RESPONSIBLEOHIO'S PRELIMINARY ECONOMIC MODEL

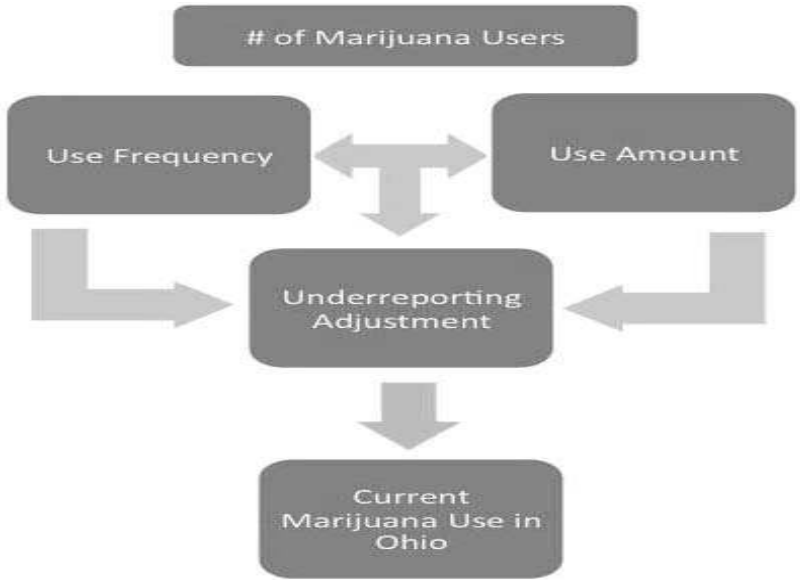
Methods & Assumptions

The model to estimate revenue from the commercial legalization of marijuana in Ohio was constructed using the best data and methods currently available in academic literature. It is comprised of two distinct components:

1. **Current Marijuana Demand in Ohio:** This is the estimate of the current demand for marijuana in Ohio;
2. **Projected Price, Market Share, and Tax Revenue of a Legal Market:** This simulation projects the sale price of marijuana that will maximize retail, manufacturing, and cultivation business income and is premised on the assumption that these entities are economically rational actors. This simulation also provides a ratio of legal market share v. black market share, and calculates tax revenues at each level of the market (cultivation, manufacturing, and retail).

Following are the assumptions and methods used in each segment of the model.

1. Current Marijuana Demand in Ohio

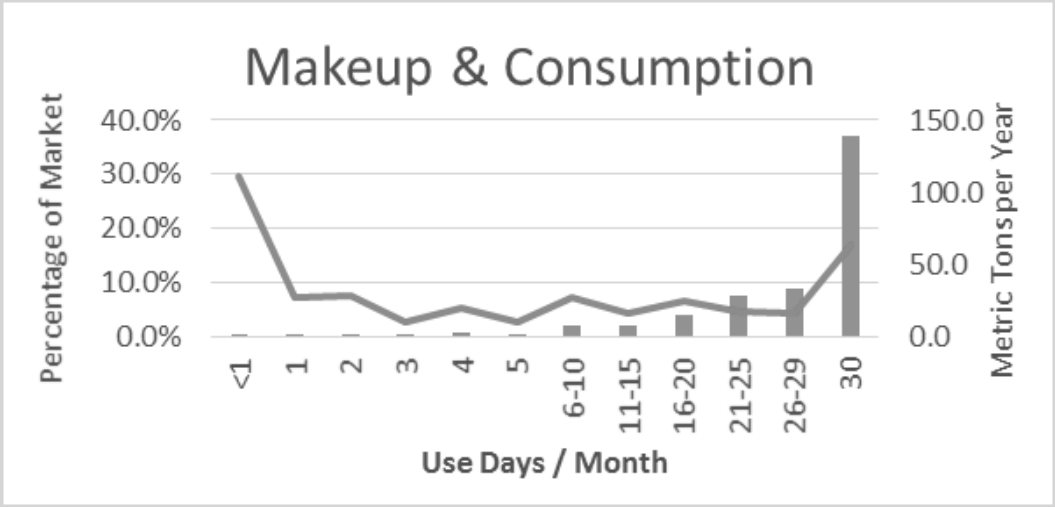


# of Marijuana Users

OH EST. 21+ POPULATION IN 2020	8,507,415	U.S.CENSUS BUREAU, POPULATION DIVISION, INTERIM STATE POPULATION PROJECTIONS, 2005.

# USED MJ PAST YEAR (21+)	1,008,749	11.86%*	SAMHSA, CENTER FOR BEHAVIORAL HEALTH STATISTICS AND QUALITY, NATIONAL SURVEY ON DRUG USE AND HEALTH, 2012 AND 2013.
# USED MJ PAST MONTH (21+)	570,606	6.71%*	
* Adjusted to track users 21 or older			

b. Use Frequency and Amount



i. Use Frequency

Use Days / Month	% of Users
<1	29.5%
1	7.40%
2	7.61%
3	2.75%
4	5.36%
5	2.89%
6-10	7.40%
11-15	4.44%
16-20	6.49%
21-25	4.65%
26-29	4.44%
30	17.06%
National Survey on Drug Use and Health: 2-Year R-DAS (2002 to 2003, 2004 to 2005, 2006 to 2007, 2008 to 2009, and 2010 to 2011). Analysis ran on 2015-01-08 (10:45 AM EST) using SDA 3.5: Tables.	

ii. Use Amount

1 JOINT	**= 0.46**	**GRAMS**	B. Kilmer, j. Caulkins, b. Bond, & p. Reuter. (2010). Reducing drug trafficking revenues and violence in Mexico: would legalizing marijuana in California help? Op-325. Santa Monica, ca: rand.
USE FREQUENCY			
20 D/M +	= 3.87	joints/day	Kilmer, B., Caulkins, J. P., Midgette, G., Dahlkemper, L., MacCoun, R. J., & Pacula, R. L. (2013). Before the Grand Opening. RAND Corporation; National Institute on Alcohol Abuse and Alcoholism. (2006). National Epidemiologic Survey on Alcohol and Related Conditions (NESARC). Washington, D.C.
4-19 D/M	= 1.92	joints/day	
1-3 D/M	= 1.68	joints/day	
<1 D/M	= 1.17	joints/day	

UNDERREPORTING ADJUSTMENT FACTOR (UAF)	1.2583	Kilmer, B., Caulkins, J. P., Midgette, G., Dahlkemper, L., MacCoun, R. J., & Pacula, R. L. (2013). Before the Grand Opening. RAND Corporation. The model's 25.83% UAF is calculated by averaging the following six UAF values reported in the RAND study cited above: (CCLP, 2012/CFC, 2013) 20.0% (Kilmer, 2009) 20.0% (RAND, 2013), Mean 22.0% (Kilmer, 2011) 25.0% (Abt Associates, 2012) 33.0% (Harrison, et al., 2007) 35.0%
LEGALIZATION RELATED ADJUSTMENT FACTOR*	1.2	Caulkins, J. P., Andrzejewski, S., & Dahlkemper, L. (2013). How much revenue could the cannabis tax generate under different scenarios? Olympia, WA: Washington State Liquor Control Board.
* Estimate due to tourist sales, increased medical marijuana availability, and potential small increase in some adult use		

Calculating the preceding factors produces this result:

Use Days / Average Month	% of Market	Use Days / Average Month	Underreporting Adjustment Factor	Metric Tons / Yr.
<1	29.50%	123,992	1.2583	1
1	7.40%	74,673	1.258	0.9
2	7.61%	153,612	1.258	1.8
3	2.75%	83,207	1.258	1
4	5.36%	216,195	1.258	2.9
5	2.89%	145,790	1.258	1.9
6-10	7.40%	597,381	1.258	8
11-15	4.44%	582,447	1.258	7.8
16-20	6.49%	1,177,695	1.258	15.7
21-25	4.65%	1,079,554	1.258	29
26-29	4.44%	1,254,501	1.258	33.7
30	17.06%	5,163,082	1.258	138.8
Total				242.44
Adjusted for Legalization Total				**290.92**

The current (as of January 2015) average black market price of marijuana is described below:

	Ohio Black Market Current Marijuana Prices Source: priceofweed.com				
Quality	Average ($/Oz.)*		Sample Size	% of Samples	Gram Price
High Quality	$332.44		4273	46.78%	$11.73
Medium Quality	$219.16		4309	47.18%	$7.73
Low	$168.17		552	6.04%	$5.93
Average Oz Price:	$269.07				
Avgas Gram Price	$9.49				

Based on these data and calculations annual black market sales of marijuana in Ohio are estimated to be $ 2.3 billion dollars.

2. **Projected Price, Market Share, and Tax Revenue of a Legal Market:** This component of the model can be further divided into two parts:

   a. The market share that the legal market would capture with a given average price per gram to consumer.

   b. The gross revenues, and corresponding taxes, that are associated with the retail, manufacturing, and cultivation segments of the industry at the given price to consumer.

Determining Market Share

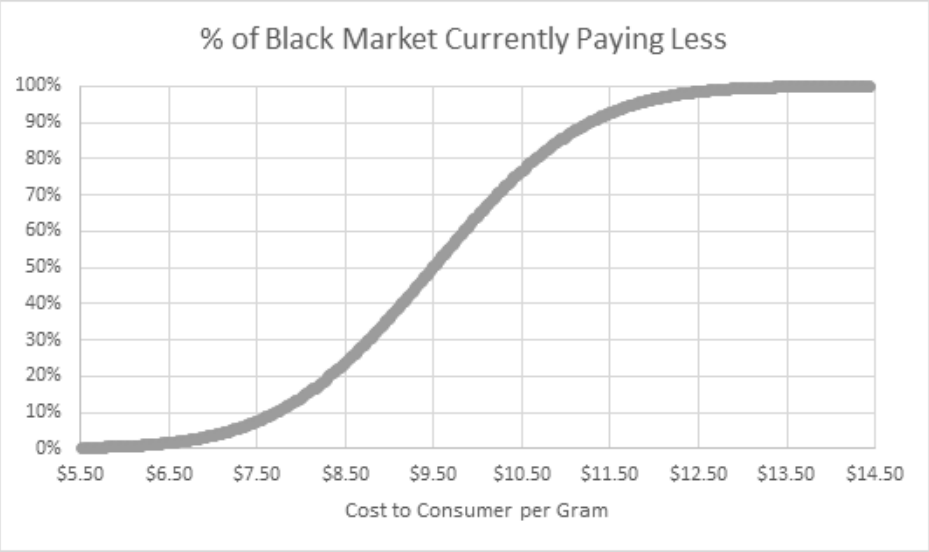
The rationale underlying the market share calculation follows:

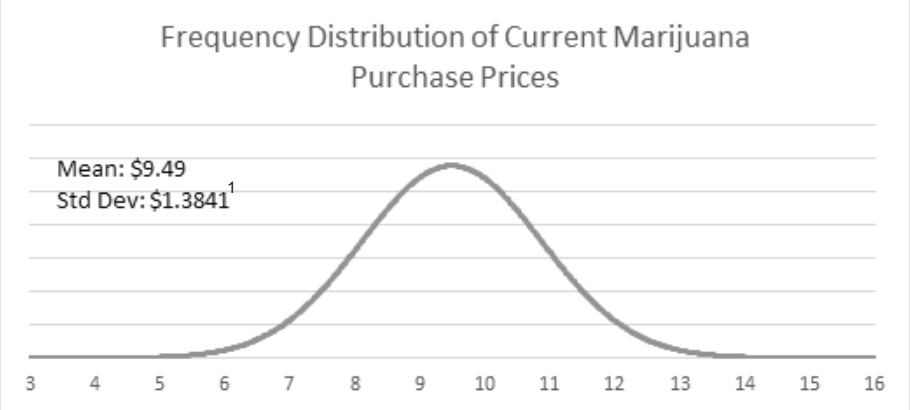
For a given price to consumers, the legal market would capture:

1. Consumers who would pay less for marijuana on the legal market than they currently pay.
2. Consumers who are willing to pay a price premium to purchase marijuana legally.

The model then defines the optimal price to the consumer as the value that will maximize income to the retail, manufacturing, and cultivation businesses.

The average price of a gram of marijuana in Ohio is currently estimated to be $9.49. Viewing the frequency distribution of current marijuana purchase prices as a Normal distribution, we used the RAND study's data on price premiums respondents to their survey were willing to pay, as shown below.

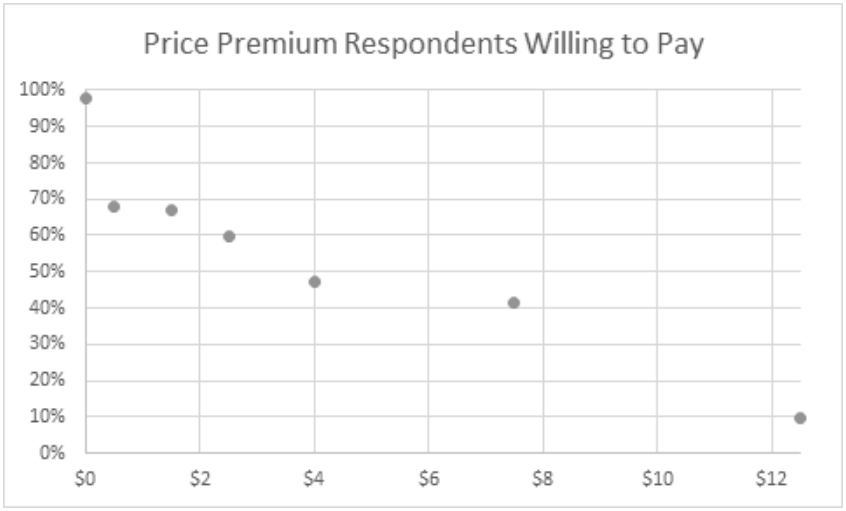




1 Bitcoin and the PPP Puzzle; Calebe de Roure; Paolo Tasca; (2014)

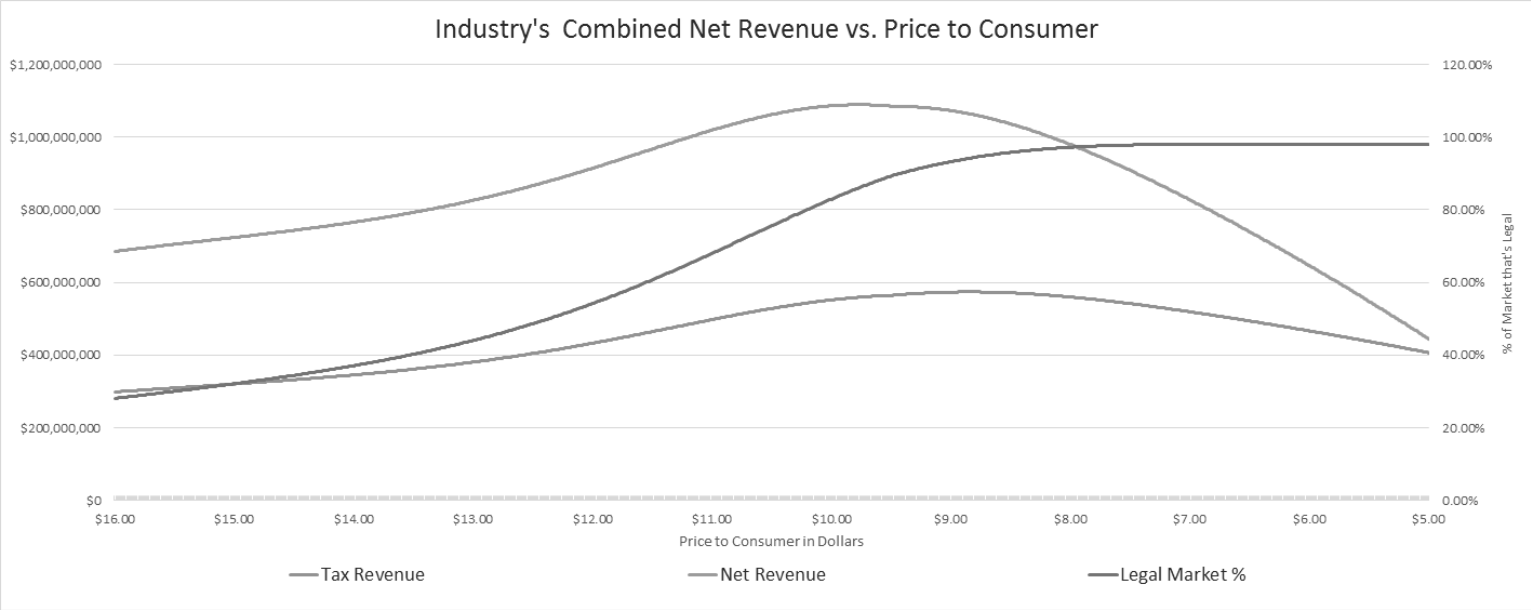
Price Premiums Respondents Were Willing to Pay

Premium $ (midpoints)	Weighted by Use Days (USA) Respondents willing to pay this premium	Weighted by Use Days (USA) Proportion of purchases from Legal Market
12.5	9.60%	9.60%
7.5	31.70%	41.30%
4	5.70%	47.00%
2.5	12.60%	59.60%
1.5	7.40%	67.00%
0.5	1.00%	68.00%
0	30.00%	98.00%



Source: Considering Marijuana Legalization Insights for Vermont and Other Jurisdictions (2015) RAND. at 125

The model determined the optimal price to consumer to be $9.93.



Calculating Gross Revenue and Tax Revenue at Retail, Manufacturing, and Cultivation

Starting with a base wholesale price requisite markups and processing costs are incorporated as the product moves from the cultivation facilities to manufacturing facilities and then to retail stores. The assumptions below come primarily from Caulkins et al.'s 2013 analysis titled *How much revenue could the cannabis tax generate under different scenarios*.[2] One exception based on current market trends was made: the assumption that 60% of the market would be for usable marijuana. Caulkins et al. fix that rate at 80%. In addition, we changed the model to encompass ResponsibleOhio's approach to taxation because it differs from Washington's, which Caulkin et al used to prepare their analysis.

2 Caulkins, J. P., S. Andrzejewski, and L. Dahlkemper. "How much revenue could the cannabis tax generate under different scenarios." Olympia, WA: Washington State Liquor Control Board. 2013.

An in-depth outline of the process described above appears in the following table using values that flow from an optimal consumer price of $9.93.

				Type of Product/Intermediate Product									
Market Level	Parameters			Useable MJ				MJ for Infused products					
GCE	25%	Proportion of MJ in infused products that is bought from oil extractors						MJ for infused	MJ for Oil				
	60%	MJ Sold as Useable MJ vs. Infused Product	Share of all MJ going to that type of processor	60%				30%	10%				
	$3.72	Producers' base selling price	Base Selling price	$3.72				$3.72	$4.47				
	$0.50	Additional cost of extracting oil, per gram processed											
	50%	Markup to cost of extraction (%)	Type of Brand	Standard		Prestige							
	15%	Tax on producer (incorporated into the markup)	Markups by Type of Brand & Product	35%		55%							
	$4.67	Average wholesale of gram after markups	Price to Retail	$5.02		$5.77							
	$0.70	Average Tax revenue from GCE per gram grown											
			Proportion of all MJ going into that type of product	48%		12%							
Processors								Infused Products					
	$0.25	Additional processing cost per gram of MJ in an infused product					Weighted average cost of all materials (MJ & oils)	$3.91					

							Proces-sor's total cost of product & processing	$4.16					
	80%	% of prod-uct sold as Std vs. Prestige brands											
							Type of Brand	Standard		Prestige			
	15%	Processor tax rate (in-corporated into the markup)					Processor Markups by Type of Brand & Product	75%		95%			
							Processor price to Retail	$7.28		$8.11		Overall Avg. Price to Retail	7.441406
	$0.45	Average Processor tax paid per gram grown					Proportion of all MJ going into that type of product	32.0%		8.00%			
			Type of Product	Useable Marijuana				Infused Products					
Retailers			Type of Brand	Standard		Prestige		Standard		Prestige			
	Retailer Markup by retailer type		Type of Re-tailer	Price	Touch	Price	Touch	Price	Touch	Price	Touch		
	Price	30%	Price to re-tailer (copied from above)	$5.02	$5.02	$5.77	$5.77	$7.28	$7.28	$8.11	$8.11		
	Touch	100%	Retailer markup (from table at left)	35%	105%	35%	105%	35%	105%	35%	105%		
			Retailer price pre-tax	$6.78	$10.29	$7.78	$11.82	$9.82	$14.91	$10.94	$16.62	Overall Avg. Price pre-Sales Tax	$9.27

	5%	Retail tax rate (incorporated into the markup)											
			Sales tax	$0.48	$0.73	$0.55	$0.84	$0.70	$1.06	$0.78	$1.18		
			Price to Consumer	$7.26	$11.03	$8.34	$12.66	$10.52	$15.98	$11.72	$17.80	Overall Avg. Price to Consumer	$ 9.93
	7.12%	Sales tax rate											
	75%	Proportion of retailers competing on Price vs. Touch	Share of Market	36.0%	12.0%	9.0%	3.0%	24.00%	8.0%	6.0%	2.0%		
Tax Summary	Tax Summary, per gram grown		Tax Summary (per gram sold, by product, brand, & store type)										Average Tax Rev
	$0.70	Producer Tax	1st Level Tax	$0.75	$0.75	$0.86	$0.86	$0.59	$0.59	$0.59	$0.59	1st Level Tax	$0.70
	$0.45	Processor Tax	2nd Level Tax	$ -	$ -	$ -	$ -	$1.09	$1.09	$1.22	$1.22	2nd Level Tax	$0.45
	$0.46	Retailer Tax	3rd Level Tax	$0.34	$0.51	$0.39	$0.59	$0.49	$0.75	$0.55	$0.83	3rd Level Tax	$0.46
	$0.66	Sales Tax	Sales Tax	$0.48	$0.73	$0.55	$0.84	$0.70	$1.06	$0.78	$1.18	Sales Tax	$ 0.6598
	$2.27	Total	Total	$1.57	$2.00	$1.81	$2.30	$2.87	$3.48	$3.13	$3.82		
			Tax Burden (Taxes' Proportion of Price to Consumer)	21.7%	18.1%	21.7%	18.1%	27.3%	21.8%	26.7%	21.4%		
			Products' Proportion of Tax Revenues	25.0%	10.6%	7.2%	3.0%	30.3%	12.3%	8.3%	3.4%		100.0%
												Avg. Tax Rev /g	$2.27

There is a linear relationship between any given base price and the resulting price to consumer and tax revenue. The relationships, given the parameters outlined above, are the following:

Base Price -> Price to Consumer

y= 2.531997846x+ 0.511708597

Base Price -> Avg. Tax Rev

y= 0.578935346x+ 0.11612516

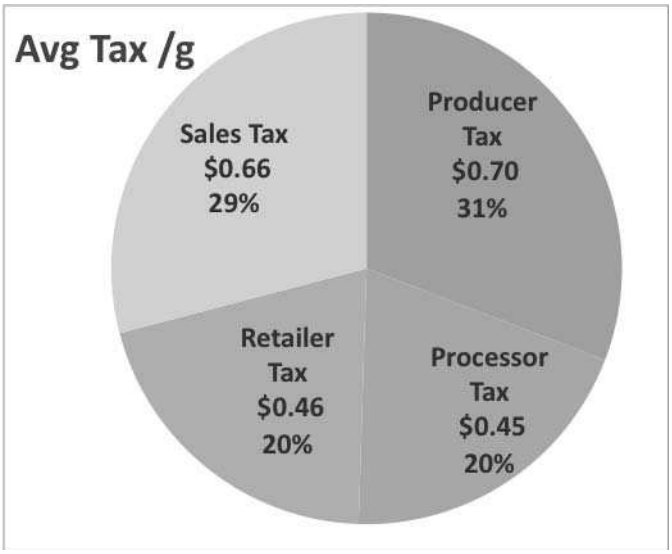
Using the table above, at the optimal price to consumer of $9.93, the market would be constituted as follows:

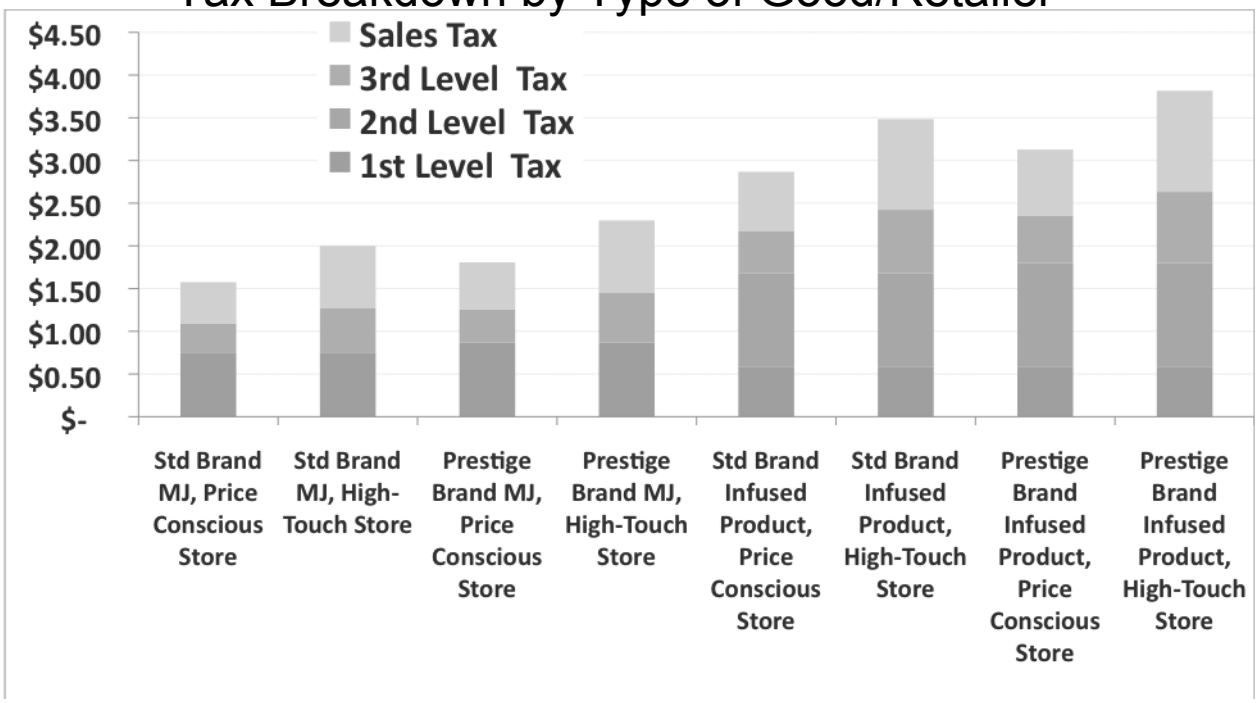
	Gram		Oz
Avg. Wholesale Price	$4.67		**$132.25**
Average Tax Revenue	**$2.27**		**$64.34**
Pre-Sales Tax Avg. Price to Consumer	**$9.27**		**$ 262.80**
Overall Avg. Price to Consumer	**$9.93**		**$281.51**

Gross Market Size	No Black Market	With Residual Black Market
Producers	$1,357,186,786	**$1,139,041,002**
Processors	$865,947,553	**$726,760,994**
Retail	$2,696,896,862	**$2,263,415,883**
		^ (Not Including Sales Tax) ^
Tax Revenue	$660,275,687	**$554,028,226**

Effective Tax Rate:	**22.86%**
Markup Wholesale to Retail (Pretax):	**198.71%**

	Grams	Percent
@ Legal Market Size of:	244,161,185	83.93%
@ Black Market Size of:	46,760,841	16.07%





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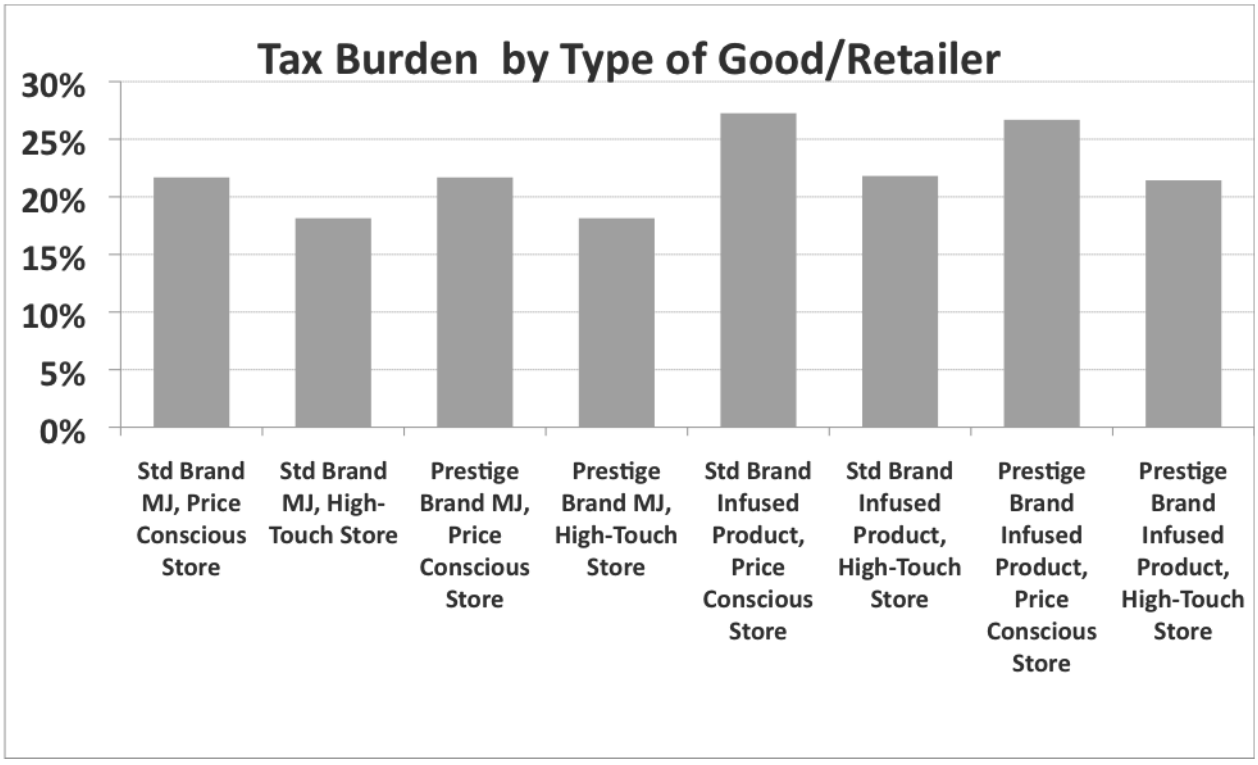

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