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

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## Abstract

**Aim:** To examine the price and tax structures of cannabis products sold in Ontario in order to formulate a policy recommendation regarding the best cannabis tax base to use from a public health standpoint.

**Design:** Economic analysis to compare price and tax structures of various cannabis products by applying two tax bases (grams [g] of flower versus milligrams [mg] of tetrahydrocannabinol [THC]).

**Setting:** Ontario, Canada

**Data Sources:** Data of cannabis products legally sold in Ontario according to the Ontario Cannabis Store's (OCS) buy and sell prices and product characteristics, including the product's type, quantity per package, and quantity of THC and cannabidiol (CBD). The OCS provided data on 2,601 units of cannabis products in March 2022.

**Measures:** Measures include the harmonized sales tax, the seller's mark-up, the producer's price, the flat-rate tax, *ad valorem* tax, effective excise tax, provincial adjustment tax, and excise tax per milligram of THC. The percentage of each tax compared to the retail price was also calculated.

**Findings:** Cannabis prices were correlated to the products' THC levels rather than their flower weights. The current taxation system based on grams of flower produced lower tax rates for the higher THC potency products. This situation would be improved if the tax base were changed from grams of flower to milligrams of THC.

**Conclusions:** The Ontario government may consider changing the cannabis excise tax base from grams of flower to milligrams of THC to make the strong THC products less affordable. Moreover, indexing the flat-rate tax to inflation is important to prevent the tax's flat rate from becoming lower over time.

## Introduction

Cannabis legalization in Canada occurred upon the passage of the *Cannabis Act* on October 17, 2018, resulting in cannabis dried/fresh flower, plant, seed, and oil being made available on the legal market. One year later, on October 17, 2019, edibles, extracts, and topicals were also made available for sale (Government of Canada - Department of Justice, 2019). As part of a legal framework, cannabis taxation (as covered under the *Excise Act)*, is an important measure that can be used to control cannabis consumption and harms, as well as to generate tax revenues for the government (Government of Canada, 2019a). Evidence demonstrated that some groups of Canadians consumed

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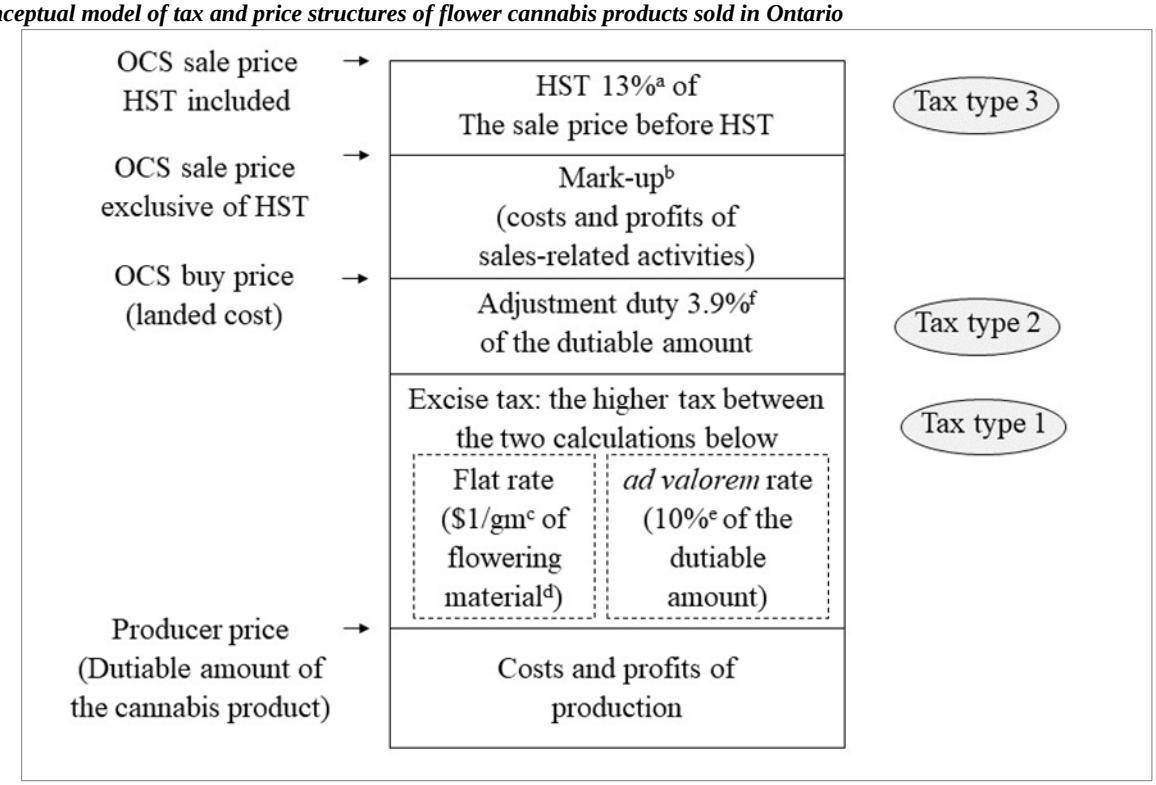
cannabis more than others. The results of the Canadian Cannabis Survey 2023 (conducted five years after legalization) show evidence of statistically significant increases in cannabis use among adolescents (16 to 19 years old) and adults (25 years and older; Government of Canada, 2023).

Of all the Canadian provinces, Ontario residents in particular consumed the greatest amount of legal cannabis products (Ontario Cannabis Store [OCS], 2020). Legal sources of cannabis products have become more relevant after cannabis legalization in Canada, from 37% of the total market in 2019 to 73% in 2023 (Government of Canada, 2023). Many Canadians, including Ontarians, aged 16 years and older preferred high tetrahydrocannabinol (THC)-concentration products and used them more frequently than those using low-THC products (Government of Canada, 2023). In Ontario, dried-flower products were the most popular type of cannabis sold, accounting for 42.5% of sales by value (OCS, 2023b); the "high-strength" range (over 20% THC) covers 52% of the sold dried-flower products (OCS, 2020). The public health concern is that cannabis products with a high THC potency are associated with an increased risk of psychosis and cannabis use disorder, possibly depression and anxiety (relative to products with a lower potency; McDonald et al., 2024; Petrilli et al., 2022), and an increased severity of dependence, particularly in young people (Freeman & Winstock, 2015).

Canadian federal and provincial governments (including Ontario's) apply a complex taxation system to cannabis products (Canada Revenue Agency, 2018, 2019). See Figures 1 and S1 (in the supplementary materials) for conceptual frameworks of Ontario tax and price structures for unprocessed (including dried/fresh flowers, pre-rolls, cannabis plants, and seeds) and processed cannabis products (covering cannabis edibles, extracts, oils, and topicals), respectively (Canada Revenue Agency, 2018, 2019).

**Figure 1**

***Conceptual model of tax and price structures of flower cannabis products sold in Ontario***




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

***Notes***: [a] HST = harmonized sales tax; 13% for Ontario; [b] Mark-up = sell-related activity costs and profits of the sellers; [c] Flat rate of $1/g of flower consists of $0.25 for the federal cannabis tax and $0.75 for the additional cannabis tax for Ontario; [d] Flat rate is $1/g of flowering material, $0.3/g of non-flowering material (i.e., hemp), and $1/cannabis plant or seed; [e] *Ad valorem* rate of 10% consists of $2.5% for the federal cannabis tax and 7.5% for the additional cannabis tax for Ontario; [f] Adjustment rate = 3.9% for Ontario

Figure 1 illustrates three types of taxes imposed on each legal cannabis product sold in Canada. The first type is the cannabis tax levied by the federal government, plus an additional cannabis tax levied by provincial governments. The second type of tax is the adjustment imposed on the additional cannabis tax by the provincial governments. Only three provinces and one territory impose this adjusted additional tax on cannabis products sold in their regions (called "adjustment tax" in this article). This adjustment rate varies from 3.9% of the cannabis product's producer price

for Ontario, 6.5% for Saskatchewan, 16.8% for Alberta, to 19.3% for Nunavut. The third type of tax is the Harmonized Sales Tax (HST): a sales tax that consumers pay on most goods and services sold or provided in Canada. It is called HST because it combines the 5% federal goods and services tax and the 8% retail sales tax to become 13% of the retail price in Ontario.

It is well established in economic theories that consumers use more if goods are cheaper; price is also the most influential factor for Canadians' cannabis-buying decisions. For instance, among past 12-month cannabis users, the most important factors influencing their purchasing decisions were price (42%), followed by convenience (15%), and product strength (9%; Government of Canada, 2023).

Prices are affected by excise tax structures, including excise tax method, tax base, the tax rate per unit of active ingredient, and the tax rate as a percentage of the price (Babor et al., 2023; Barzel, 1976; Keen, 1998; Myles, 1996; Sornpaisarn et al., 2015, 2017; World Health Organization [WHO], 2010). Excise tax is a tax imposed on selected goods that are consumed within a country, whereas the tax method is the method of taxation that the government uses to impose an excise tax on selected goods. Generally, there are two types of tax methods: *ad valorem* (taxing based on product price) and specific taxation (taxing based on product quantity (e.g., grams of flower)). The government can use either one of these two tax methods or apply both methods simultaneously. The tax base is the value used to calculate tax liabilities, while the tax rate is the value of tax imposed on a product, such as 10% of the producer price (for the *ad valorem* tax) or $1 per gram of cannabis flower (for the specific tax).

In Canada, the federal and provincial governments employ two types of tax methods. One is a combination tax method using a flat-rate tax (equivalent to the specific tax) based on weight of cannabis flower ($1 per gram of flower, viable seed, and vegetable cannabis plant; $0.3 per gram of non-flowering material) or an *ad valorem* tax (10% of the producer's price of products) depending on which one provides the higher tax value (Canada Revenue Agency, 2018). The other is a flat-rate tax based on weight of THC ($0.01 per milligram of THC) contained in cannabis products (Canada Revenue Agency, 2019). The former tax method is for unprocessed, and the latter is for processed products; they are called the '*Ad valorem* with specific floor taxation' (ASF) and the specific taxation in the tobacco and alcohol fields, respectively (Babor et al., 2023; Barzel, 1976; Keen, 1998; Myles, 1996; Sornpaisarn et al., 2015, 2017; WHO, 2010, 2023).

Evidence from the alcohol literature demonstrates that the specific tax based on the alcohol contained in alcoholic beverages by volume (equivalent to the flat-rate tax based on grams of flower) influences the production and consumption of high-content alcoholic beverages (Sornpaisarn et al., 2017; WHO, 2023). Thus, the present study focused on comparing the differential effects of taxing cannabis products based on the weight of the flower ($1 per grams of flower) and the weight of THC ($0.01 per milligram of THC) on price and tax structures of cannabis products sold legally in Ontario (Canada's most populous province and the province with the greatest amount of legal cannabis consumed; OCS, 2020). Understanding how these different tax bases may influence taxes and prices per milligram of THC of cannabis products is important for developing recommendations for improving the cannabis tax policy.

## Methods

In order to study how two types of tax bases (based on grams of flower and milligrams of THC) impact the price and tax structures of legal cannabis products sold in Ontario, we obtained data from the Ontario Cannabis Store (OCS; www.OCS.ca). The OCS is the only legal online retailer of recreational cannabis products and the monopolized wholesaler supplying all cannabis products to all retail stores in Ontario (OCS, 2020). Data provided included 2,601 legal cannabis products (in terms of Stock Keeping Units [SKU]) sold in Ontario in 2022. An SKU is a unique number assigned to each product's type, brand, and product item (e.g., a pack of 3.5g of dried flower of Brand X), which allows vendors to automatically track inventory in their stores.

The information provided to us by the OCS included product types, THC and CBD potencies, and quantity per pack; as well as OCS purchase and retail sale prices. The cannabis product types sold in the OCS include dried flowers, pre-rolls, extracts, edibles, and topicals. Cannabis oils, capsules, hash, kief, resin, rosin, shatter, wax, isolates, and distillates are sub-types of extracts. Even though the data provided by the OCS for our analysis covered only dried flowers, pre-rolls, edibles, beverages, and vapes, they accounted for 70% to 95% of the market share by value in 2022 to 2023 (OCS, 2023b). Cannabis potencies are based on the amount of THC and CBD present in the product. Ontario Cannabis Store purchase prices (officially called landed costs) are the product prices at which the producers sell cannabis products to the OCS. These OCS purchase prices included producers' production costs and profits, as well as cannabis taxes and adjustment taxes. The OCS retail sale prices are the prices at which the OCS sells cannabis products to consumers. These retail sale prices are equal to the OCS purchase prices plus mark-ups (costs and profits of cannabis sellers) and the HST. Please note that the OCS's retail sale prices are usually lower than the retailers' sale prices. The reason is that the OCS sells cannabis products with reduced mark-up prices to retailers and they can add additional mark-ups freely (OCS, 2023b). Box S1 (in the supplementary materials) shows our step-by-step price and tax structure calculations for three selected cannabis products sold in the OCS: a cheaper dried flower, a more expensive dried flower, and an edible.

To see the differential effects of using the two different tax bases for the flat-rate taxation of processed and unprocessed cannabis products, we examined price and tax structures influenced by these two tax bases among various cannabis products containing different ratios of the two main cannabinoid components (THC-predominant [THC:CBD $\geq$ 1.5], CBD-predominant [THC:CBD < 0.67], and balanced products [1.5 > THC:CBD $\geq$ 0.67]). We also assessed the impact of cannabis products' different THC potencies (percentage of THC [%THC]: very mild, 0 to 4%; mild, 5 to

10%; medium, 11 to 15%; strong, 16 to 20%; and very strong, 21% or greater). We also did a simulation to see how taxes and prices per milligram of THC would change if the tax base for unprocessed products were changed from grams of flower to milligrams of THC.

## Results

Tables S1 to S5 in the supplementary materials illustrate the price and tax structures of dried flowers, pre-rolls, edibles, beverages, and vape products sold in Ontario, respectively. These data are stratified by the THC:CBD ratio and THC potency (%THC). We have summarized the essential points of tables S1 to S5 in Table 1 and Figure 2 below. Table 1 shows the total number of SKUs for cannabis products legally sold in Ontario in 2022 by product type, THC:CBD ratio, and THC potency. The total number of SKUs was 2,601, which included 1,291, 565, 158, 105, and 482 for dried flower, pre-rolls, edibles, beverages, and vapes, and accounted for 49.6%, 21.7%, 6.1%, 4.0%, and 18.5%, respectively. The majority of cannabis product types were THC-predominant products, with the proportion around 90% for dried flowers, pre-rolls, and vapes. Cannabis beverages had higher proportions of CBD-predominant and balanced products compared to other product types. Whereas all cannabis edibles and beverage products had very low THC levels (< 5% THC), more than 90% of dried flower, pre-roll, and vape cannabis products contained strong (16% to 20% THC) and very strong (>20% THC) THC levels.

**Table 1**

***SKUs* of Cannabis Products sold in Ontario in 2022 by Product Type, Predominance, and THC potency***

| Product type | Product Predominance | # (%)[a] of SKU* in each product type and THC ratio | | | | | Total # (%)[b] |
|---|---|---|---|---|---|---|---|
| | | 0-4% THC* | 5-10% THC | 11-15% THC | 16-20% THC | 21%+ THC | |
| **Dried flowers** | THC predominant | 1 (0.1%) | 10 (0.9%) | 104 (8.9%) | 460 (39.6%) | 588 (50.6%) | 1,163 (90.1%) |
| | Balanced | 0 (0.0%) | 62 (88.6%) | 0 (0.0%) | 7 (10.0%) | 1 (1.4%) | 70 (5.4%) |
| | CBD*-predominant | 35 (60.3%) | 23 (39.7%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 58 (4.5%) |
| **Pre-rolls** | THC-predominant | 0 (0.0%) | 6 (1.2%) | 42 (8.2%) | 237 (46.0%) | 230 (44.7%) | 515 (91.2%) |
| | Balanced | 0 (0.0%) | 21 (91.3%) | 0 (0.0%) | 1 (4.4%) | 1 (4.4%) | 23 (4.1%) |
| | CBD-predominant | 13 (48.2%) | 14 (51.8%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 27 (4.8%) |
| **Edibles** | THC-predominant | 114 (100.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 114 (72.2%) |
| | Balanced | 12 (100.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 12 (7.6%) |
| | CBD-predominant | 32 (100.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 32 (20.3%) |
| **Beverages** | THC predominant | 44 (100.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 44 (41.9%) |
| | Balanced | 23 (100.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 23 (21.9%) |
| | CBD-predominant | 38 (100.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 38 (36.2%) |
| **Vapes** | THC-predominant | 0 (0.0%) | 1 (0.23%) | 0 (0.0%) | 0 (0.0%) | 428 (99.8%) | 429 (89.0%) |
| | Balanced | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 22 (100.0%) | 22 (4.6%) |
| | CBD-predominant | 13 (41.9%) | 3 (9.7%) | 2 (6.5%) | 1 (3.2%) | 12 (38.7%) | 31 (6.4%) |

***Notes:*** * SKUs = Stock-keeping units; THC = Tetrahydrocannabinol; CBD = Cannabidiol. [a] % row, [b] % column

Table 2 demonstrates various attributes (including tax per grams of package, THC per package, equivalent tax per milligram of THC, and price per milligram of THC) of legal cannabis dried flowers, pre-rolls, edibles, beverages, and vapes. We can observe that under the ASF the tax per grams of product (Parameter #1) for cannabis dried flowers and pre-rolls were $1/gram of flower or more. We can also observe that the equivalent tax per milligram of THC (Parameter #3) for cannabis edibles, beverages, and vapes was equally at $0.01/milligram of THC for all THC-potency product varieties under the specific (only) taxation. However, the equivalent tax per milligram of THC for dried

flowers and pre-rolls was higher than \$0.01/milligram of THC if their products' THC potencies were lower than or equal to 10%; whereas they were less than \$0.01/milligram of THC for the products having greater than 10% THC potency. (See a mathematical proof of how the THC concentration affects the equivalent tax per milligram of THC in Table S6). As a result, the average tax per milligram of THC was \$0.01/milligram of THC for all three processed cannabis products, while it was \$0.009 (10% less) and \$0.008/milligram of THC (20% less) for dried flowers and pre-rolls, respectively. This lowering of taxes per milligram of THC was even obvious in the high THC-potency category (e.g., \$0.004 (60% less) and \$0.005 (50% less) for the greater than 20% THC dried flower and pre-roll products, respectively).

Table 2 also shows the cannabis products' average prices per milligram of THC (Parameter #4) under the current tax system for all product types. The prices per milligram of THC were more correlated to the effective excise tax per milligram of THC than to the effective excise tax per grams of flower. The Pearson Correlation Coefficients were 0.972 ($df$ = 1,290; $p < 0.001$) and 0.963 ($df$ = 564; $p < 0.001$) for the relationship between the price and the THC-based tax; while they were 0.044 ($df$ = 1,290; $p$ = 0.118) and 0.111 ($df$ = 564; $p$ = 0.008) for the relationship between the price and the flower-based tax for dried flowers and pre-rolls, respectively. This analysis was not relevant for the processed products because their cannabis excise taxes per milligram of THC were at a fixed rate.

**Table 2**

***Attributes of Different Cannabis Products under Current Tax Method, Base, and Rate, Stratified by Product THC Potency***

| Tax method | Product type | Parameter | THC potency 0-4% | 5-10% | 11-15% | 16-20% | 21%+ | Average |
|---|---|---|---|---|---|---|---|---|
| **ASF taxation (\$1/g of Flower or 10%)** | Dried flower | Tax per g of product (\$) | 1.000 | 1.010 | 1.000 | 1.000 | 1.000 | |
| | | THC per package (mg) | 98 | 395 | 1,072 | 1,285 | 1,312 | |
| | | Equivalent tax per mg THC (\$) | 0.123 | 0.014 | 0.007 | 0.005 | 0.004 | 0.009 |
| | | Price per mg THC (\$) | 0.971 | 0.117 | 0.056 | 0.043 | 0.044 | 0.076 |
| | Pre-rolls | Tax per g of product (\$) | 1.000 | 1.030 | 1.000 | 1.010 | 1.010 | |
| | | THC per package (mg) | 43 | 128 | 215 | 338 | 414 | |
| | | Equivalent tax per mg THC (\$) | 0.086 | 0.014 | 0.007 | 0.005 | 0.005 | 0.008 |
| | | Price per mg THC (\$) | 0.890 | 0.197 | 0.084 | 0.066 | 0.060 | 0.093 |
| **Specific (only) taxation (\$0.01/mg THC)** | Edibles | Tax per g of product (\$) | 0.010 | N/A | N/A | N/A | N/A | |
| | | THC per package (mg) | 9 | N/A | N/A | N/A | N/A | |
| | | Equivalent tax per mg THC (\$) | 0.010 | N/A | N/A | N/A | N/A | 0.010 |
| | | Price per mg THC (\$) | 26.099 | N/A | N/A | N/A | N/A | 26.099 |
| | Bever-ages | Tax per g of product (\$) | 0.035 | N/A | N/A | N/A | N/A | |
| | | THC per package (mg) | 5 | N/A | N/A | N/A | N/A | |
| | | Equivalent tax per mg THC (\$) | 0.010 | N/A | N/A | N/A | N/A | 0.010 |
| | | Price per mg THC (\$) | 15.808 | N/A | N/A | N/A | N/A | 15.808 |
| | Vapes | Tax per g of product (\$) | 0.270 | 0.750 | 1.110 | 1.510 | 7.450 | |
| | | THC per package (mg) | 17 | 38 | 42 | 76 | 417 | |
| | | Equivalent tax per mg THC (\$) | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 |
| | | Price per mg THC (\$) | 3.882 | 1.220 | 1.297 | 0.609 | 0.127 | 0.243 |

***Notes***: ASF: *Ad Valorem* with Specific Floor Taxation; N/A = no product in this category

We did a simulation by changing the ASF with the flat rate and base of \$1/gram of flower to \$0.01/milligram of THC for dried flowers and pre-rolls and compared it to the current tax system. Table 3 illustrates the average excise tax per grams of flower (Parameter #1) and the average equivalent cannabis tax per milligram of THC (Parameter #2) for these two products, stratified by products' THC potency. Moreover, it also shows the number of products with their effective tax methods (the higher tax between the *ad valorem* or the specific taxation) and the summarized ASF. We can observe that all products with greater than 10% THC concentration attracted the cannabis tax below \$0.01/milligram of THC even though they never attracted tax below \$1/gram of flower under the current ASF based on grams of flower.

According to our simulation, there were no products that attracted the cannabis tax below \$0.01/milligram of THC under the simulated ASF, with the flat-rate tax based on milligrams of THC even in the greater than 10% THC product categories. As a result, the overall average taxes increased from 0.009 to 0.011 (22% increase) and 0.008 to 0.011 (38% increase) and prices increased by 2.6% (0.078/0.076) and 4.3% (0.097/0.093) for dried flowers and pre-rolls, respectively. Furthermore, the ratio of the average tax rates per milligram of THC for the very strong THC potency product category (greater than 20% THC) was 2.0 and 2.5 times greater (\$0.010 vs. \$0.004 and \$0.005) if we compare the simulation to the current scenarios, resulting in a price per milligram of THC that increases by 15% (0.051/0.044) and 10% (0.066/0.060) for dried flowers and pre-rolls, respectively. Therefore, this category's average price per milligram of THC was not the lowest compared to other THC potency categories.

**Table 3**
***Comparison of Current Cannabis Excise Taxes with Simulations****

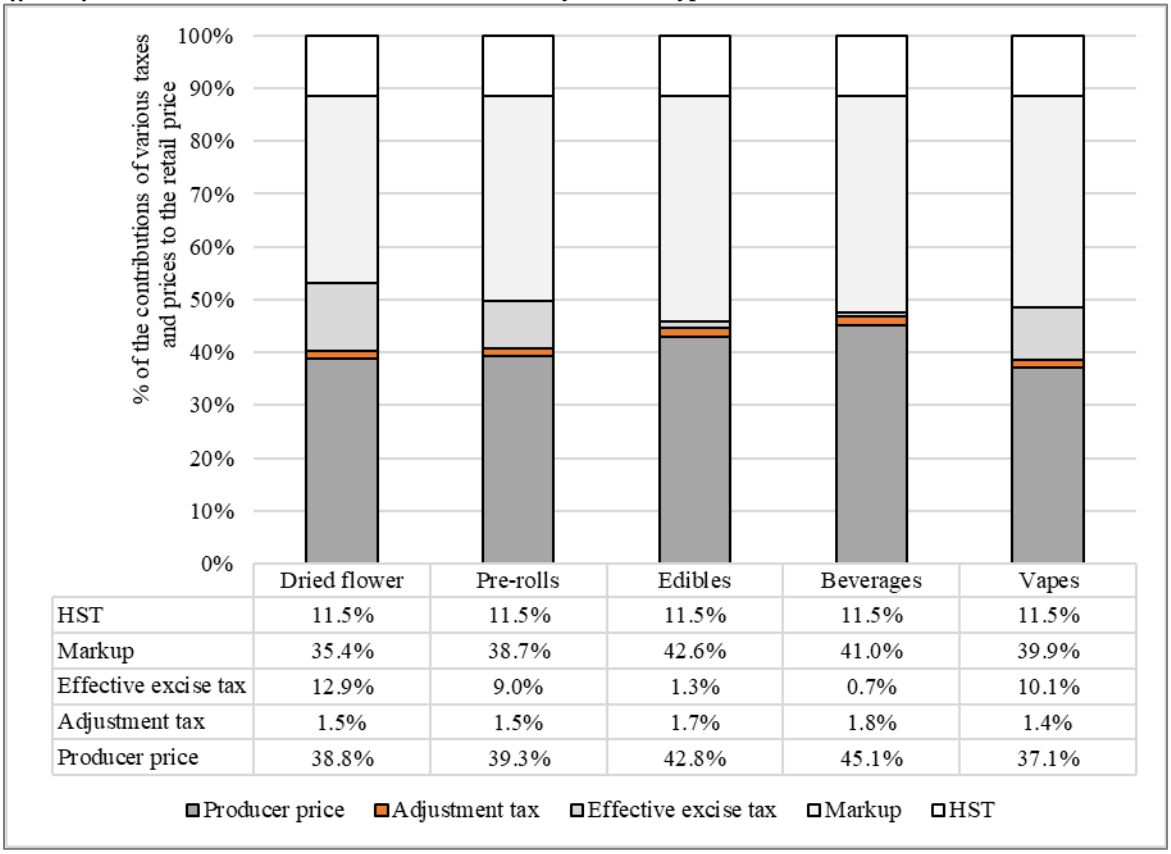
| Tax System | Parameter | Effective tax type | THC potency [(*n*), $] 0-4% | 5-10% | 11-15% | 16-20% | 21%+ | Average [(n), $] |
|---|---|---|---|---|---|---|---|---|
| **Dried flowers** | | | | | | | | |
| Current | Number of products charged by this tax and the average tax per g | AV | (0) | (3) | (0) | (4) | (6) | (13) |
| | | | | 1.228 | | 1.115 | 1.079 | 1.124 |
| | | SP | (36) | (92) | (104) | (463) | (583) | (1,278) |
| | | | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| | | ASF | (36) | (95) | (104) | (467) | (589) | (1,291) |
| | | | 1.000 | 1.007 | 1.000 | 1.001 | 1.001 | 1.001 |
| Current with transformation to tax per mg THC | Number of products charged by this tax and the average equivalent tax per mg THC | AV | (0) | (3) | (0) | (4) | (6) | (13) |
| | | | | 0.015 | | 0.006 | 0.004 | 0.007 |
| | | SP | (36) | (92) | (104) | (463) | (583) | (1,278) |
| | | | 0.123 | 0.014 | 0.007 | 0.005 | 0.004 | 0.009 |
| | | ASF | (36) | (95) | (104) | (467) | (589) | (1,291) |
| | | | 0.123 | 0.014 | 0.007 | 0.005 | 0.004 | 0.009 |
| | Current price per mg THC ($) | ASF | (36) | (95) | (104) | (467) | (589) | (1,291) |
| | | | 0.971 | 0.117 | 0.056 | 0.043 | (0.044) | 0.076 |
| Simulation | Number of products charged by this tax and the average tax per mg THC | AV | (26) | (3) | (0) | (0) | (0) | (29) |
| | | | 0.060 | 0.015 | | | | 0.055 |
| | | SP | (10) | (92) | (104) | (467) | (589) | (1,262) |
| | | | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 |
| | | ASF | (36) | (95) | (104) | (467) | (589) | (1,291) |
| | | | 0.046 | 0.010 | 0.010 | 0.010 | 0.010 | 0.011 |
| | Simulated price per mg THC ($) | ASF | (36) | (95) | (104) | (467) | (589) | (1,291) |
| | | | 0.885 | 0.113 | 0.059 | 0.048 | 0.051 | 0.078 |
| **Pre-rolls** | | | | | | | | |
| Current | Number of products charged by this tax and the average tax per g of product | AV | (0) | (6) | (0) | (7) | (13) | (26) |
| | | | | 1.0222 | | 1.170 | 1.157 | 1.176 |
| | | SP | (13) | (35) | (42) | (231) | (218) | (539) |
| | | | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| | | ASF | (36) | (41) | (42) | (238) | (231) | (565) |
| | | | 1.000 | 1.033 | 1.000 | 1.005 | 1.009 | 1.009 |
| Current with a transformation to tax per mg THC | Number of products charged by this tax and the average equivalent tax per mg THC | AV | (0) | (6) | (0) | (7) | (13) | (26) |
| | | | | 0.014 | | 0.007 | 0.005 | 0.008 |
| | | SP | (13) | (35) | (42) | (231) | (218) | (539) |
| | | | 0.086 | 0.014 | 0.007 | 0.005 | 0.004 | 0.008 |
| | | ASF | (13) | (41) | (42) | (238) | (231) | (565) |
| | | | 0.086 | 0.014 | 0.007 | 0.005 | 0.005 | 0.008 |
| | Current price per mg THC ($) | ASF | (13) | (41) | (42) | (238) | (231) | (565) |
| | | | 0.890 | 0.197 | 0.084 | 0.066 | 0.060 | 0.093 |
| Simulation | Number of products charged by this tax and the average tax per mg THC | AV | (9) | (14) | (0) | (0) | (0) | (23) |
| | | | 0.054 | 0.013 | | | | 0.029 |
| | | SP | (4) | (27) | (42) | (238) | (231) | (542) |
| | | | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 |
| | | ASF | (13) | (41) | (42) | (238) | (231) | (565) |
| | | | 0.040 | 0.011 | 0.010 | 0.010 | 1.010 | 0.011 |
| | Simulated price per mg THC ($) | ASF | (13) | (41) | (42) | (238) | (231) | (565) |
| | | | 0.839 | 0.193 | 0.087 | 0.071 | 0.066 | 0.097 |

***Note***: *Current cannabis excise taxes on dried-flower and pre-roll products was compared to simulations by changing the tax flat rate and base of $1/g of flower to $0.01/mg THC, stratified by the product's THC potency

Figure 2 illustrates the financial effects of various taxes and prices on the retail prices of various cannabis product types. All calculated percentages are based on the retail prices. The two main cost drivers were the producer prices and the mark-ups, accounting for about three-quarters or more of the retail prices. The effective excise taxes accounted for about a tenth of the retail prices: 13% for dried flowers, 9% for pre-rolls, and 10% for vapes. They contributed an even smaller proportion to the retail prices (around 1%) of edibles and beverages, at 1.3% and 0.7%, respectively.

**Figure 2**

***Effects of Various Taxes and Prices on the Retail Price, by Product Type***




| | Dried flower | Pre-rolls | Edibles | Beverages | Vapes |
|---|---|---|---|---|---|
| HST | 11.5% | 11.5% | 11.5% | 11.5% | 11.5% |
| Markup | 35.4% | 38.7% | 42.6% | 41.0% | 39.9% |
| Effective excise tax | 12.9% | 9.0% | 1.3% | 0.7% | 10.1% |
| Adjustment tax | 1.5% | 1.5% | 1.7% | 1.8% | 1.4% |
| Producer price | 38.8% | 39.3% | 42.8% | 45.1% | 37.1% |

## Discussion

By calculating the effects of two different tax bases of the specific taxation (flat rate) imposed on cannabis products legally sold in Ontario, Canada ($1 per gram of flower applied for unprocessed cannabis products and $0.01 per milligram of THC utilized for processed cannabis products), our study found the following: First, the latter tax base produces a similar tax rate of $0.01 per milligram of THC on various cannabis products regardless of their THC potency. The former provides taxes less or more than $0.01 per milligram of THC, depending on whether the cannabis product contains a THC concentration of greater or less than 10%, respectively. As a result, all three processed cannabis products had cannabis excise taxes of $0.01/milligram of THC imposed, while this rate was $0.009 (10% less) and $0.008 (20% less) for dried flowers and pre-rolls, respectively. The lowering of taxes per milligram of THC was also clearly seen in the high-THC potency category. This empirical evidence suggests that the cannabis flat-rate tax based on grams of flower functions much like the alcohol tax based on the volume of alcoholic beverages in lowering the tax rate per active ingredients (ethanol) for high-concentration products (Sornpaisarn et al., 2017; WHO, 2023). Since the high THC-potency products were preferred among cannabis users and the cannabis prices affected consumers' buying decisions (Government of Canada, 2023), the current taxation based on grams of flower may influence consumers to increase their consumption of more potent products (OCS, 2020), which are known to be associated with increased risk of psychosis and cannabis use disorder (Freeman & Winstock, 2015; Petrilli et al., 2022).

Our second finding was that cannabis retail prices correlated more to the latter tax base (based on milligrams of THC) than to the former tax base (based on grams of flower). This means that manipulating the cannabis products' excise taxes per milligram of THC may impact their prices per milligram of THC, in a similar manner to how tobacco and alcohol excise taxation affects the prices of the corresponding products (Sornpaisarn et al., 2017; WHO, 2023).

The third finding was that THC could be used as a base of cannabis excise taxation, as we found that the cannabis excise taxes for the high-THC potency products (especially those in the very high-THC category) would increase (resulting in corresponding price increases) if the tax base was changed from grams of flower to milligrams of THC. Moreover, taxing THC would be a public health strategy similar to that of the suggestion by the World Health Organization; it has been suggested that Member States tax tobacco and alcohol products based on their active ingredients (Sornpaisarn et al., 2017; WHO, 2023).

Hoffer (2023) argued that the flat-rate tax based on grams of flower may be needed if testing of the THC level proves to be too impractical and costly, even though the author believed that taxing THC is the ideal cannabis taxation (Hoffer, 2023). We argued that it is possible to tax based on the THC level in practice. Three U.S. states – Connecticut,

Illinois, and New York – out of a total of 19 states that tax cannabis products, tax cannabis products based on THC (Auxier & Airi, 2022). Furthermore, the Canadian Cannabis Regulations (SOR/2018-144) already require cannabis license holders to test for the quantity or concentration of THC, THCA, CBD, and CBDA, as well as the amounts of contaminants and pesticide residues, in representative samples of each lot or batch of cannabis products before selling or exporting those products (Government of Canada, 2018, 2019). All cannabis products legally sold in Ontario have a label containing product THC and CBD levels; therefore using the THC potency level as a base for cannabis excise taxation purposes is feasible and economical in terms of testing-related costs.

Canadian public health advocates have long called for legal cannabis products to be priced in a way that steers consumers toward lower potency and less risky products (Canadian Public Health Association, 2017; Centre for Addiction and Mental Health, 2014). Accordingly, the government of Canada taxes the flower-based cannabis products at a higher rate than the non-flower-based products (Canada Revenue Agency, 2018). Using the same principle, some U.S. jurisdictions (such as Alaska, Colorado, Main, and Nevada) use different tax rates for different parts of the plant, with flower taxed at the greatest rate because it is the most potent part of the plant (Auxier & Airi, 2022). Based on our findings, we propose a policy recommendation to improve the cannabis tax system in Ontario by switching from the flat-rate tax currently being based on grams of cannabis flower to one based on milligram of THC. This THC-based taxation would help further reduce the consumption of high-THC flower products since cannabis users commonly titrate the amount of products they consume (e.g., self-rolled joint) based on the concentration of THC in the product (Freeman et al., 2014). Moreover, the flat-rate tax rate should be indexed to the inflation rate to prevent the lowering of the tax's flat rate over time (Davis et al., 2019).

This study has some limitations. First, while our data include most of the products sold in Ontario, they do not include all of them. Second, we did not include the illegal market, which seems to influence the pricing of the legal products (Statistics Canada, 2020). Third, the data in our analysis were provided for 2022, prior to the new OCS mark-up policy introduced in 2023. In order to reduce costs for retailers, the OCS reduced its mark-up for the retailers from 31% of the OCS purchase price (landed cost) to 23% for dried flowers, 29% for pre-rolls, and 25% for most other cannabis products (OCS, 2023a). Fortunately, these mark-up reductions have no effect on our excise and adjustment tax calculations because these two calculations are based only on the OCS purchase prices that were not affected by this mark-up reduction policy. The only calculation that is affected is the sum of effective excise tax as a percentage of the retail price (Figure 2), but the effect is very small, accounting for an average increase of 5% (per the authors' calculations).

The following studies are recommended for further investigation: (a) a study of the differential effects of the two tax methods (the ASF and the specific [only] taxation) and tax rates applied in Ontario and in Canada, and other types of tax methods and tax rates employed outside Canada on price and tax structures of cannabis products and tax revenues generated by selling these products (Grossman et al., 2024); (b) an assessment of the cannabis products most commonly consumed by heavy users and used as entry-level by adolescents to examine the relationships between products' taxes and prices and their product-preference choices; (c) a study of the price and tax structures of cannabis products sold in other provinces and territories, and a comparison of them to determine the effects of different cannabis taxes imposed across Canada; and finally (d) a comparative study of the pricing and consumption levels between legal and illegal products, since price and consumption levels are the main reasons consumers choose legal products over illegal products—and the role of taxation, and its indirect effect on price, strongly affects their choices.

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## Author contributions

BS: Conceptualization, methodology, formal analysis, writing of original draft, revising, and editing.
FA, JFC, SI, CR, NHS: revising and editing.
JR: Conceptualization, formal analysis, funding acquisition, supervision, review, and editing.
All authors: approval of the submitted manuscript.

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