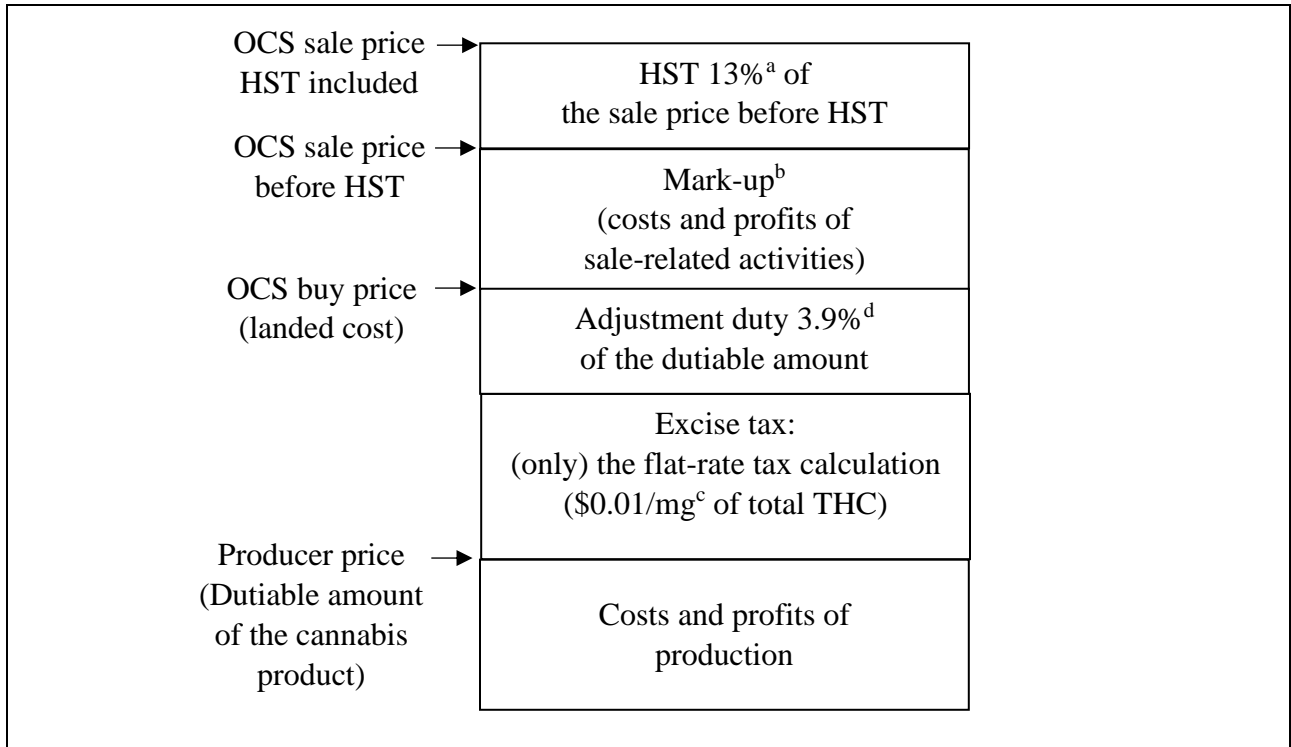


**Comparing two cannabis tax-base systems: Lessons learned from legal cannabis products sold in Ontario, Canada**

**Supplementary Materials**

**Figure S1.** A conceptual model of tax and price structures for cannabis oil, edible cannabis, cannabis extracts, and cannabis topicals sold in Ontario



Source: Canada Revenue Agency (Canada Revenue Agency, 2018b, 2019b)

Abbreviation: HST: harmonized sale tax

<sup>a</sup> HST = 13% for Ontario

<sup>b</sup> Mark-up = = sell-related activity costs and profits of the sellers

<sup>c</sup> Flat rate of 0.01/mg of total THC consists of \$0.0025 for the federal cannabis tax and \$0.0075 for the additional cannabis tax for Ontario

<sup>d</sup> Adjustment rate = 3.9% for Ontario

**Box S1.** Examples of price and tax structure calculations of selected cannabis products sold in the Ontario Cannabis Store (OCS)

Example 1: A 10-15% THC and 0.05-0.07% CBD dried-flower product (medium strength, THC predominant) with a retail price of \$28.95 and its OCS landed cost (the producer price)<sup>a</sup> of \$15.75 for a dried-flower product of 3.5 grams. This landed cost already includes the excise and the adjusted additional tax. The following price and tax values are for this product:

1. Retail price (HST included): \$8.27 per gram of flower ( $\$28.95/3.5$  grams)
2. Price before HST: \$7.32 per gram of flower ( $= \$8.27/1.13$ ) (The HST is 13% of the price before HST in Ontario)
3. HST: \$0.95 per gram of flower ( $= \$7.32 \times 13\%$ )
4. OCS buy price or landed price: \$4.5 per gram of flower ( $\$15.75/3.5$  grams)
5. Flat rate tax: \$1.00 per gram of flower (regardless of price)
6. To calculate the ad valorem tax, we have to calculate the product's (tentative) dutiable price first. By definition, if the ad valorem tax is the effective tax, the (tentative) dutiable price plus 3.9% (for the adjustment tax) and 10% (for the ad valorem tax) is equal to the OCS buy price. Therefore, the (tentative) dutiable price is equal to 'the producer price'  $\times [100\% / (100\% + 10\% + 3.9\%)]$ . As a result, the (tentative) dutiable price in this example is \$3.95. ( $= \$4.50 \times [100\% / (100\% + 10\% + 3.9\%)]$ )
7. Ad valorem tax: \$0.40 ( $= \$3.95 \times 10\%$ ) (The ad valorem tax is 10% of the product's (tentative) dutiable price.)
8. Effective excise tax rate: \$1.00 per gram of flower (The effective tax is the higher tax between \$1.00 and \$0.40)
9. To calculate the (real) dutiable price if the flat-rate tax is the effective tax, the (real) dutiable price plus 3.9% (for the adjustment tax) and \$1 per gram (for the flat-rate tax) is equal to the OCS buy price. Therefore, the (real) dutiable price is equal to ['the OCS buy price' - \$1]  $\times [100\% / (100\% + 3.9\%)]$ . As a result, the (real) dutiable price in this example is \$3.37. ( $= [\$4.50 - \$1.0] \times [100\% / (100\% + 3.9\%)]$ )
10. Adjusted additional cannabis tax: \$0.13 ( $= \$3.37 \times 3.9\%$ ) (The adjusted additional cannabis tax is 3.9% of the product's (real) dutiable price in Ontario.)
11. Effective excise tax per unit of active ingredient (mg THC): \$0.008 per mg THC ( $= \$1.00/125$  mg THC) (This one-gram flower product, having 12.5% THC ( $=$  the mid-point between 10% and 15%), has 125 mg THC ( $= 12.5\% \times 1,000$  mg flower).
12. All taxes as a percentage of the retail price: 25.18% ( $= \$2.08/\$8.27$ ) (The total of all taxes is a combination of the effective excise tax (\$1), the adjusted additional cannabis tax (\$0.13), and the HST (\$0.95), \$2.08.
13. Note: The ratio of the effective excise tax to the base flat rate per mg THC for the processed products: 0.8 ( $= \$0.008 / \$0.01$ ) (The base flat rate per mg THC for the processed products is \$0.01 per mg THC.)

Example 2: A 19-26% THC and 0-1.0% CBD dried-flower product (very strong, THC-predominant) with a price of \$79.30 and its producer price of \$48.94 for a dried-flower product of 3.5 gram. The following price and tax values are for this product: its retail price

1. Retail price including HST: \$22.66 per gram of flower ( $\$79.30/3.5$  grams)
2. Price before HST: \$20.05 per gram of flower ( $= \$22.66/1.13$ ) (The HST is 13% of the price before HST in Ontario)

3. HST: \$2.61 per gram of flower (= \$20.05 x 13%)
4. OCS landed price or the producer price: \$13.98 per gram of flower (\$48.94/3.5 grams)
5. Flat-rate tax: \$1.00 per gram of flower (regardless of price)
6. To calculate the ad valorem tax, we have to calculate the product's tentative dutiable price first. By definition, if the ad valorem tax is the effective tax, the tentative dutiable price plus 3.9% (for the adjustment tax) and 10% (for the ad valorem tax) is equal to the producer price. Therefore, the tentative dutiable price is equal to 'the producer price' x  $[100\% / (100\% + 10\% + 3.9\%)]$ . As a result, the tentative dutiable price in this example is \$12.28 (= \$13.98 x  $[100\% / (100\% + 10\% + 3.9\%)]$ )
7. Ad valorem tax: \$1.23 (= \$12.28 x 10%) (The ad valorem tax is 10% of the product's tentative dutiable price.)
8. Effective rate: \$1.23 per gram of flower (The effective tax is the higher tax between \$1.00 and \$1.23)
9. To calculate the (real) dutiable price if the ad valorem tax is the effective tax, see Line 6 above. Therefore, the (real) dutiable price in this example is \$12.28.
10. Adjusted additional cannabis tax: \$0.48 (= \$12.28 x 3.9%) (The adjusted additional cannabis tax is 3.9% of the product's (real) dutiable price in Ontario.)
11. Effective excise tax per unit of active ingredient (mg THC): \$0.004 per mg THC (= \$1.23/225 mg THC) (This one-gram flower product, having 22.5% THC (= the midpoint between 19% and 26%), has 225 mg THC (= 22.5% x 1,000 mg flower).
12. All taxes as a percentage of the retail price: 19.04% (= \$4.31/\$22.66) (The total tax is a combination of the effective excise tax (\$1.23), the adjusted additional cannabis tax (\$0.48), and the HST (\$2.61), \$4.31.
13. Note: The ratio of the effective excise tax to the base flat rate per mg THC for the processed products: 0.5 (= \$0.005 / \$0.01) (The base flat rate per mg THC for the processed products is \$0.01 per mg THC.)

Example 3: A pack of 4 pieces of soft candy with 10 mg THC and 10 mg CBD (1:1 product) with a retail price of \$7.30 and its producer price of \$3.31. The following price and tax values are for this product:

1. Retail price including HST: \$7.30 per pack
2. Price before HST: \$6.46 per gram of flower (= \$7.30/1.13) (The HST is 13% of the price before HST in Ontario)
3. HST: \$0.84 per gram of flower (= \$6.46 x 13%)
4. OCS landed price: \$3.31 per pack
5. Flat-rate tax: \$0.01 per mg THC (regardless of price).
6. Effective tax per pack: \$0.10 (= 10 mg THC x \$0.01). (This 4-piece pack of soft candy contains 10 mg THC.) Dutiable amount of the cannabis product
7. To calculate the dutiable price for the processed cannabis products, the dutiable price plus 3.9% (for the adjustment tax) and (\$0.01 per mg THC x #mg THC/pack) (for the flat-rate tax) is equal to the producer price. Therefore, the dutiable price is equal to ['the producer price' - (\$0.01 x #mg THC/pack)] x  $[100\% / (100\% + 3.9\%)]$ . As a result, the dutiable price in this example is \$3.09. (= [ $[\$3.31 - (\$0.01/\text{mg} \times 10\text{mg})] \times [100\% / (100\% + 3.9\%)]$ ])

8. Adjusted additional cannabis tax: \$0.12 (= \$3.09 x 3.9%) (The adjusted additional cannabis tax is 3.9% of the product's dutiable price in Ontario.)
9. Effective excise tax per unit of active ingredient (mg THC): \$0.01 per mg THC (= \$0.1/10 mg THC) (The effective tax is \$0.1 (see Line 6)), and this soft candy pack has 10 mg THC as a given).
10. Total tax as a percentage of the retail price: 14.52% (= \$1.06/\$7.30) (The total tax is a combination of the effective excise tax (\$0.1), the adjusted additional cannabis tax (\$0.12), and the HST (\$0.84), \$1.06.
11. The ratio of the effective excise tax per mg THC to the base flat rate per mg THC for the edibles products: 1.0 (= \$0.1 for 10 mg THC/\$0.01 per mg THC) (The base flat rate per mg THC for the processed cannabis product is \$0.01 per mg THC.)

<sup>a</sup>The OCS landed cost is the cost at which the OCS buys a cannabis product from the producer.

The explanation for Box S1 is elaborated upon here. Box S1 (in the supplementary materials) shows our calculations regarding various price and tax structures for three selected cannabis products sold in the Ontario Cannabis Store (OCS). We also explain the steps involved in the first example in Box S1 in detail here: a 10-15% THC and 0.05-0.07% CBD dried-flower product (medium strength, THC predominant) with a price of \$28.95 and its producer price (officially called the OCS landed cost) of \$15.75 per a pack of 3.5 grams of flower. Line 1: this product's retail price (HST included) is \$8.27 per gram of flower. Lines 2-3: the price before HST is \$7.32 and the HST is \$0.95 per gram of flower (\$0.95 is 13% of \$7.32). Line 4: the product's producer price (OCS landed cost) is \$4.5 per gram of flower. Line 5: the flat-rate tax is \$1 per gram of flower regardless of the product price.

Lines 6-10 are calculated together. We have to calculate the product's producer price (officially called the dutiable price) to be able to calculate the ad valorem tax and the adjustment to the additional cannabis tax. However, calculating the dutiable price is not straightforward because it depends on whether the product is charged with the flat-rate tax or the ad valorem tax. We already know the flat-rate tax from Line 5; hence we can calculate the (tentative) dutiable price and the ad valorem tax simultaneously in these steps. If the ad valorem tax is applied, the (tentative)

dutiable price and the ad valorem tax are equal to \$3.95 ( $= \$4.50/1.139$ ) and \$0.40 ( $= \$3.95 \times 10\%$ ), respectively (Line 6 and 7). Please note that  $1.139 = 1$  (the dutiable price) +  $0.1$  (the ad valorem tax of 10%) +  $0.039$  (the adjusted additional tax of 3.9%). This calculation case is not effective because the ad valorem tax of \$0.40 is less than the flat-rate tax of \$1. As a result, the effective excise tax for this example is \$1.0 per gram of flower (Line 8). Consequently, the (real) dutiable price in this example product must be \$3.37 ( $[\$4.50 - \$1] / 1.039$ ) (Line 9) and the adjusted additional cannabis tax is \$0.13 ( $\$3.37 \times 0.039$ ) (Line 10). Please note that  $1.039 = 1$  (the dutiable price) +  $0.039$  (the adjusted additional tax);  $\$3.37 + (\$3.37 \times 0.039) + \$1 = \$4.50$ .

Line 11: since one gram in this example product contains 125 mg THC ( $= 12.5\% \times 1,000$  mg), its cannabis tax is \$0.008 per mg THC ( $= \$1.0/125$  mg). Line 12: the total of all taxes (cannabis tax + adjustment tax + HST) as a percentage of the retail price (HST included) is 25.18% ( $= (\$1.0 + \$0.13 + \$0.95) / \$8.27$ ). Lastly, Line 13 illustrates an indicator—the effective tax ratio to the base flat rate per mg THC—which shows how much the effective cannabis tax is when comparing it to the flat-rate tax per mg of THC of processed cannabis products. The tax ratio is 0.8 times the base rate ( $= \$0.008/\$0.01$ ).

Example 2 demonstrates a dried-flower product that is more expensive than the Example 1 product and it incurs the ad valorem tax rather than the flat-rate tax. Example 3 is of a cannabis edibles product which only incurs the flat-rate tax and the adjusted additional cannabis tax. There is no ad valorem tax involved in the calculation at all in the third example. All the calculations in these two examples follow the same logic of those given in Example 1.

**Table S1**

**Price and Tax Structures of OCS's Dried-Flower Products Sold in Ontario**

Product's potency category	# SKU	Price Structure			Cannabis-Related Tax Structure						Tax Effectiveness		
		Retail price per gram flower (HST included)	HST per gram flower	Mark-up per gram flower	OCS landed cost per gram flower	Flat-rate tax per gram flower	Ad valorem tax per gram flower	Effective excise tax per gram flower	Adjusted additional tax per gram flower	All taxes as a % of the retail price per gm flower	Effective excise tax per mg THC	Ratio: effective excise tax to the flat rate per mg THC	Retail price per mg THC
		(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	(%)	(\$)	(ratio)	(\$)
<b>THC predominant (THC:CBD ≥1.5)</b>													
1	1	5.30	0.61	2.03	2.66	1.00	0.23	1.00	0.06	31.6	0.022	2.2	0.118
2	10	9.37	1.08	3.08	5.22	1.00	0.46	1.00	0.16	26.9	0.012	1.2	0.115
3	104	7.58	0.87	2.70	4.01	1.00	0.35	1.00	0.11	28.1	0.007	0.7	0.056
4	460	7.89	0.91	2.79	4.20	1.00	0.37	1.00	0.12	27.4	0.005	0.5	0.043
5	588	10.03	1.15	3.54	5.34	1.00	0.47	1.00	0.17	24.2	0.004	0.4	0.044
<b>Balanced (THC:CBD ≥0.7, &lt;1.5)</b>													
2	62	8.41	0.97	2.93	4.51	1.00	0.40	1.00	0.13	26.2	0.013	1.3	0.110
4	7	9.82	1.13	3.30	5.39	1.00	0.47	1.00	0.16	23.8	0.005	0.5	0.051
5	1	8.84	1.02	3.25	4.57	1.00	0.40	1.00	0.13	24.3	0.004	0.4	0.035
<b>CBD predominant (THC:CBD &lt;0.7)</b>													
1	35	8.10	0.93	2.83	4.34	1.00	0.38	1.00	0.13	26.0	0.126	12.6	0.996
2	23	8.25	0.95	2.99	4.32	1.00	0.38	1.00	0.12	27.3	0.017	1.7	0.140

Potency: (1) THC<5%, (2) THC ≥5% and ≤10%, (3) THC>10% and ≤15%, (4) THC>15% and ≤ 20%, and (5) THC > 20%

**Table S2**

**Price and Tax Structures of OCS's Pre-Roll Products Sold in Ontario**

Product's potency category	# SKU	Price Structure			Cannabis-Related Tax Structure						Tax Effectiveness		
		Retail price per gram flower (HST included)	HST per gram flower	Mark-up per gram flower	OCS landed cost per gram flower	Flat-rate tax per gram flower	Ad valorem tax per gram flower	Effective excise tax per gram flower	Adjusted additional tax per gram flower	All taxes as a % of the retail price per gm flower	Effective excise tax per mg THC	Ratio: effective excise tax to the flat rate per mg THC	Retail price per mg THC
		(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	(%)	(\$)	(ratio)	(\$)
<b>THC predominant (THC:CBD <math>\geq</math>1.5)</b>													
2	6	14.80	1.70	5.29	7.80	1.00	0.69	1.00	0.25	24.0	0.013	1.3	0.190
3	42	11.50	1.32	4.55	5.63	1.00	0.49	1.00	0.17	23.1	0.007	0.7	0.084
4	237	12.18	1.40	4.76	6.02	1.00	0.53	1.00	0.19	22.3	0.0054	0.54	0.066
5	230	13.44	1.55	5.15	6.74	1.00	0.59	1.00	0.22	21.4	0.0045	0.45	0.060
<b>Balanced (THC:CBD <math>\geq</math>0.7, &lt;1.5)</b>													
2	21	13.91	1.60	5.23	7.09	1.00	0.62	1.00	0.23	21.5	0.013	1.3	0.173
4	1	9.98	1.15	3.92	4.91	1.00	0.43	1.00	0.15	23.0	0.0053	0.53	0.053
5	1	9.98	1.15	3.92	4.91	1.00	0.43	1.00	0.15	23.0	0.0048	0.48	0.048
<b>CBD predominant (THC:CBD &lt;0.7)</b>													
1	13	9.95	1.14	3.78	5.02	1.00	0.44	1.00	0.15	24.4	0.086	8.6	0.890
2	14	13.85	1.59	5.52	6.74	1.00	0.59	1.00	0.22	21.3	0.017	1.7	0.237

**Table S3**

*Price and Tax Structures of OCS's Edible Products Sold in Ontario*

Product's potency category	# SKU	Price Structure			Cannabis-Related Tax Structure			Tax Effectiveness			
		Retail price per 1-gm pack (HST included)	HST per 1-gm pack	Mark-up per 1-gm pack	OCS landed cost per 1-gm pack	Effective excise tax <sup>a</sup> per 1-gm pack	Adjusted additional tax per 1-gm pack	All taxes as a % of the retail price per 1-gm pack	Effective excise tax per mg THC	Ratio: effective excise tax to the flat rate per mg THC	Retail price per mg THC
		(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	(%)	(\$)	(ratio)	(\$)
<b>THC predominant (THC:CBD ≥1.5)</b>											
1	114	7.10	0.82	3.03	3.26	0.10	0.12	14.7	0.01	1.0	0.71
<b>Balanced (THC:CBD ≥0.7, &lt;1.5)</b>											
1	12	6.84	0.79	2.94	3.12	0.10	0.11	14.7	0.01	1.0	0.68
<b>CBD predominant (THC:CBD &lt;0.7)</b>											
1	26	16.48	1.90	6.93	7.65	0.04	0.29	13.7	0.01	1.0	149.14

**Table S4**

***Price and Tax Structures of OCS's Beverage Products Sold in Ontario***

Product's potency category	# SKU	Price structure			Cannabis-related tax structure			Tax effectiveness			
		Retail price per 1-gm pack (HST included)	HST per 1-gm pack	Mark-up per 1-gm pack	OCS landed cost per 1-gm pack	Effective excise tax <sup>a</sup> per 1-gm pack	Adjusted additional tax per 1-gm pack	All taxes as a % of the retail price per 1-gm pack	Effective excise tax per mg THC	Ratio: effective excise tax to the flat rate per mg THC	Retail price per mg THC
		(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	(%)	(\$)	(ratio)	(\$)
<b>THC predominant (THC:CBD ≥1.5)</b>											
1	44	7.83	0.90	3.22	3.71	0.08	0.14	14.3	0.01	1.0	1.17
<b>Balanced (THC:CBD ≥0.7, &lt;1.5)</b>											
1	23	6.63	0.76	2.75	3.12	0.05	0.12	13.9	0.01	1.0	1.71
<b>CBD predominant (THC:CBD &lt;0.7)</b>											
1	38	10.24	1.18	4.02	5.05	0.01	0.19	13.4	0.01	1.0	50.39

**Table S5**

***Price and Tax Structures of OCS's Vape Products Sold in Ontario***

Product's potency category	# SKU	Price Structure			Cannabis-Related Tax Structure			Tax Effectiveness			
		Retail price per 1-gm pack (HST included)	HST per 1-gm pack	Mark-up per 1-gm pack	OCS landed cost per 1-gm pack	Effective excise tax <sup>a</sup> per 1-gm pack	Adjusted additional tax per 1-gm pack	All taxes as a % of the retail price per 1-gm pack	Effective excise tax per mg THC	Ratio: effective excise tax to the flat rate per mg THC	Retail price per mg THC
		(\$)	(\$)	(\$)	(\$)	(\$)	(\$)	(%)	(\$)	(ratio)	(\$)
<b>THC predominant (THC:CBD ≥1.5)</b>											
2	1	79.90	9.19	31.65	39.06	0.38	1.44	13.8	0.01	1.0	1.04
5	428	82.84	9.53	33.29	40.02	4.39	1.21	19.9	0.01	1.0	0.11
<b>Balanced (THC:CBD ≥0.7, &lt;1.5)</b>											
5	22	105.78	12.17	43.11	50.50	1.68	1.75	15.1	0.01	1.0	0.28
<b>CBD predominant (THC:CBD &lt;0.7)</b>											
1	13	73.42	8.45	28.91	36.07	0.17	1.34	13.6	0.01	1.0	3.88
2	3	95.90	11.03	38.49	46.37	0.38	1.71	13.7	0.01	1.0	1.28
3	2	142.85	16.43	61.47	64.95	0.42	2.40	13.5	0.01	1.0	1.30
4	1	91.90	10.57	35.73	45.60	0.76	1.65	14.2	0.01	1.0	0.61
5	12	128.16	14.74	53.58	59.83	1.11	2.14	14.5	0.01	1.0	0.44

<sup>a</sup> Edibles are imposed by the flat-rate taxation only.

**Table S6*****Comparison of Actual Tax Rate/Mg THC between Unprocessed Cannabis Products<sup>1</sup> and Processed Cannabis Products<sup>2</sup>***

Product type	Potency of THC	Tax per gram flower	Tax per mg THC	Ratio to the base flat rate (\$0.01/mg THC)
	[a] (mg)	[b] (\$)	[c = b/a] (\$)	[d = c/\$0.01] (ratio)
Oil	1 mg THC/gm of oil	-	0.01	1
	10 mg THC/gm of oil	-	0.01	1
	20 mg THC/gm of oil	-	0.01	1
Dried flower	1% THC = 10 mg THC/gm of flower	1.0	0.1	10
	5% THC = 50 mg THC/gm of flower	1.0	0.02	2
	10% THC = 100 mg THC/gm of flower	1.0	0.01	1
	15% THC = 150 mg THC/gm of flower	1.0	0.007	0.7
	20% THC = 200 mg THC/gm of flower	1.0	0.005	0.5

<sup>1</sup> Unprocessed cannabis products – using dried-flower products as examples<sup>2</sup> Processed cannabis products – using oil products as examples

Table S6 shows that each mg of THC of the processed cannabis products (e.g., cannabis oil) is imposed with a similar flat-rate tax (\$0.01/mg THC) regardless of its THC potency. However, each mg of THC of the unprocessed cannabis products (e.g., dried flower) is imposed with different flat rates per mg THC, which vary with their THC potencies—even though their taxes are equal, at \$1 per gram of flower. Each mg of THC in the higher THC-potency (>10%) products results in a lower flat-rate tax, while the lower THC-potency (<10%) products pay a higher flat-rate tax, when compared to the 10% THC products. For example, under the equal rate of \$1 per gm of flower, taxes of \$0.005, \$0.01, \$0.1 are imposed on one mg THC for the 20%, 10%, and 1% THC dried-flower products, respectively.