seller should try to land at or just below 35% because a product with potency of 35.1% bears a much higher tax

⁵⁹ <https://caselaw.findlaw.com/wa-supreme-court/1167777.html>; <https://pacificlegal.org/wp-content/uploads/pdf/yim-v-city-of-seattle/Opening-Brief-Yim.pdf>.

⁶⁰ Flower cultivars rarely if ever achieve levels as high as 35%, so the over-35% category effectively applies only to concentrates (or kief-enriched flower), though product class is not mentioned in the law.

burden (25%) than product testing at 34.9% or 35% (10%). An increase of a fraction of one percent in the tested amount of THC in a \$10 product could result in an additional \$1.50 of tax, raising the after-tax price from \$11 to \$12.50.

To avoid this, producers could mix potent concentrates with flower to create a product with a THC content just below the higher tax threshold. Washington producers mentioned an existing practice of spraying flower with high-THC alcohol distillate and allowing the alcohol to evaporate, and this is done without any tax motivation.

Accuracy of tests

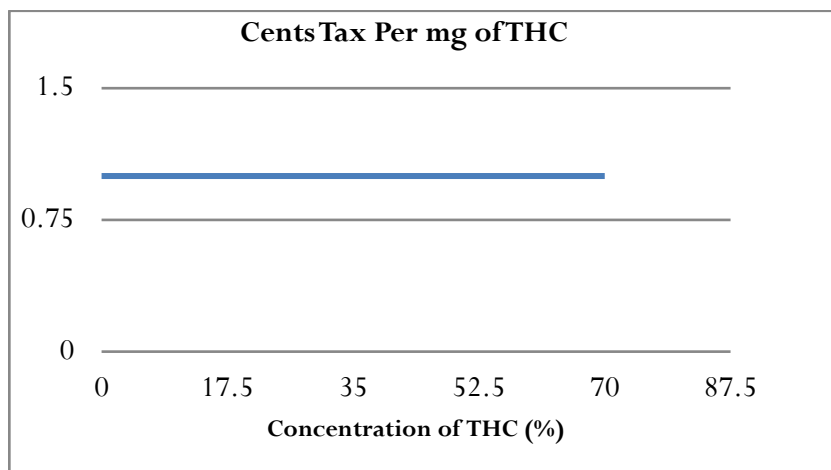
If potency can be accurately measured, ranges or cliffs must be calibrated to put qualitatively different products into different tax regimes, with more harmful or risky products taxed more. The brackets are correctly drawn if risky products fall over the numerical cliff while safer products don't. For instance, if concentrates meant for flash vaporization are found to be especially dangerous, and if a numerical categorization can isolate them better than a description in words can, taxation by ranges achieves the policy goal of promoting public health. If ranges place products into different tax categories on the basis differences of degree rather than of kind, they fail to achieve that policy goal. Cannabis potency cannot be measured to a degree of accuracy that rules out error, so putting high stakes on small differences between brackets is unfair.

Types of ranges

Continuous ranges

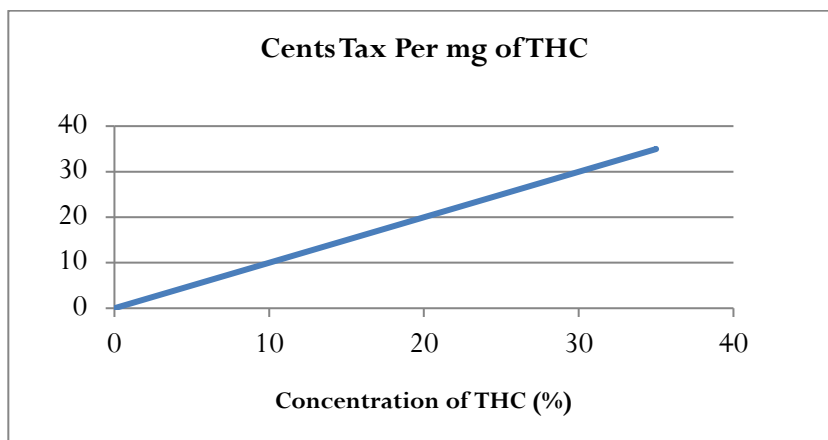
A continuous range is one with no gaps or cliffs, and no marginal tax rates above 100%.

The simplest tax structure is not only continuous, it also involves no change in the rate. That's a flat tax. For instance, "THC is taxed at one cent per milligram." This chart shows that tax rate:



A tax could also be progressive, increasing with THC content. The following is an example to help visualize a tax with that kind of continuous range. Say the tax varied directly with THC content, with tax being one cent per milligram times the THC potency. The tax rate could, for instance, start at zero for 0% concentration of THC, with the tax rate rising to reach one cent per milligram at 35%.

That produces a straight-line function that slopes:

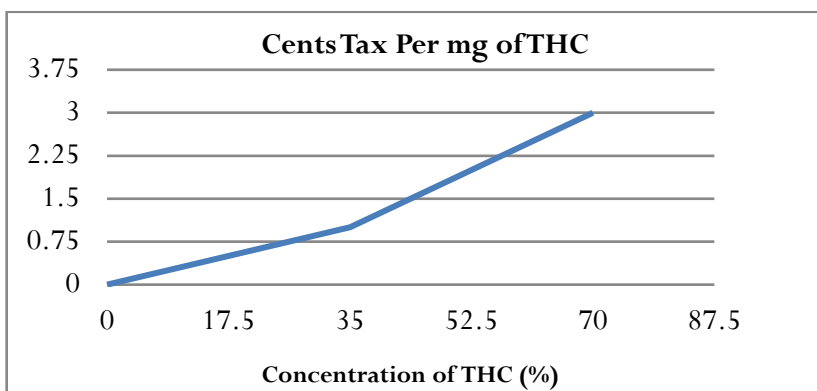


But there’s still more nuance: There could be a continuous but kinked “Excess Potency Tax.” With a continuous range the State might want more potent product to bear not just more tax, or proportionately more tax, but *disproportionately* more tax.

The following is an example to help visualize a continuous (and elaborate) kinked Excess Potency Tax. The State could increase the slope of the tax rate curve when THC concentration reached some particular point -- for instance 35%. That would result in a kink in the graph. The tax would start out the way the previous example did, with the tax rate being one cent per milligram times the THC potency – until THC potency reaches 35%. For higher THC content, the tax would be the sum of (1) 35 cents per milligram and (2) Two times the excess potency (over 35%) in cents per milligram.

So, a gram of product with 17.5% THC (175 milligrams) would bear tax of 17.5 cents; a gram with 35% THC (350 milligrams) would bear tax of 35 cents; and a gram with 70% THC (700 milligrams) would bear tax of \$1.05.⁶¹

The table below illustrates a break point at 35%. Below that point a doubling in concentration would result in a doubling of the tax rate: e.g., material of 20% carries twice the tax rate of material of 10%. Above the break point a doubling in the concentration would accelerate the tax burden; e.g., material of 70% concentration will have triple the tax burden of material with a concentration of 35%.

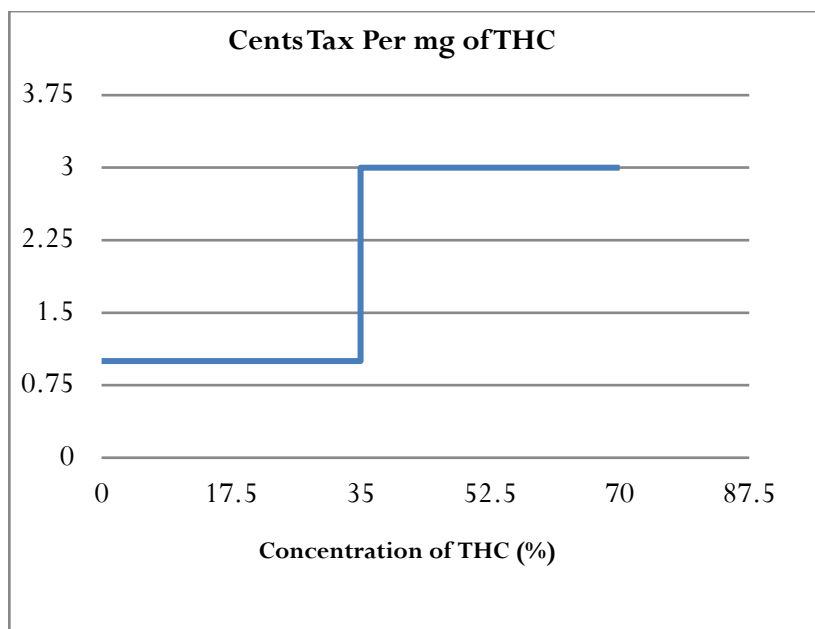


⁶¹ The increment doubles from .002857 cents per tenth of a percent of potency (1/35) after that point to .005714 cents per tenth of a percent of concentration. The continuous tax rate displayed in the chart is 2.857 percent (1/35) of the percentage of concentration per milligram of THC up to 35%, with the tax increment doubling at that point to .005714 percent (2/35) of the percentage of concentration per milligram of THC.

Finally, for theoretical completeness, a cannabis tax could increase *exponentially* based on the amount of THC. Certain potency thresholds can trigger a faster increase in tax rate as a function of potency. For instance, material with 30% THC could be taxed at twice the rate of material with 15% THC. Material with 60% THC could be taxed at four times the rate of material with 15% THC. The model for such a function could be a smooth curve with kinks, but without the cliffs and breaks of a discontinuous range. There are precedents for tax schemes that avoid steps or discontinuities by using continuous ranges. For example, 42 U.S. Code section 6295(u)(3) sets a sliding scale for taxing energy use by applying a tax of 0.09 times the natural logarithm of the output. Note that this kind of curved function would be very hard for taxpayers to understand and evaluate.

Discontinuous ranges

Only discontinuous taxes are said to create “cliffs” or “gaps” or “steps.” A discontinuous range involves a function by which the total THC of a product is taxed at the same rate, and products in different ranges of THC content are taxed at different rates. This creates a graph of taxes owed as a function of THC content that has cliffs, gaps, or steps. Here is a chart showing a discontinuous tax rate of 1 cent per milligram of THC on cannabis with THC content below 35%, and 3 cents per *every* milligram of THC on cannabis with THC content of 35% and over. So a gram of cannabis with 34% THC would bear tax of 34 cents, but a gram of cannabis with 36% THC would bear tax of \$1.08.



Hybrid potency tax

The three methods described above detail distinct bases for taxing potency as described in the literature. However, in practice there is no reason why they cannot be considered in conjunction with one another. The two jurisdictions which have established potency taxes to date (Illinois and Canada) have utilized components of more than one of the above. Canada for example taxes flower on the greater of either an ad valorem or weight excise basis, with a tax per milligram of THC applied to edibles, extracts, and concentrates.

One advantage of using a combination of two or more of the above is that you can achieve different combinations of advantages and benefits for different products. For example, an ad valorem excise tax could be applied to transactions up-stream of laboratory potency tests, with a tax per milligram applied at the point of sale based on the results of the laboratory test. Alternatively, an ad valorem tax basis could be applied to certain products, with a different basis e.g., price per milligram applied to other products, as is the case in Canada. This system would combine features of two

potency taxation methods, distinguishing between flower and other products for tax purposes, and applying a tax per milligram to the processed/potent products. This may be especially true of the most price-sensitive consumers including youth and frequent users – two groups likely to be exposed to the most significant public health harms associated with THC consumption. However, this tax would leave the majority of the market unaffected, since the majority of THC consumed is still in the form of bud. Keeping the current excise tax un-changed for the majority of purchases, while increasing it somewhat for the most potent products seem likely to protect revenues, at least in the short term and barring unintended consequences. Building in a degree of flexibility in the rule, reserving the right to adapt the levels at which the potency tax operates, e.g. the price per milligram would allow the state to respond to changes in demand and new information about public health implications of THC consumption as they come to light. This in turn could play an important role ensuring that the potency tax is a net benefit both in terms of protecting public health and protecting revenues.

Previously, the value of dynamism was discussed as a means of dealing with the uncertain responses of the market to external influence. The downside of this dynamism, and indeed of hybrid models in general, is that the additional complexity comes at a price. Complexity makes for policies which are difficult for stakeholders to understand and hard to enforce. Complexity leads to additional compliance costs and creates opportunities for violations which could lead to tax evasion, tax avoidance or diversion of product to the illicit market. A highly complex policy may also give rise to contentious circumstances which may in turn lead to legal interpretation and additional revisions, all of which can take time and cost money. There is therefore an important trade-off to be made between designing a policy that is flexible enough to survive an uncertain future and rigid enough to be practically enforceable.

8. Stakeholder input and impacts

Changing from the current system to a potency tax would require stakeholders to spend time and money complying with the new regime. Producers and processors would likely adapt their product offerings and production techniques, which have been designed to cater to a customer preference for high THC. Point of sale system operators would need to design, build out, test, and deploy updates to their existing systems to include potency figures to be included throughout the supply chain. To understand more about the adaptation and compliance costs that a hypothetical potency tax would impose on industry stakeholders, phone and in-person interviews were conducted with stakeholders including the Departments of Revenue and Ecology, out of state regulators in Canada, California and Illinois with experience designing and implementing effective cannabis tax structures, Tier 1, 2 and 3 producers and processors, medical and non-medical retailers, medical cannabis consumers, testing laboratories, Point-of-Sale (POS) Systems operators, industry investors, and stakeholder groups. In total nearly 40 interviews were conducted, with in-person interviews taking place in Olympia, Tacoma and Seattle from September 3–6, 2019, and telephone interviews taking place between August 26 and September 13, 2019. Stakeholders groups were identified through public information and by referral. Interviews were semi-structured, with a script of general questions leading to an organic conversation. These conversations provided crucial insights into on how the change might affect stakeholders in Washington, and ultimately the feasibility of any tax on THC concentration. The following is a summary of what we learned from interviews with key stakeholders.

Producers

Most of the larger producers were indifferent about the effect of a potency tax on their operations, suggesting that any changes in demand resulting from a change in tax structure could be accommodated in a relatively short time by switching product offerings and, if necessary, adjusting production methods. These businesses recognized that there would be adaptation costs for these activities but, with as many as five harvests a year many larger producers believed that it wouldn't take long for production to respond to any change in demand, assuming the availability of the correct seed or clone types. "That would be a change for retailers, not for us," one producer said. These larger, better-financed operations are already putting significant money into their businesses in the hope of recognizing profit at a later date. Spending a little more in response to a change in the tax structure would not be a radical departure from 'business as usual. The largest producers also consider that they would benefit from any additional competition that may result from changes in product demand motivated by the hypothetical change in tax. According to one producer, a tax on 30% THC products would disproportionately "help people with money who can [afford the calibration work needed to] get to 29.9." Producers also demonstrated confidence that consumers are going to buy what they want regardless of a tax change. "People want what they want, and we want to make it for them." But that doesn't mean that producers think taxing THC is a good idea. One producer suggested that, although they would be able to accommodate the change, switching to a THC-based tax would comparable to Seattle's recent tax on soda⁶², which has apparently not reduced consumption and placed a disproportionate burden on the poor.

Smaller producers were more split in their attitude to the hypothetical change. Some smaller producers who have been trying to carve out a niche for their products considered that a hypothetical potency tax might actually benefit their operations by driving interest in their lower THC products, thus diversifying the market's offerings and leveraging greater interest in product characteristics such as local production, sustainable production methods, etc. Some of these smaller producers have spent years waiting for the market to recognize these values and now, with the price recovery in 2019, they feel that the "tide is moving in the right direction." However, many other smaller producers, especially those catering to the market for concentrates, were concerned a potency tax might cause changes in product preference so large as to require them to re-develop their product offerings to remain competitive in the new landscape. With less access to capital and less ability to invest than larger businesses, one tier 1 producer expressed fear the policy would lead

⁶² ORD 125325

to further market concentration among larger producers. “It’s taken us since 2013 to develop the right kinds of strains and processes to cater to a market that is obsessed with high potency THC. If something tests below 16 or 17 [% we] don’t grow it.” Reversing that consumer preference would be, “a complete disaster.”

Interestingly, however sanguine producers were about their ability to adapt, they were less confident in the state’s ability to administer this change. Producers of all sizes expressed skepticism that the existing traceability infrastructure would support a shift to potency tax, referring to the existing traceability infrastructure as little more than an ‘honor system’. Many also doubted laboratories’ ability to accurately and consistently test product potency – at least to the extent that the state’s cannabis revenues should be based upon those readings. Many expressed skepticism that THC could be effectively measured. We also heard some general opposition to the idea that public health officials should concern themselves with THC potency at all. Producers sending the same product to different labs described variance rates of up to 25%. Addressing the inconsistencies of in current testing procedures and standards, one producer said, “Testing is a racket. I already have to compete with folks who are cheating on sampling - picking bud that came from the top of the plant and sending samples of flower from a batch that tested well, or to diluting oil that tested high before selling.” Some interviewees suggested that sampling could be performed by labs or even the State, “but even the most scientific sampling does not make raw plant material more homogeneous.” And detection of violators is not easy: “It can be extremely difficult to catch a savvy cheater.”

On the other hand, some producers, especially the smaller ones, were sympathetic to the concerns about very high potency. Perhaps the “adoption of a THC tax could benefit the cannabis industry and community [in terms of] informing and cautioning consumers particularly with regards to concentrates.” This sounds “perfectly acceptable.” In general, though, concerns about potency seemed generally too focused on dabs, especially cheap dabs, rather than on potency in general. As one Tier 1 producer explained, “the notion that 10% flower is half as damaging as 20% flower is just false.” The suggestion that potency taxes could be based only on certain product types or reserved for the most harmful products had somewhat more support than more general potency taxes because producers generally seemed to think they could adapt to such a scenario more easily.

Producer-processors catering specifically to the medical market were concerned that patients would be unreasonably penalized if they required higher potency products. As one interviewee explained, “many patients use the rec system because they don’t want to be on a database. It’s already unfair that medical patients ... have to pay 37% tax.⁶³ A further potency tax would punish them specifically.” This topic will be discussed more fully shortly.

Processors

Processors are more insulated from the shift in demand that might follow a potency tax than are producers because they are not concerned with the time-consuming process of production⁶⁴. However, like the smaller producers, we interviewed, processors who were largely unenthusiastic about the potential adaptation costs they would face in the event of a potency tax. This group voiced concern about bottlenecks especially at pain-points such as testing labs. Like producers, processors were also skeptical of the ability of the labs to test accurately and consistently for potency and doubted the ability of the POS systems to convey appropriate data throughout the supply chain. Processors, particularly those manufacturing concentrates and extracts were particularly concerned. Whilst these businesses felt that their businesses could survive a change (“concentrates are the future – oil for dabs, vape, edibles etc.”) processors were concerned about the impact of the tax on their illicit competition: “The legal market has killed the black [sic] market in Washington. [But] if a THC tax made concentrates too expensive, the black [sic] market would return.” According to another, ‘Say concentrates were taxed at 60%. [The] black [sic] market would benefit.’

⁶³ Registered medical patients are exempt state and local sales taxes.

⁶⁴ The obvious exception is the producer processor licensees who are licensed to both grow and process cannabis. Producer/processor licensees were interviewed as part of this project, but their views are presented as either one or the other to avoid repetition.

Some processors were sympathetic to those who are “nervous about health complications of higher potency.” Many processors shared the concerns of other stakeholders that a lack of standardization regarding lab-testing, the prevalence of lab-shopping, and issues regarding sample selection and user error would challenge the implementation of a potency tax. “It’d be like herding cats” said one processor. However some processors interviewed also expressed cautious optimism that taxing THC might have some benefits such as “helping [to] standardize labs,” resolving “lab shopping,” and doing something about the “THC toxicity (uncontrollable vomiting) and consumption of heavy metals and pesticides [associated with the heaviest users of concentrates].” But processors were also skeptical that this would be done for what they see as the wrong reasons. “If the goal is preservation of taxes it’s going to be hard to reshuffle the deck.”

Laboratory Operators

Laboratory testers might confront benefits and costs if Washington shifted its tax base from ad valorem to THC content. Under a potency tax, labs will experience increased pressure to produce standard, verifiable results. Standardization will consume resources, and laboratories may need to supply those resources. However, this group may welcome reduced pressure from sellers to produce high THC results (and less competition from other testers whose methods produce high THC results). Standardization will make it more difficult for testers to satisfy the desires of sellers to show high THC numbers. Second, sellers will be less interested in showing high THC numbers because, working against the marketing benefit of appealing to some consumers, those high numbers will entail a direct tax cost.

As the stakes for testing rise, enforcement against inaccurate test results or inconsistent lab procedures may become more important. License suspensions are a powerful tool to encourage compliance. If the state regulatory body can take away something valuable via the administrative action of license revocation, then powerful incentives to abide by the law are created.⁶⁵

Point of Sale software vendors

Point of sale (POS) software vendors would design, build out and test the software architecture necessary to carry potency test results through the supply chain along with global product numbers. In general POS system providers considered a potency tax to be ‘technically feasible – given enough advanced notice’. Estimates of what that would mean varied but the general consensus was that designing, testing and implementing the software update would require “several months and tens of thousands of dollars” per system. According to another, “I don’t know if it would be a disaster, it would have to be well thought out, and would require at least 6 months of lead time.” POS system vendors interviewed said that any costs associated with this change would inevitably have to be passed on to the POS clients and ultimately the end user. Some POS system vendors are closer to being able to incorporate this level of potency detail than others, creating a possible competitive advantage for those firms. One POS vendor also suggested that potency tax could expose the state to expensive legal battles. The implementation costs could negate at least some of the benefit of safeguarding tax revenues. POS vendors considered that a flat tax differential between product types would be the easiest model and could allow focus to be put on the product types with the most public harms associated with use. But one POS vendor advised, “keep it as simple as possible. Banding (ranges) makes it complex, but different categories make it more achievable.”

POS vendors also expressed concern about the ability of the state’s traceability system to track potency across products and throughout the supply chain, especially given that “potency is not uniform—not homogeneous, and changes over time.” One vendor estimated that it would cost his firm \$5,000,000 to implement sufficient traceability infrastructure for the state. Testing costs would also increase, and laboratories would pass those costs on to their clients. POS vendors also considered that inconsistent, inaccurate or manipulated lab testing results would undermine the goal of taxing potency, and so the change would require significant additional enforcement to ensure compliance which would increase

⁶⁵ Caulkins, et al., 2013.

regulatory costs and count against any gains made by a potency tax in terms of revenue generation.

Retailers

Retailers had a good understanding of the costs and limitations of a hypothetical potency tax. On one hand, many retailers identified the potential for a potency tax to diversify the demand for products, creating opportunities for new product lines containing less THC, or perhaps catering to consumers' demands for product characteristics other than low price and high THC. Retailers reported that customers tastes were already diversifying, and that this trend could be accelerated with a tax on potency. On the other hand, retailers also had little confidence that the POS systems could provide the information that they would need to process sales efficiently. Unless potency readings are reliable and readily available at the point of sale, or unless the state uses a simpler model such as a product-based potency estimate to determine a product's tax, retailers fear that their staff would have to manually calculate tax liability for each item at the point of sale. This would create impossible bottlenecks for stores, many of which move tens of thousands of dollars of product each day. The system of attributing potency to a product would need to be streamlined and automated so as to avoid bud tenders inadvertently collecting the wrong amount, or worse, gaming the system to create a commercial advantage.

Retailers also speculated that a potency tax could do more harm than good: If the tax persuaded consumers to switch to lower THC products en masse, the resulting public health gains may come at the expense of revenues, unless the fall in revenue from lower potency products is off-set by an increase in revenue from more potent ones. Because the relative harms across product types are not known it's also possible that persuading consumers to switch products might result in increasing their exposure to harm. "Who's to say that vaping is actually better than smoking?"⁶⁶ Alternatively, if the tax did not persuade buyers to change their purchasing patterns, the industry would have incurred significant adaptation costs without a concomitant benefit to public health or tax revenues. Thus, one retailer warned that the "state c[ould] shoot itself in foot and will lose money if [they] tax THC." The only way to guarantee that revenues would not fall as a result of a potency tax would be to set the lowest potency products at a tax basis that is equal to the present 37%, with stronger products carrying a higher tax. However, Washington already has the highest cannabis taxes in the nation and imposing additional taxes risks creating incentive for illicit arbitrage.

Medical Consumers/Consumer Groups

Medical consumers are more likely to be affected by a tax on potency because many of them specifically target higher potency products. "Who needs high potency THC?" one interview asked. "Those suffering from chronic pain, chemo patients, and people switching from opioids." Many patients already 'layer products, using full extract oils, tinctures and suppositories all at one." Taxing these products would disproportionately impact these patients. Medical patients today pay the full 37% ad valorem tax on cannabis products. Those who register with the state are exempt from the relatively small additional tax burden of standard state and local sales taxes (which combined are close to 10%), but despite the economic advantage, some medical consumers are resistant to the registration requirement. Many therefore prefer to pay the full tax; others already bypass the legal market altogether and buy from illicit sources. One patient warned that although taxing concentrates higher may make sense for some groups, "there is a possibility that people will start home-manufacturing concentrates." This prospect has significant risks to public health risks through exposure to unregulated products but further implications for public safety (the manufacture of many concentrates constitutes a fire risk), as well as a loss to public revenues.

Medical use of illicit sources seems to be widespread. "All the patients I know participate in the unregulated market. You go to these farmers markets and there's so many wheelchairs! Law enforcement doesn't want to arrest those people."

⁶⁶ On October 2, 2019, as this report was being edited, Governor Jay Inslee announced an executive order directing state officials to impose a ban on flavored vaping products, following a spate of fatalities nationwide linked to e-cigarettes. According to the CDC the vaping of products containing THC seems to have been a common factor in these deaths. The details of this executive order and the implications for Washington's cannabis industry are unclear at this time. But we note this development here because of its relevance to the discussion of the relative harms to different methods of cannabis consumption.

Another interviewee suggested that medical consumers might not use the retail stores because of the emphasis on novelty products: “Patients don’t want candy bars. We need to get back to cannabis as medicine. Taxing potency signals that this substance is sinful; that it’s something we shouldn’t be using.”

But the public health arguments may go the other way too. One processor who catered exclusively to the medical community said that she was concerned about the rise of ‘cheap dabs,’ expressing concern that many of them contained harmful adulterants; pesticide residue and heavy metals that are not eliminated by the current testing standards. Given these concerns, “encouraging people not to dab might be valid. People are certainly dabbing more than they used to.” Several interviewees suggested that a focus on dabs might be preferable to a blanket THC tax.

Cannabis products with low THC and high CBD are said to be especially appropriate for medical use: “High-CBD strains tend to deliver very clear-headed, functional effects without the euphoric high associated with high-THC strains. They’re typically preferred by consumers who are extremely sensitive to the side effects of THC (e.g., anxiety, paranoia, dizziness). A high-CBD strain would also be a great choice for someone needing to medicate throughout the day to control pain, inflammation, anxiety, or other chronic conditions.”⁶⁷ But others believe that THC is more generally medically effective than CBD.⁶⁸ Many medical consumers seek high THC products for therapeutic purpose, and others need more THC as they build up a tolerance over time. In both medical and recreational users, we see a clear preference for specific modes of consumption. So, a tax on THC, or differentially applied to different products could be seen as an unreasonable imposition on medical consumers. The medical impacts of the various components of cannabis are still uncertain. But there are stakeholders who believe in the “entourage effect,” meaning that the components of whole plant cannabis add up to more than the sum of the parts. To the extent that CBD or other cannabinoids or terpenes serve as a therapeutic driver, a shift from taxing by price to a tax on THC might result in lower after-tax prices for low THC products that are high in other cannabinoids.

Non-Medical Consumers

It remains to be seen how non-medical consumers would respond to a tax on potency in the aggregate. Several consumers interviewed feared that a switch in the tax system would bring about a net tax increase – some worried about the effect of a tax increase on their own pockets, and others worried about a tax increase on the marijuana community as a whole.

It may be helpful to consider non-medical consumers in two categories: those who focus exclusively on THC content in deciding what to buy, and those who consider a broader array of product characteristics.

Non-medical consumers who now “do the THC math” to buy the most milligrams of THC for the fewest dollars would presumably face a tax increase. (Here we assume revenue neutrality, as difficult as that target may be to hit.) In reacting to that increase, they have several options: 1) pay the higher tax for their product of choice, 2) use less of their chosen product, or 3) use illicit sources to obtain their product of choice.

Non-medical consumers who already consider a broader array of product characteristics – not just THC -- may well react differently. Again, assuming revenue neutrality, these consumers could presumably face a tax *decrease* if one or more of their preferred products fell into the low THC category. Consumers of low THC products, who would be the beneficiary of a tax decrease on low THC products, face a different set of options: 1) Save money by buying and using the same amount of their product of choice, or 2) use more of their chosen product. Consumers of low THC products from illicit sources might switch to legal sources to obtain their product of choice. Again, there’s a corollary category of these consumers: those who prefer products whose price will go down if it were taxed by potency rather than by price, but who have been economizing by restricting themselves to other products. This group would likely increase demand for products that are relatively low in THC but have other appealing characteristics.

⁶⁷ CBD vs. THC: What’s the Difference? <https://www.leafly.com/news/cannabis-101/whats-the-deal-with-these-high-cbd-strains>

⁶⁸ Stith, S. S., Vigil, J. M., Brockelman, F., Keeling, K., & Hall, B., 2019.

This latter category of consumer is likely to include non-medical consumers who don't focus solely on THC and may tend to think of themselves as more sophisticated than the pure THC-seekers; even as connoisseurs. Interviewees in this category indicated that dabbing is a problem for public health and suggest that terpenes and non-THC cannabinoids add to the fun or pleasure of cannabis consumption. Interviewees who identified with this category also expressed exasperation at the notion that the state would try to tax THC or cannabinoids based on their propensity to cause impairment. Speaking about the effect of the combination of different cannabinoids and terpenes, one interviewee said, "it's impossible to accurately describe, let alone tax. It's too personal, too subjective. Even talking about it is like dancing about architecture."

Various other changes in consumer behavior, including different product choices, might arise from a switch from ad valorem to potency taxation. Today, a product containing 5mg of THC and 300mg of CBD bears the full 37% excise tax. It can be expected that a THC tax designed to be revenue neutral would result in relatively less tax for that product, so it will be more attractive after tax, especially to consumers who are not THC-centric. In addition, it may also be that a different product delivers the biggest THC bang for the buck after a change from ad valorem taxation to THC taxation. For instance, the pre-tax price of processed material includes value that does not come from THC; a THC tax, unlike an ad valorem tax, would ignore that added value, so there might be a nudge toward consuming products other than flower (compared to present law). If so, unintended public health consequences may result.

Department of Revenue

While the LCB is charged with administering and collecting the 37% cannabis *excise* tax, the Washington Department of Revenue collects and administers the standard 6.5% sales tax, any local sales tax, and Business and Occupations taxes on cannabis sales. But while cannabis taxes represent an important revenue stream for the state, the LCB's appropriation from marijuana excise tax was less than 3% of the total collected. To the DOR too, cannabis commerce and revenue are a small part of their sales tax collections (consisting of all taxable sales in the state). Thus, both department's funding is relatively insulated from any fluctuations in general cannabis tax revenue. However, under the current system, since both excise and sales tax are based on retail price, the LCB and the Department of Revenue are able to share a common basis for monitoring and auditing tax compliance. This efficiency would be sacrificed if the excise tax were switched away from a price basis likely resulting in increased costs for these activities.

Department of Ecology

The Department of Ecology will eventually oversee the accreditation process for testing laboratories. We spoke with members of the Cannabis Task Force, charged with overseeing the transition away from the Department of Agriculture, working first on pesticides, but ultimately on potency. Since the DOE's mandate includes laboratory accreditation, based on a standard set by the LCB and Departments of Health and Agriculture, they are not concerned by a move towards taxing potency. They acknowledge that doing so would require enforcement capacity on the part of the regulator because of the incentive to downgrade potency of product. The DOE also envisioned the possibility of a bottleneck created by more and better testing which could affect sales prices in the short term.

9. Feasibility: Costs and Considerations

A potency-based cannabis tax requires the ability to test products accurately, report and track the results of those tests, and calculate how those results affect a product's tax liability. Ideally, a potency tax should be supported by data systems that are reliable, secure, accurate, and convenient for auditing. Currently, audits and investigations by LCB Enforcement draw on three data sources: traceability data; records held on-premises including Certificates of Analysis (COAs); and records from third-party integrators. These data sources are the foundations of Washington State's capacity to carry out enforcement activities.

Prerequisites for success

Traceability system

If optimally designed, implemented, and enforced, a traceability system is a foundational tool for the implementation of a potency tax, performing the central function of facilitating audits of retailers' reported sales and potency tax obligations. To perform this function fully, the traceability and related data systems should be equipped to facilitate accurate data reporting, reliable and secure data storage, and efficient auditing.

To ensure accurate reporting of potency results and adherence to the proper chain of inheritance from the tested sample, licensees and regulators alike should be able to use an electronic data system to link a product to its associated potency test(s) and calculate the amount of THC contained therein. Without this functionality, auditing would rely solely on paper COAs, which are more susceptible to tampering and more time-consuming to look up. The need to check COAs manually would present additional inconvenience to licensees as they price product or make sales, and to regulators seeking to audit tax payment.

To facilitate reporting and auditing, the traceability system, integrators, and perhaps also point of sale software should handle product or potency information in the necessary formats. These would vary by tax design and product type. Software should be able to calculate and display potency data at the level of precision required by the taxation scheme, e.g. per milligram THC, percentage concentration THC, potency range, or product type. This would allow for the look-up of a product's THC from the traceability system, and for retailers to report aggregate amounts of THC sold. To facilitate auditing, the system should enable look-up of a product's potency results, perhaps by easily accessible bar codes or a unique ID affixed to the product package.

To enhance data quality, oversight is needed to ensure licensees understand reporting rules, and are equipped with adequate software to comply with those rules and allow licensees to seek and be provided with technical assistance from LCB and/or the vendor as needed. Further, it may be helpful to enforce certain conversion rules to prevent licensees from intentionally or accidentally entering inaccurate information or omitting information. On the other hand, such a feature could cause additional difficulty if the software has unexpected bugs.

Ancillary data systems

Under the current system, retailers collect cannabis excise and sales taxes. To minimize disruption to this system, a potency tax may seek to preserve this structure.

Currently, retailers calculate tax obligations by multiplying the sale price by 0.37. This feature is built into point-of-sale systems. Under a potency tax, additional information would be required for the point-of-sale system, namely: the milligrams of THC contained in the product; and/or the THC concentration and product net weight; and/or the potency range or product category that may be used as the basis for taxation. The data needed would depend on the specifics of the potency tax structure. If the relevant data are not available, retailers would have difficulty setting product prices or charging the correct tax to customers.

Under a potency tax, this process should be kept as simple as possible. For instance, retailers ought to be able to retrieve or calculate their products' tax obligations upon purchase from the supplier. Retailers could then reconcile their records

of tax receipts, on-hand inventory and delivery to ensure that the full tax for their sales is collected. Any shortfall not accounted for by returns, spoilage, or theft could indicate tax evasion or tax avoidance and thus provide the auditor with reasonable grounds for inspection. If products arriving on retail shelves have a record of tax liability, any licensee who received a shipment could be held liable for remitting appropriate taxes. This would serve as a barrier to diversion and provide an additional level of protection for tax revenues.

This means that the integrators providing POS systems would play a vital role in facilitating the correct taxation of cannabis products. Although many POS systems have the capacity to convey potency information, none of the systems used in Washington do so for tax purposes.

Current capacities

Traceability system

The traceability system is a wide-reaching database that records events throughout the supply chain from seed to sale. Under the first-generation traceability system in Washington, no matter where a cannabis product is in the supply chain it carries a unique ID by which it can be tracked. Producers report the location of plants as they move through vegetation, flowering, and harvest stages, after which harvested materials are processed and grouped into batches before either being packaged for retail distribution or used as an input for further processing (e.g., into a cannabis concentrate or edible). Unwanted cannabis material must also be tracked before it can be destroyed by composting or incineration. After harvesting, but before retail packaging, each lot must be tested for THC and CBD content and content of various harmful adulterants including fertilizer residue, heavy metals, and molds. Under Washington regulations, a single lot of flower weighing up to five pounds may be represented for testing purposes by a four-gram sample selected by the licensee. Each of these events must be recorded by the licensee in the traceability system.

More recently, the role of the state's seed-to-sale traceability system has evolved. Originally the traceability system was conceived as a foundational approach to preventing diversion of product to the illicit market as well as a means of ensuring product safety and quality. LCB specified a "compliance reporting system" in their instructions to bidders during the last attempt to implement a traceability system, which resulted in the awarding of the state contract to MJ Freeway. However, the system has now taken on a role in inventory management to accommodate licensees' expectations, which were based on their use of the first-generation traceability system.

Gartner Consulting, the state's independent verification and validation (IV&V) subcontractor⁶⁹, confirms this:

Originally intended to track and manage compliance only, the system is relied upon by the industry for inventory management...The primary purpose of the system is now for compliance reporting...(yet) the intent for LEAF as a 'compliance' rather than an 'inventory management' system was not fully understood by all stakeholders; adoption of the deployed system was negatively impacted by the perception that external user needs were not accommodated.

Interviews with licensees both in 2018 and 2019 record a widespread perception that the Leaf Data system is not able to provide much of the basic functionality that would be expected of a traditional inventory management system, leading in turn to serious concerns about the general functionality of the system. According to one licensee:

We understand this is not an inventory management system but if we cannot rely on correct inventory numbers in traceability, how can an enforcement officer do an accurate audit of our inventory, or how can we allocate product for shipment if the system thinks we are out?

Many licensees have reported that they are generally unable to use the traceability data system to display the cannabinoid content or test results of a product. LCB staff are sometimes able to link a product to its test results, but this functionality is not always available, and doing so is especially difficult when a product has taken a complex path through the system.

⁶⁹ Gartner Consulting (2018). Leaf Implementation IV&V Report. August 24, 2018.

The former BioTrack THC system used a 16-digit unique bar code that could track a product along the supply chain simply by entering the number, which also appeared on the retail product packaging.⁷⁰ Leaf Data system assigns new ID numbers to products when they are transferred from one licensee to another, breaking this simple path of traceability, complicating the necessary database merges required to link a product to its associated potency test(s).

The Gartner report indicated several other problems with the traceability system, including inconsistencies with API documentation; imperfect modeling for returns; inability to track the parent lineage of items; failure to track unit weight which makes it impossible to calculate the weight of raw material that is eventually converted to end product; too many upgrades relative to the previous system; incompatibility between the new traceability system and the old one causing many third-party integrators' data to be incorrect in the database; and batches disappearing from the system and reappearing without explanation.

Aggregate sales data reported to the traceability system are not independently reliable for the purpose of an audit for two reasons: First, some data do not appear quickly, as third-party integrators can be slow to push data reports to the traceability system. It may take ten days or longer before all sales for a given day are reported. Second, even after all data arrive, totals may not be accurate, for several reasons, including:

- Licensees reporting: A substantial number of retailers were not reporting sales; LCB has taken some enforcement actions regarding this.
- Integrators fail to work with the API. LCB enforcement agents blame integrators, but integrators report being hobbled by bad API design and poor documentation.
- Licensees report data inconsistently.
- Integrator/API malfunctions lead to double- or non-reported sales.
- Products become stuck in “transfer” status.⁷¹

Anecdotal licensee statements in the Gartner report bear out the above: “Leaf Data is grossly over reporting our sales every month by at least \$200,000. Returns and rejections are not working properly and do not deduct from the overall sales total for the month.” Independent data scientist Jim MacRae has made similar claims, voicing concerns that totals are not always calculated accurately.

Industry stakeholders have had concerns about the reliability of the Leaf Data system since it went live on February 1, 2018.⁷² Only days after rollout of the new system, exploitation of a software vulnerability shut the system down for three days until service was resumed on February 5, 2018. In the interim, disruption in inventory transfer data required many businesses to account for business transactions using Excel spreadsheets after the fact. According to the Washington State Office of the Chief Information Officer (OCIO), “This incident, along with the disrupted system workflows and the backlog of responses to phone calls, tickets, and bug fixes severely deteriorated the trust that licensees and software integrators had in Leaf Data Systems, the vendor, and WSLCB staff.” Multiple licensees report having accidentally entered inaccurate information in the traceability system, and when they later corrected that data, they were not asked about the incident by an enforcement officer as they expected. That led these licensees to report feeling the system was not regularly monitored for inaccuracies and therefore intentional inaccuracies were going left undetected along with unintentional ones, undermining the reliability of the overall system.

Cannabinoid testing system

⁷⁰ One Gartner Consulting interviewee writes: “IDs change from license to license, so the required number on the package and manifest isn’t even in the system as a primary key.”

⁷¹ Conversation with Kendra Hodgson, LCB.

⁷² Stellar Associates LLC. Report for the Washington State Liquor and Cannabis Board. Seed to Sale Traceability System, Marijuana Traceability Project, March 2019, available at: <https://waocio.secure.force.com/sfc/servlet.shepherd/version/download/0680P000004ks5zQAA?asPdf=false&>

Currently, the lack of standardization of testing procedures allows laboratories a large degree of discretion over testing methods. This causes problems of both inaccuracy and imprecision.

Given consumer preference for potency, lab-shopping (whereby producers and producer-processors search for a lab that will give their products the desired result) is widely reported. Some of the lab operators interviewed wanted to see greater standardization of testing procedures and a greater degree of scrutiny to eliminate unfair competitive advantages. One laboratory operator told us that he was leaving “millions of dollars in revenue on the table” by refusing to compromise the integrity of his tests. But given the business model used by labs, it is not in their interest to report clients when they do detect violations, since doing so will lose business and harm their reputations. The reliance on producers and producer processors to do their own sample selection also allows room for manipulation.

Most labs that currently test cannabis in Washington were not established facilities with experience testing other substances such as food or pharmaceutical products at the time of cannabis legalization. A wide variance of test procedures exists, and each test produces a range of estimated potency, with significant room for error. Further, large differences between results for similar products have been observed, even when controlling for expected variations in individual plant samples. Jikomes and Zoorob (2018) report “systematic differences in the results obtained by different testing facilities in Washington, with some labs consistently reporting higher or lower levels of cannabinoids than others.” They rule out the possibility of sampling bias and instead blame differences in testing methodologies.

The state is taking steps to standardize testing procedures, and the accreditation of testing labs is being moved to the jurisdiction of the Department of Ecology. However, the DOE does not anticipate standardizing potency testing until 2024, at the earliest. Any potency tax would require standards that yield results that are reproducible across labs. If the state were to adopt a potency tax prior to that date it would need labs to subscribe to the common standards of some third-party accreditation body.

Changes and Costs

If a traceability system is relied upon to help enforce a potency tax, one pressing issue will be to resolve uncertainty with the present traceability system. The current update, version 1.35.7, was launched on July 13, 2019, almost one year later than initially scheduled. All future releases of the vendor’s traceability software are on hold and there is no timeline for adding new features to the system. At the time of writing the current contract with MJ Freeway is due to expire at the end of September 2019. The LCB will have the option to extend contract, begin a search for a new vendor, and/or make plans to move away from a traceability system entirely.

Many of the ways in which a traceability system could support a potency tax are not available under the current scope of the Leaf Data system. In particular, the system neither provides inventory management services nor enforces consistent reporting of inventory or its potency characteristics. Further, the system has exhibited repeated bugs and delays that could create difficulties for a potency tax if the system were relied upon for the collection of that tax.

If the state continues with a traceability system, that system should be updated as needed in the case of a potency tax, allowing for time to design and implement changes in the software, coordinating with integrators and point-of-sale vendors as needed. Whatever the design, build-out implementation and testing phases would take at a minimum several months according to the POS system managers we spoke to. The cost estimate they gave us for this build-out was in the order of low hundreds of thousands of dollars. These costs would likely be shared between POS system providers and their clients (retailers). Licensees will also have to purchase new software, expend more employee effort on recordkeeping and training for the new system, and may have to pay a fee for new tags.

Given the history of difficulty with the current traceability vendor and the fragility of the current contract, further changes to the traceability system may be expensive, slow, and uncertain in their reliability. The Gartner report concluded that the traceability vendor landscape is emerging and immature, without any options available for commercial off-the-shelf-solutions, and with substantial customization requirements needed to specify a system for intended uses in

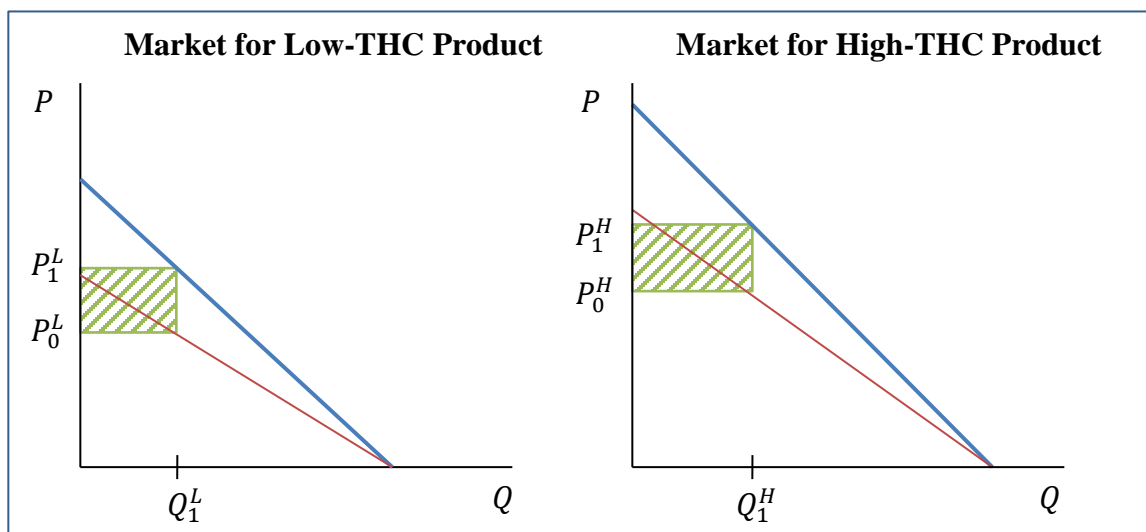
Washington State. An extensive overhaul of the current system to build out inventory management capabilities would be outside of the scope of the current contract, and the time and money required to make such a change would be extensive and difficult to predict with certainty. Such a change would also impose additional adaptation costs faced by licensees, integrators, and point of sale vendors in order to update their systems to comply with new regulations. At minimum, POS vendors would need to add data fields to track potency data. We interviewed several POS system operators and though none could be precise about the costs and timeline for implementing this upgrade, cost estimates ran into the low hundreds of thousands of dollars and time estimates of several months or longer.

Alternately, the state may seek to build a process for tax reporting and auditing that does not rely on the current traceability system. If the state does not choose to use the track-and-trace platform to enforce a potency tax, then the state may either develop a separate reporting system (likely to also result in very high associated costs) or trust licensees to maintain records and self-report and audit them regularly – thus incurring the additional enforcement costs associated with regular audits.⁷³

⁷³ There are also creative alternatives to a state-managed traceability system, including decentralized approaches like a distributed public ledger modeled on blockchain technology or a third-party partnership, such as giving a non-profit responsibility for managing data.

10. Revenue estimates

Consider a change from the current ad valorem tax to a THC-differentiated tax on cannabis products of the following form: there is an ad valorem tax rate of τ_L on low-THC products (market “L”) and a higher rate of τ_H on high-THC products (market “H”). For simplicity it is assumed that there are only two product classes and that each has a linear demand curve; the same general arguments apply to multiple (or a continuum of) product/potency classes and linear demand can be viewed as a first-order approximation to nonlinear curves.⁷⁴ The two products could be, for example, usable marijuana of differing concentrations, or usable marijuana (low THC) and concentrates (high THC). In the broad outlines considered here, similar results would obtain if the new tax on THC was a specific (unit) tax instead of an ad valorem tax.⁷⁵



The initial situation is illustrated in the figure above. Relative to the market demand curves (in blue), the revenue tax rotates the tax-adjusted curves down to the red tax-adjusted curves. The height of the unadjusted demand curve is $(1 + \tau)$ times the height of the adjusted curve. Thus $P_1^L = (1 + \tau)P_0^L$ and similarly in market H. For any given quantity, the vertical distance between the red and blue curves, $p\tau$ (where the price is found from the adjusted curve), is the average amount of tax revenue generated per unit sold. Given the tax-inclusive price and market quantities, total tax revenue $\tau P_0 Q_1$ is thus the shaded region in each market as shown above.⁷⁶

Now consider an increase in the tax rate for the high-THC good and a decrease in the tax rate for the low-THC good. The new rates may be designed to be revenue-neutral at best guess, but that is not important for this illustration. When the tax rate rises in the high-THC market, the adjusted demand curve rotates further down. This is shown in the left panel of the figure below (note the swapping of the positions of the markets in the figure compared to the previous one). Holding all else constant for the moment, the new quantity produced will fall and the tax-inclusive price will rise (by how much depends on the supply side of the market, which is not shown in the graphs). Before proceeding with the analysis, note that the figure already implies that a naïve estimate of new tax revenue, which would come from applying

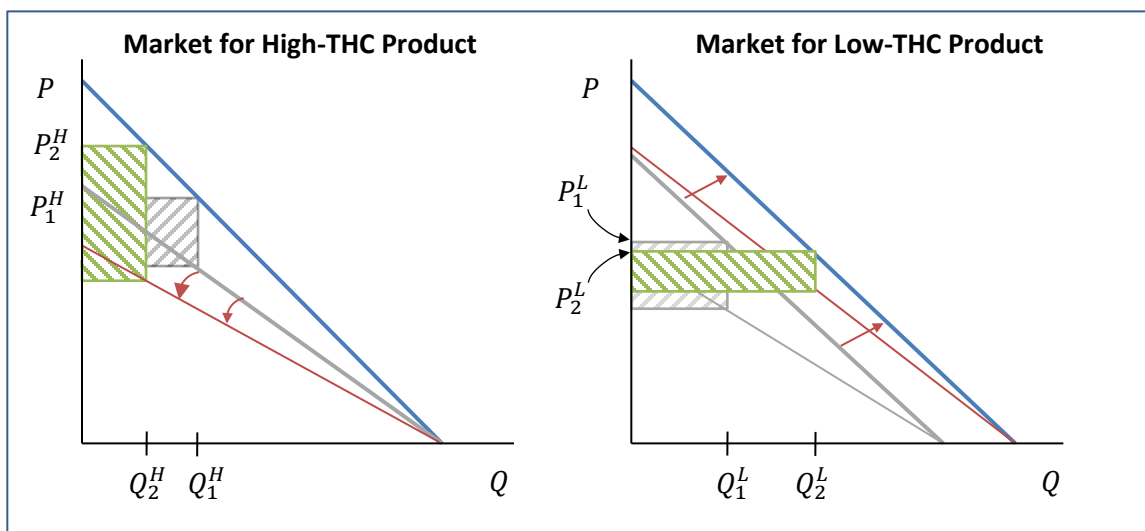
⁷⁴ Also, for simplicity, although at the expense of academic rigor, the analysis will be presented graphically instead of using functions and calculus.

⁷⁵ In the case of a specific tax, the tax-adjusted demand curves would be parallel to the unadjusted demand curves instead of rotated down.

⁷⁶ If the market were competitive, the quantities would be determined by the intersection of the market supply curves with the adjusted demand curves. Given the evidence in Hollenbeck and Uetake (2019), it is not safe to assume that the market is competitive on the supply side, and so the story of how final price/quantity pairs are determined is not shown on the graphs.

the new tax rate to the old market revenue, is likely to be quite wrong. Demand is not perfectly inelastic, as shown from the review of price elasticity earlier in this report, and therefore the quantity demanded will change.

The tax revenue in market *H* changes from the original rectangle (now shown in gray and partially obscured) to the new green hatched rectangle. The new rectangle is taller but narrower. The increase in height comes from the direct effect of increasing the rate (market sales revenue is multiplied by a higher rate, generating more tax revenue). The decrease in width comes from the indirect effect that the higher tax rate increases the tax-inclusive price, thus reducing the quantity sold. Whether the new tax revenue is larger or smaller than the previous case depends on the scale and elasticity of the demand function and the tax-inclusive prices in the two cases. In theory, both outcomes are possible.



The analysis now shifts to the right side of the second figure. Since the two goods are presumed to be substitutes and the price of good *H* has risen, demand for good *L* rises. This means that for any given price in market *L*, the new demand curve is further to the right of the original curve. This is shown in the graph for market *L* with the original demand curve (now in gray) shifting to its new location (in blue). The other change is that the tax rate has fallen in this market. Thus, the new tax adjusted demand curve (in red) is both further to the right and not as far below the unadjusted demand curve as before. These changes compound (along with the unspecified response on the supply side) to imply that the quantity consumed of good *L* rises to Q_2^L . Thus, more sales are taxed but each unit earns less tax revenue on average; the new tax revenue rectangle (in green) is shorter but wider than before. Again, the impact on total tax revenue depends on the scale and elasticity of demand and the prices (determined in part by the supply side). Of course, with all the changes in market *L*, the tax-inclusive price will probably change as well (shown in the graph as a change from P_1^L to P_2^L). The new price may be higher or lower than before. Since the price of good *L* has changed, there will be additional effects in market *H*, with the demand curve in the high-THC market shifting due to the cross-price effects. These additional effects are not depicted.

What can be learned from this simple, textbook analysis of imposing a potency tax? Consider what information needs to be known at each step of the analysis:

Step 1: Initial tax revenue

If all that is desired to be known in the first figure is the total area of the tax revenue rectangles, that (as well as all marked prices and quantities on the graphs) can easily be computed from market and tax data. However, predicting how that revenue will change requires information about the slope (or elasticity) of the curves.

Step 2: How tax revenue changes in the high-THC market

To know how the revenue rectangle changes in market *H* in the left panel of the second figure above, the following would need to be known:

1. The price elasticity of demand (which is a function of price) for good *H*. Since the entire demand curve must be known (so that the tax-adjusted, red demand curve can be found), the price elasticity of demand (which is a function of price), or the slope of the demand curve, for good *H* must be known.⁷⁷ That elasticity function, in turn, depends on:
 - a. The availability of substitutes, whether they be cannabis procured from illicit sources, other illicit drugs, or other legal products such as alcohol.
 - b. Consumer preferences for high-THC product, perhaps as shaped by experience, perception, or (illegal) advertising.
2. Behavior on the supply side. If the supply side is competitive, then the marginal costs can be aggregated into a market supply curve; in that case the quantities shown in the graph would be determined by the intersections of the supply curve with the tax-adjusted demand curves. If there is market power in the supply side, however, then the nature of competition among suppliers must be known or modeled, so that the tax pass-through implied by the conduct can be ascertained.

Step 3: How tax revenue changes in the low-THC market

To know how the revenue rectangle changes in market *L* in the right panel of the second figure above, the cross-price elasticity of demand between these two markets would need to be known. The cross-price elasticity (i.e., the percentage change in the quantity of good *L* demanded when the price of good *H* increases by 1%) will depend on these factors:

1. The degree to which goods are distinct from each other. If the two goods are both usable marijuana (flower), then the cross-price elasticity will likely be higher (i.e., they will be better substitutes) than if the goods are entirely different product categories (e.g., concentrates and edibles). The more distinct the goods, the more possibility there is that some consumers will value the good in its own right for its unique characteristics (e.g., edibles) instead of just as a substitute for some other method of consuming THC or CBD. For example, in alcohol markets, where liquor is taxed at higher rates than wine and beer, there is almost no substitution observed: the cross-price elasticities appear to be near zero (Coate & Grossman, 1988).
2. Consumers' experience with and perception of how readily one good may be made to substitute for another.
 - a. For example, there is at least some evidence that consumers titrate their THC intake by inhaling less when smoking higher-potency cannabis (although not so much that they do not end up consuming more THC; van der Pol, et al., 2014). If consumers view such compensatory behavior as nonintrusive to their experience, then they care less about exactly which concentration they consume and the two goods in the illustration would be highly substitutable.
 - b. Advertising and marketing campaigns, when allowed, can increase the perceived differentiation among products. Sometimes this occurs through making known unique product attributes, but often marketers attempt to create "artificial" product differentiation by means of associating their product with enjoyable social experiences, celebrities, or other positive external phenomena.⁷⁸ Where such advertising is disallowed, perceptions can still be influenced by word of mouth campaigns and personnel at retail establishments.

⁷⁷ With linear demand curves, knowing the scale of demand and the slope allows calculation of the elasticity. Thus, given observable information on price and quantity pinning down a point on the demand curve, from the slope one can compute the elasticity and vice versa.

⁷⁸ The purpose of such "noninformative" advertising, of course, is to allow higher margins and profits and to raise entry barriers to would-be competitors. See Comanor and Wilson (1974).

3. Consumers' knowledge of and response to the potential additional health risks of consuming high-THC products.

Note that some of these factors in all these steps can be affected by policy. The number of licenses that are allowed to the various parts of the supply chain will affect competition on the supply side. Restrictions on advertising and public health informational campaigns about health risks will affect users' perceptions of substitutability and the desirability of lower-concentration products. And the tax rates themselves affect every part of the adjustment to a new equilibrium and therefore the resulting tax revenue.

Note further that the textbook treatment of demand and prices above leaves out an important real-world factor: the salience of the taxes. Research has shown in many settings that when taxes are included in prices facing the consumer, the taxes affect demand behavior more than if they are not applied until checkout (as with sales taxes; Chetty and Kroft, 2009). This raises an interesting possibility: taxing THC may raise the salience of potency—with its attendant potential health risks—for consumers. Thus, the mere fact of taxing potency may cause behavior to change, even before the direct “demand responds to price” mechanisms kick in.

In conclusion, it is clear that accurately forecasting how tax revenue would change from revising the tax structure is essentially impossible. In addition to the usual considerations about how responsive demand for cannabis as a whole is to a change in tax and price, there are many other factors involved. This further implies that no proposed change in the tax structure along the lines of a potency tax could confidently be asserting to be revenue neutral within tight bounds; any honest prediction interval on the resulting revenue change would be very wide. As a starting point, one could assume no change in the quantity demanded for the various goods after the tax change, and then merely apply the new rates to the pre-existing sales revenue. However, that estimate is sure to be incorrect, given what we know about price elasticity and what we don't know about cross-price elasticity and all the other factors discussed above.

The fact that the last change in the tax regime—mainly a change in which parties are legally responsible for paying the tax—was roughly revenue neutral should not lead policy-makers or -implementers to underestimate the difficulty of predicting the impacts of the more profound change in the tax *structure* underlying a potency tax. The economic theory of tax invariance suggests that in the simplest “textbook” models of competition and consumers, which actor in the supply chain or demand side is legally obligated to pay the tax bears no relation to final economic outcomes. Thus, elementary theory suggests that revenue neutrality is the *default* expectation when a change in regime merely redistributes the legal incidence of the tax. While there is some evidence that the invariance hypothesis did not hold for the 2015 regime change, the resulting tax per gram was nearly the same as before the change (Hansen, Miller, & Weber, 2017). Therefore, the expectation that would have been held by any student leaving an intermediate microeconomics class was borne out. There is no like expectation of revenue neutrality as the default when raising taxes on some goods and lowering them on others, and thus the task of revenue projection is inherently more difficult.

11. Concluding remarks

The goal of this report was to describe the feasibility of imposing a cannabis tax based on THC ‘potency’, either on top of or in addition to the current ad valorem excise tax.

Several different models of taxing potency have been presented. First, a direct potency tax would address THC content directly, but would create concerns about the ability of a sampling and testing system to tax cannabis in a non-random way. Concerns about sampling in particular are much more serious for raw plant material than for concentrates. Second, taxing products by categories would offer opportunities to tax potency by proxy, though adequate attribution of harm to specific products has yet to be done. Third, using tax thresholds and continuous ranges would allow more potent products to bear disproportionately high taxes, if that were a goal the state sought; using discontinuous ranges could achieve that kind of result but also invite tax gaming.

The following is a review of key findings related to the likely effectiveness and feasibility of each model.

The desired effects of a THC tax include defending against falling public revenues and protecting public health by encouraging consumers to shift purchasing behavior away from targeted products and towards lower-tax products.

Effectiveness

The effectiveness of a potency tax is difficult to estimate a priori, due to the limited nature of academic research and practical experience. Given limited research on consumer responses, it is difficult to predict how consumers would respond to such a policy. How responsive to price would they be? Would they respond by shifting to lower-THC products, or to consuming the same products produced at home or obtained through illicit channels? The cross-elasticities of demand between cannabis products of various potencies, as well as across licit and illicit sources, are yet unknown.

There is incomplete evidence regarding the marginal harms of various levels or forms of THC consumption, such that it is not clearly known how a given shift in consumer purchasing behavior would further public health goals. The role of CBD and other cannabinoids in augmenting or mitigating health harms from THC consumption are also unclear. Even the marginal harms of THC consumption are not perfectly understood.

Regarding the effectiveness of revenue collections, there are two key areas of uncertainty. First, due to a limited understanding of the likely consumer response to a potency tax, it is difficult to estimate how to structure a new tax to be revenue neutral relative to the current scheme. Second, the potential of a THC-based tax structure to protect future revenues relative to the current price-based excise depends on the speed of future price declines in Washington’s cannabis market. After rapid price declines observed in Washington from 2014 to 2017, prices appear to have steadied somewhat, based on data reports from the current traceability system. Price declines are likely to occur again, as technology improves and business processes continue to become increasingly efficient, though the magnitude of those declines are difficult to estimate. Considering these areas of uncertainty, it is difficult to forecast how tax revenue would change in response to the implementation of a potency tax, and we cannot be sufficiently confident that a hypothetical potency tax would be revenue neutral.

Feasibility

Further, there are several features of Washington’s regulatory and enforcement infrastructure that may limit the effectiveness of any potency tax implemented at this time.

First, the integrity of Washington’s testing regime is already vulnerable, and the imposition of a THC tax may put additional stress on that system requiring that the LCB invest in additional enforcement capacity. (Though imposing such a tax also presents an opportunity to improve the integrity of the testing system by introducing a countervailing pressure balancing the current incentive towards inflated THC results.)

Second, the reduced scope of the current traceability system and the persistence of bugs and malfunctions has limited the ability of the state to use the system to monitor and enforce compliance among licensees. Under the current system, where both excise and sales tax are based on retail price, the LCB and the Department of Revenue are able to share a common basis for monitoring and auditing tax compliance, an efficiency which would be sacrificed if the excise tax were switched away from a price basis.

The current Leaf Data system is unable to consistently link a product to its associated potency test(s), and therefore would not allow consistent auditing of sales of cannabinoid content reported by licensees. Adding such a capability would require a comprehensive overhaul of the current database.

However, even without updating the Leaf Data system to connect a product to its measured potency, there may be more modest adjustments to the system that would help track potency data. One proposal would be for licensees or laboratories to manually input potency data relating to each product, perhaps with reference to the associated certificate(s) of analysis. This would require modifying the traceability system to add fields relating to product type and/or cannabinoid content, and to recalculate cannabinoid content as necessary as a product moves along the supply chain. Even these changes may be difficult to implement given the current contract status and the length of the existing backlog of scheduled updates. In this scenario, potency tax obligations would not be able to be audited solely with reference to data stored in the traceability system but could be supplemented by reference to paper certificates of analysis. (One way to bolster the security of this system would be to create an electronic database for certificates of analysis, so results could be verified from a central location.)

Finally, any change to reporting requirements or the traceability system would require corresponding changes to integrators and/or point of sale software providers. In the past, integrators have expressed some difficulty in updating their platforms to work in sync with the traceability system, causing delays to a recent traceability system update. Eventually third-party software providers were able to successfully update their systems, though only after expending considerable time and cost. In the case of a potency tax, similar complications may be expected, with some software vendors able to adapt quickly and others taking longer to adjust.

Summary

In summary, a potency tax is likely to shift consumer purchasing habits, but to an extent that is currently unknown. Furthermore, it is currently impossible to quantify the public health gains of a particular switch in consumption, e.g. from solid concentrates to flower, or from high-THC flower to low-THC flower. Nor is it feasible to estimate the potential long-term revenue changes from switching away from a price-based tax, given uncertainties about long-term price forecasts. This is not to say the tax would have no effect. Microeconomic theory suggests that a potency tax would likely be effective in shifting consumer purchasing habits away from products that are targeted for additional taxation, and towards products that are not targeted. However, given the limited evidence base in academic publications and in the experience of other jurisdictions, it is difficult to predict these public health or revenue effects with any precision.

Many policies, including those that best serve the goals of public health, are born out of a similar degree of uncertainty. But until we are better able to predict consumer responses to, and the health implications of a THC tax, any change in the tax structure would require embracing large known costs and additional unknown costs in exchange for unknown benefits. This report has identified several areas of the state's regulatory and enforcement infrastructure that require improvement prior to the smooth implementation of any model of potency tax. The considerable difficulties and costs associated with such undertakings suggest the value of exploring other options for advancing the goals of public health and revenue protection before committing to a THC tax.

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