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How much revenue could the cannabis tax generate, under different scenarios?

Jonathan P. Caulkins, BOTEC, Carnegie Mellon University (CMU)
Susan Andrzejewski, CMU
Linden Dahlkemper, CMU

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BACK OF THE ENVELOPE CALCULATIONS

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Executive Summary

This report explores various scenarios concerning potential I-502 tax revenues, per year and in total over a decade. The dominant finding is sobering though perhaps not surprising: There is enormous uncertainty. Different plausible scenarios lead to radically different projections for potential revenue. It is not even clear that revenues will trend steadily over time; there are plausible scenarios under which revenues will first rise and then fall. With information currently in hand, it is not possible to set specific bounds on the possible range of tax revenues.

The biggest threat to potential tax revenues is that I-502 stores may not achieve a large market share. Some of the challenges are external, including the possibility of federal intervention against legal marijuana firms or, at the other end of spectrum, competition from other states legalizing in the next few years. (Those states might legalize in more business-friendly ways, levying lower taxes and imposing weaker regulatory controls, and so produce marijuana at lower cost.) But internal challenges are also significant. I-502 stores may not compete well on price with medical access points if they have similar production processes but face higher taxes. The medical market could be hobbled by legislative intervention, but another and perhaps even greater concern is competition from the black market, by which we mean marijuana production and distribution that is neither medical nor within the I-502 sphere. Calculations presented herein suggest that medical access points may themselves not now be competing well with the purely illegal markets despite not being burdened with excise taxes. Furthermore, since Washington's black market production supplies *national* wholesale markets, not just in-state users, it seems likely to continue after I-502 implementation, and so ensure that black market marijuana continues to be available in the state.

All is not bleak. There is upside potential for additional tax revenues, perhaps from sales to drug tourists, sales of marijuana illegally-exported across state lines, and sales of prestige-branded edibles that may sell for much more per unit of intoxicant than standard useable marijuana, and so generate greater tax revenue.

Furthermore a key driver of I-502 market share is price, which in turn depends on costs throughout the marijuana supply chain; sensitivity analysis below identifies these costs as the greatest driver of uncertainty about prices in I-502 stores. The base case herein assumes that production, processing, and retail operations under I-502 will resemble current practices in the medical marijuana industry and so, once taxes are factored in, prices will be higher than at medical access points today. However, if competition and innovation drive costs and therefore prices down, and do so faster for licensed producers and retailers than for those in the parallel markets, the volume of taxed sales, and therefore of tax revenues, might rise.

There is not consensus on this crucial question. The majority of experts argue for continuity between the operating practices of current indoor growers and I-502 firms and, hence, for high prices. A minority view holds that legalization will be like a disruptive technological innovation that fundamentally alters business practices in ways that greatly improve productivity. The two views can support (pretax) wholesale prices for useable

marijuana sold to retail stores of from under $2 to over $4.50 per gram ($800 to $2000 per pound).

Note: If over time it becomes apparent that the continuity-and-high-prices view is proving correct, then there are ways Washington State policy makers could intervene to help the I-502 industry win market share, either by lowering its costs or increasing arrest and prosecution of black market producers to drive up their cost structure.

This report considers the market system in pieces: prices & taxes, quantities, the interaction of price and quantity, and the dynamic trajectories over time. We describe below a range of scenarios concerning each piece, as well their integrated whole, identifying the major drivers of revenue and revenue uncertainty at each level.

I. INTRODUCTION

I(a): Framework for understanding tax revenue scenarios

Conceptually, estimating cannabis tax revenue ought to be simple. Revenues equal tax collected per unit sold in the I-502 market times the projected sales volume in that market.

Estimates of tax revenue per unit sold come from the same model that was used in Task 430-8(a). That model estimates the selling prices for the producer, processor, and retailer, and then multiplies by the relevant tax rates, factors in sales taxes, and makes various adjustments. These I-502 market prices can be compared with illicit-market and medical-market prices to get a sense of the I-502 market's ability to compete on price.

Market volume estimates start with the quantity consumed in Washington today, and make various adjustments: increasing by a factor that reflects how legalization affects consumption, subtracting quantities that will be supplied by the medical and/or black markets, adding quantities sold to drug tourists, etc.

Yet even though the broad outlines of the calculation are clear enough, there are enormous uncertainties. Indeed, a feasible lower bound for tax revenues might not be much above zero. We distinguish three types of uncertainties:

- *Structural uncertainty* about the larger market: Will the federal government try to interfere with the market? When and how will other states legalize? Will another state legalize with lower taxes and fewer regulatory requirements, thereby undercutting the Washington market price?
- *Parametric uncertainty* about various factors that are considered within the model can influence potential tax revenues: How large a markup will processors and retailers be able to sustain? What proportion of consumption will be in forms, such as edibles, with higher spending per unit of THC delivered? How willing are marijuana users to source from other states, either as drug tourists or from tax-evading grey markets, or to illegally home-grow?
- *Dynamic uncertainty* about how the market will evolve over time: One might expect legal producers and processors to initially produce less – and so enjoy higher prices and profits – than they will in the long run, but how long will it take the industry to mature? How will changes in supply interact with changes in demand? On the one hand, declining prices might reduce tax revenue per unit sold; on the other, increased total sales could expand the taxable sales base. Can a general upward trend in marijuana demand offset downward market pressure on prices?

We address these three types of uncertainty in order. Paradoxically, structural uncertainty is so overwhelmingly broad that it takes relatively few pages to discuss. (Section I(b)). One can describe scenarios under which tax revenues will be effectively zero and others under which they will greatly exceed base-case projections. The punch line of this rather nihilistic analysis is simple; don't spend tax revenues before they have been received.

The bulk of this paper describes models of market price, quantity, and the interaction between price and quantity, stressing various relevant scenarios for each. Most of that addresses parametric uncertainty. (Sections II – V).

The final section looks at dynamic trajectories of tax revenues over time under various scenarios, each concerning how a particular parameter or constellation of parameters might grow or shrink over time. (Section VI).

I(b): Qualitative Discussion of Structural Uncertainty

Inability to place a meaningful lower bound on tax revenues

There is little one can do to model structural uncertainties quantitatively. It is perhaps better just to acknowledge that the only true lower bound on tax revenues is $0, because the federal government could choose to enforce the Controlled Substances Act in ways that make the legal market in Washington essentially impossible to implement. That does not appear to be a high-probability scenario, but it is not entirely implausible, and we would be remiss not to mention it.

So all projections of tax trajectories described herein must be understood as being conditional. They are forecasts with asterisks or caveats. One fundamental caveat is that all scenarios assume that the legal Washington market is allowed to play out without overwhelming interference from the federal government.

Competition from the medical and entirely illicit markets for marijuana

Taxed I-502 sales will face competition from both the medical market and the black market. The medical market is the more direct competitor, but the black market may be more enduring, as is discussed in detail in Section IV(c).

The medical market already provides similar products and services to what the I-502 market is expected to produce – but with fewer taxes and lower regulatory burdens. Hence its cost structure is considerably lower.

Presumably some people will pay a premium to purchase fully legal marijuana products – perhaps users with more disposable income, or who use in smaller amounts – but not everyone will. In Washington as in the United States as a whole, college graduates account for a rather small proportion of marijuana consumption; the majority of marijuana is consumed by people with a high school education or less. Over 70% of daily and near-daily users in Washington have an income less than $50,000 per year.

At currently projected prices, the I-502 market may have great difficulty competing with the medical market. Hence the rate of growth in the I-502 market may depend substantially on the rate at which the medical marijuana market is reduced via exogenous intervention (e.g., by restricting who can get a medical recommendation). That possibility cannot be forecast with a market model, but could be brought about by policy.

By contrast, we expect the purely illegal market to be less vulnerable to changes in Washington State policy; perhaps only national legalization would eliminate it, since a substantial portion of Washington's purely illegal production serves customers living

outside the state. The Northwest HIDTA (2013 & personal communication) describes various "professional" criminal organizations as producing large quantities of marijuana in Washington, including British Columbia-based Asian organized crime groups running networks of indoor grow houses and Mexican crime groups running large guerilla grows in national forests and other sparsely populated land.[1]

The Northwest HIDTA (2013) marijuana situation report noted seizures with a nexus to Washington in many states: Oregon, Idaho, South Dakota, Missouri, Nebraska, Texas, Ohio, Arkansas, California, Georgia, Iowa and Kansas (in descending order of number of seizures). HIDTA traces the marijuana to Washington by markings on the packaging, interview with the suspects, or other identifiers such as Washington license plates on the car. Likewise, Idaho newspapers report frequent seizures of couriers driving east out of Washington, carrying loads ranging from 10 to 120 pounds of marijuana.[2]

This suggests that, even if the I-502 market succeeds in competing with the medical system, black market marijuana will continue to be available for purchase in Washington. The black market marijuana is now, and may continue to be, less expensive than I-502 marijuana if production for I-502 stores looks more or less like production of medical marijuana today. If so, then since the majority of marijuana consumption stems from people who one might expect to be price sensitive, tax revenues might suffer significantly.[3]

Competition from other states in the long run

While it is *possible* that the federal government will shut down the legal Washington market, it seems reasonable to consider a base case scenario without such dramatic interference. By contrast, the implicit assumption that no other jurisdiction will legalize in ways that affect Washington's market seems at this juncture to be rather strained. Public support for legalization continues to grow, and events in Washington and Colorado are proving that legalization is not "unthinkable".

The 17 legalization proposals discussed seriously in 2012 (of which, three were voted on and two passed) were highly varied. Some, including Colorado and Washington, proposed regulated markets. In Washington in particular, taxes represent a not insignificant component of the overall production cost.[4] Other proposals would have simply repealed the prohibition while creating no new regulatory structure or taxes (considered, e.g., in Missouri and Michigan). Oregon's proposition ("The Oregon Cannabis Tax Act") illustrates other ways that a proposition can be more "industry-friendly" than I-502 (Caulkins et al., 2012).

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[1] The Oregonian recently reported that in Oregon there are at least 69 drug trafficking organizations that supply drugs in the state, and the majority of those organizations are supplied by cartels. They can be violent;
[2] See <http://www.shoshonenewspress.com/news/article_08b5c25a-cd3c-11e2-a890-0019bb2963f4.html> and <http://www.shoshonenewspress.com/news/article_b24dd386-4adb-11e2-a0ae-0019bb2963f4.html>.
[3] Few data bear directly on the price sensitivity of different market segments. But it is known that most consumption stems from the minority of people who consume daily or near-daily, and most consumption stems from people whose educational status is not high (high school education or below). If someone who consumes a gram a day can save $2 per gram, that is a savings of almost $1,000 per year.
[4] Colorado appears to be headed toward a 15% excise and 10% marijuana-specific sales tax, in addition to normal sales taxes. That is akin to dropping Washington's producer and processor taxes. Section II(e) describes how this could make the cost to consumers in Colorado about $3 per gram less than in Washington.

There is a good chance that at least one state – perhaps even Oregon - will legalize, and do so in a way that offers its producers a competitive advantage over Washington's. Given the experience with drug tourism to the Netherlands and the considerable cross-border transport of cigarettes to evade taxes (discussed further in Section IV(d)), Washington should expect that if a neighboring state legalizes in a more permissive way, it would undercut some of Washington State's tax revenues.

So it seems prudent not to restrict projections to scenarios in which other states remain on the sideline. Indeed, an industry structure in which Washington-based production supplies primarily Washington-based consumers, and conversely, Washington residents get substantially all of their marijuana from in-state producers, is *not* the structure one would expect in the long run. There are, broadly speaking, two scenarios: either legalization in Washington and Colorado "fails" in some fundamental sense or it succeeds. Neither will necessarily lead to a market in which Washington is an island unto itself.

If legalization in Washington fails (e.g., because it is squashed by the federal government), then tax revenues will of course not meet expectations. Paradoxically, however, legalization succeeding in Washington could be almost as big a threat to tax revenues. If that success encourages other states to legalize, those states' actions might create an interstate trade, possibly in which Washington has a comparative disadvantage.

In our modern economy there are relatively few products (as opposed to services) that each state produces for its own citizens. In particular, while some crops' production is widely distributed around the U.S. (e.g., corn, wheat, and hay), production of other crops is highly concentrated. Kentucky and North Carolina together account for 75% of tobacco production; North Dakota alone produces 84% of the canola oil and 95% of the flaxseed. Of course, just because a few states dominate production does not imply Washington will be left out; Washington could be one of those few. After all, Washington produces 78% of the country's hops.[5] But Washington should not take for granted that it would host substantial production once other states have legalized.

So it seems plausible that Washington may end up either importing most of its marijuana products from states with lower costs of production (e.g., places where greenhouses can be operated most of the year without supplemental lighting), or Washington might end up being a marijuana producing center (if a first-mover advantage coupled with agglomeration economies overcomes the natural competitive disadvantages of less sun, higher humidity, and cooler temperatures). But that it remains an "island" with its own market walled off from the rest of the country is perhaps an unlikely scenario in the long run.

High tax collection may require walking a tight rope

These dynamics complicate tax revenue estimation – and tax collection. Initially the industry will be in transition, growing rapidly, exploring various forms, adapting as

[5] Proportions are based on 2012 crop values, retrieved from http://usda01.library.cornell.edu/usda/current/CropValuSu/CropValuSu-02-15-2013.pdf.

consumer preferences become better understood, all in the face of stiff competition from the residual medical marijuana market. It will be an unsettled time, with quantities, product types, and prices varying considerably, all with hard-to-predict implications for tax revenues.

In the medium run, there may be a period in which the medical market has been effectively eliminated, but the I-502 market still faces competition from the purely illegal market. At least initially, the large-scale black market production of indoor- and outdoor-grown marijuana for export to other states will ensure availability at lower prices than in the base case projection for the I-502 market.

Furthermore, the external environment is unstable so it is not clear how long that middle-run situation will pertain. We should expect other states' actions – and perhaps federal government action – to change the industry's structure in the not-too-distant future.

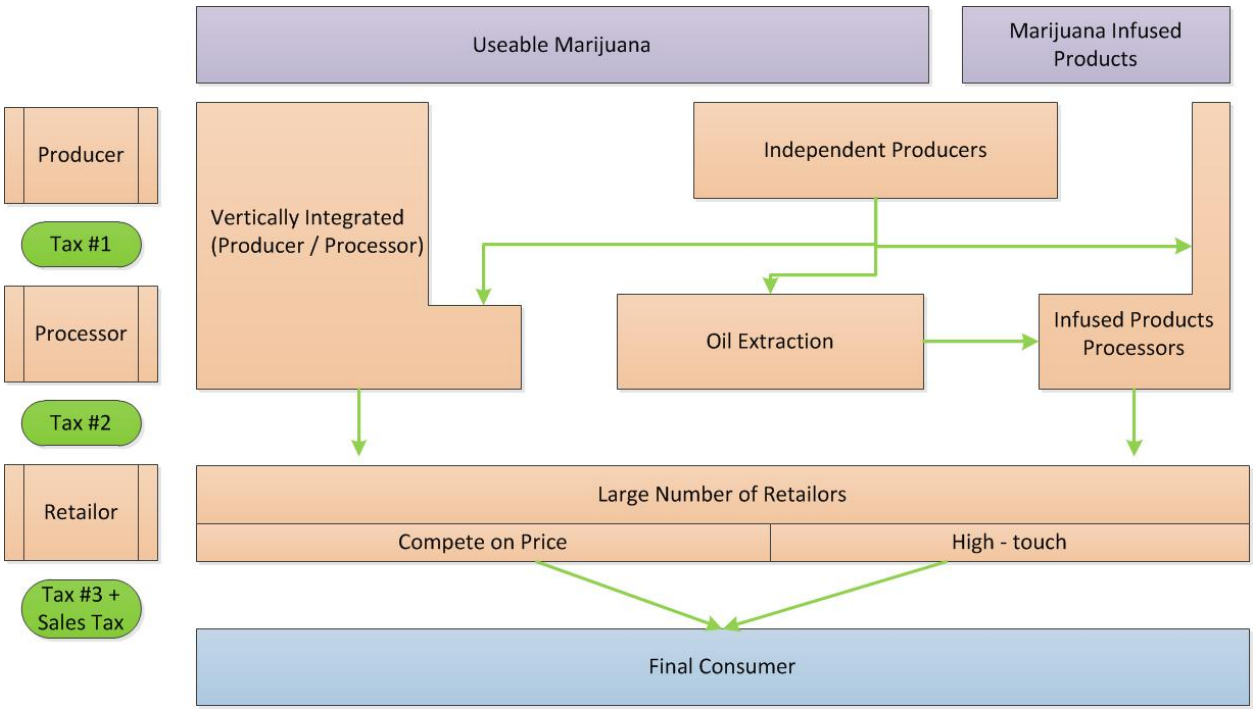
II. PRICE SCENARIOS

II(a): Review of the Model Developed with Task 8(a)

The model developed in Task 430-8(a) estimates prices and taxes per gram. The report for that task provides information about the model and how it works.

To summarize: that model translates user-determined parameters concerning markups, costs, and the mix of product types, brands, and retail venues into estimates of prices and taxes collected.

As the figure below suggests, the model has three layers: cultivation, processing, and retail. The cultivation layer distinguishes between growers who are (1) vertically integrated producer-processors (of useable marijuana and/or infused products) vs. (2) independent producers who sell to infused-product processors, oil extractors, and/or supplemental amounts to the vertically integrated processors. Parameters at this level determine, for example, producers' selling price and how much of the independent producers' marijuana is sold to oil extractors rather than other processors.



The next layer relates to processors. It differentiates between standard and prestige-brand products, which can have different markup rates. In this level, the market share for different products is determined (useable marijuana-standard brand, infused product-prestige brand, etc.).

The final layer addresses the retail level, which differentiates between retailers who compete on price vs. those who compete on service (called "high-touch" retailers).

II(b): One-at-a-Time Parametric Sensitivity Analysis (Tornado Diagrams)

The price model has 18 parameters, in addition to the three 25% marijuana taxes and the sales tax rate. There is substantial uncertainty about all eighteen; the true values could easily be 1/3 lower or 1/3 higher than our base case value. However, uncertainty in some parameters is of relatively little consequence to overall outcomes, whereas prices, taxes, and other outcomes depend heavily on certain other parameters. This section distinguishes the parameters-of-consequence from the others.

It is important to stress the particular notion of "consequence" considered here. In one sense, all parameters are important. All are part of the model; changing any one will change prices throughout the model. The key question here is: if we restrict changes to a parameter to a reasonable range, will changes within that range have much effect on the outcomes that matter?

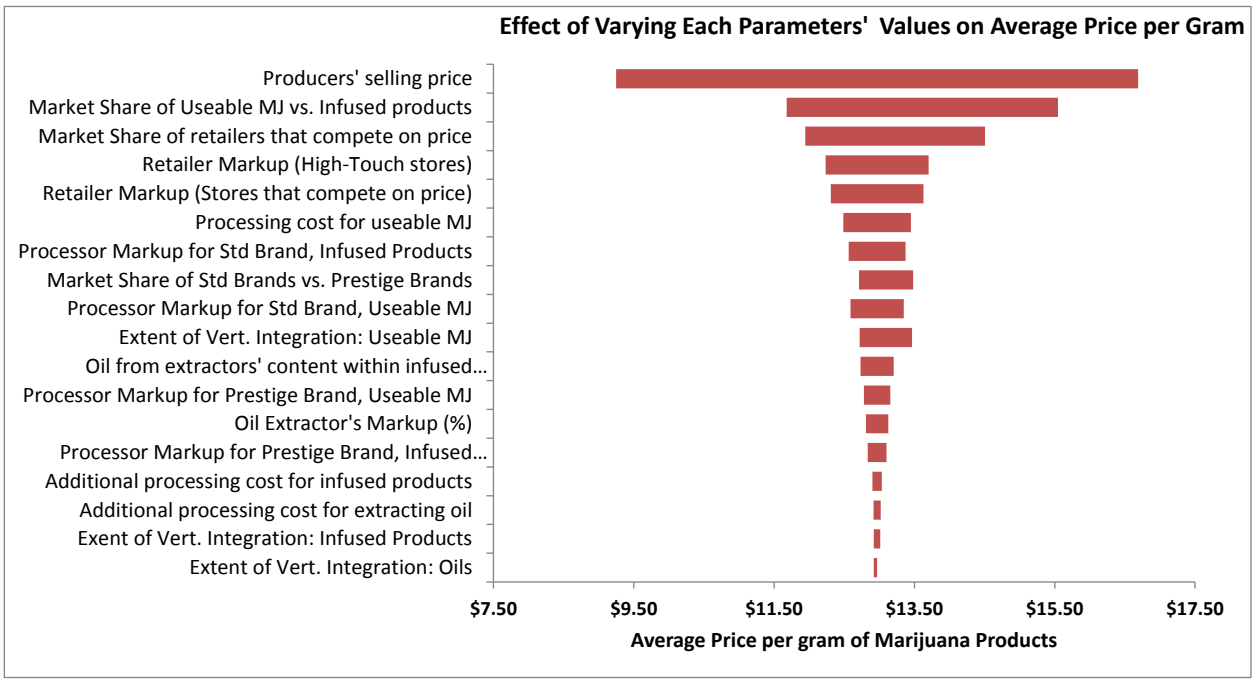
Tornado diagrams are a useful tool for answering this question. Clemens (1997) describes them in detail, but even the Wikipedia entry is reasonably informative.[6] A thumbnail description is as follows:

[6] http://en.wikipedia.org/wiki/Tornado_diagram.

- The horizontal axis measures the outcome of interest, such as average retail price per gram.
- Vary each parameter, one at a time, between its lowest and highest plausible values, noting how this affects the outcome of interest – specifically record the lowest and highest values of the outcome produced when the parameter varies.
- For each parameter, draw a bar.
- The left and right sides of the bar are aligned over the lowest and highest values of the outcome obtained when that parameter was varied, so the bar's width indicates how much that parameter can affect the outcome.
- Sort the bars so the broadest are at the top (which makes the collection of bars look like a funnel cloud, giving the diagram its name).

Often one varies each parameter over a range defined by a confidence interval, such as a 95% confidence interval arising from survey sampling variability. We do not have such well-defined ranges here. Instead, we simply set the low value for each parameter at 2/3 of its base value and – usually – make the high value one-third higher.[7]

The resulting diagram for the average retail price per gram – averaging across all types of product, brand, and store, not just for useable marijuana – is as follows.



[7] When the parameter is a proportion above 75%, this procedure cannot be followed. In those instances, we increase the base value by two-thirds of the gap between it and 100%. So a parameter whose base value is 80% is varied between 53% and 93%. The other exception is vertical integration by extractors back into production. The base value of that parameter is 0%; we more or less arbitrarily set its high value to be 20%.

By far the most important parameter is the one at the top – the producers' selling price. Varying it from its base value of $3.00 per gram down to $2.00 or up to $4.00 causes average retail price per gram to swing wildly, from down to $9.25 or up to $16.69 per gram.

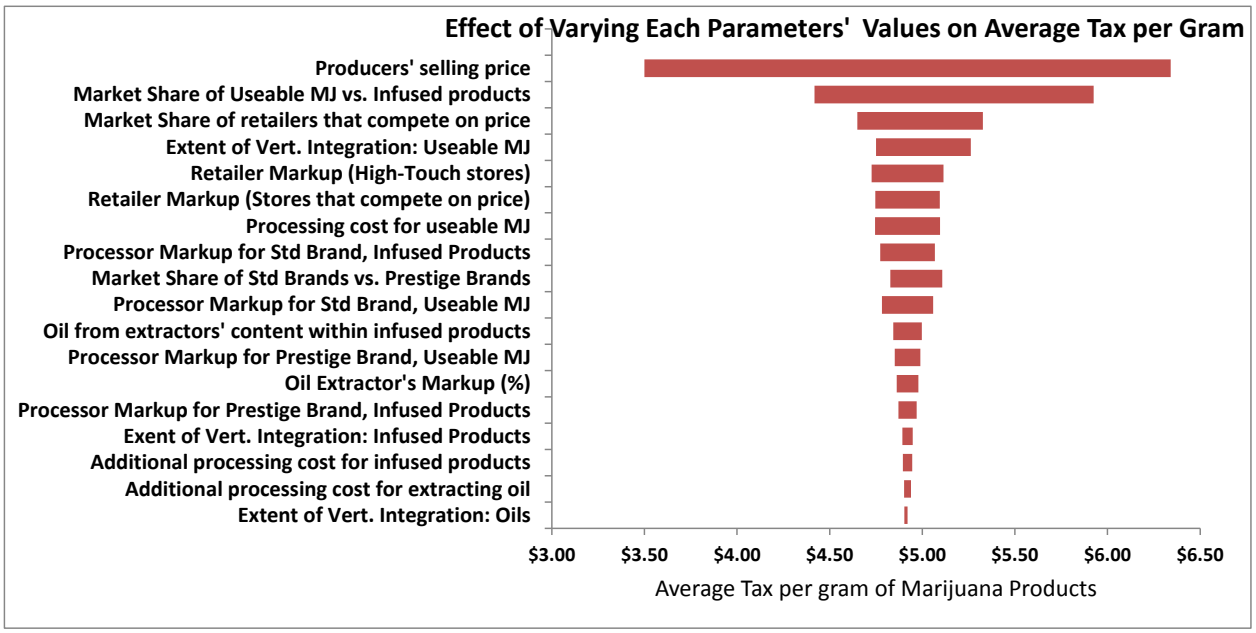
And $2.00 per gram is by no means the lowest plausible value for producers' selling price. There are arguments why it could fall as low as $1.00 per gram, in which case the average retail price would fall all the way to $5.53 (assuming downstream markups stay the same in percentage terms, even though that would imply considerably smaller markups per gram).

The other parameters that can affect retail price by more than $1.00 per gram over the ranges considered here are (in descending order of importance):

- The market share of useable marijuana vs. infused products ($3.87)
- The market share of retailers who compete on price ($2.56)
- The retail markup at high-touch stores ($1.47)
- The retail markup at stores that compete on price ($1.32)

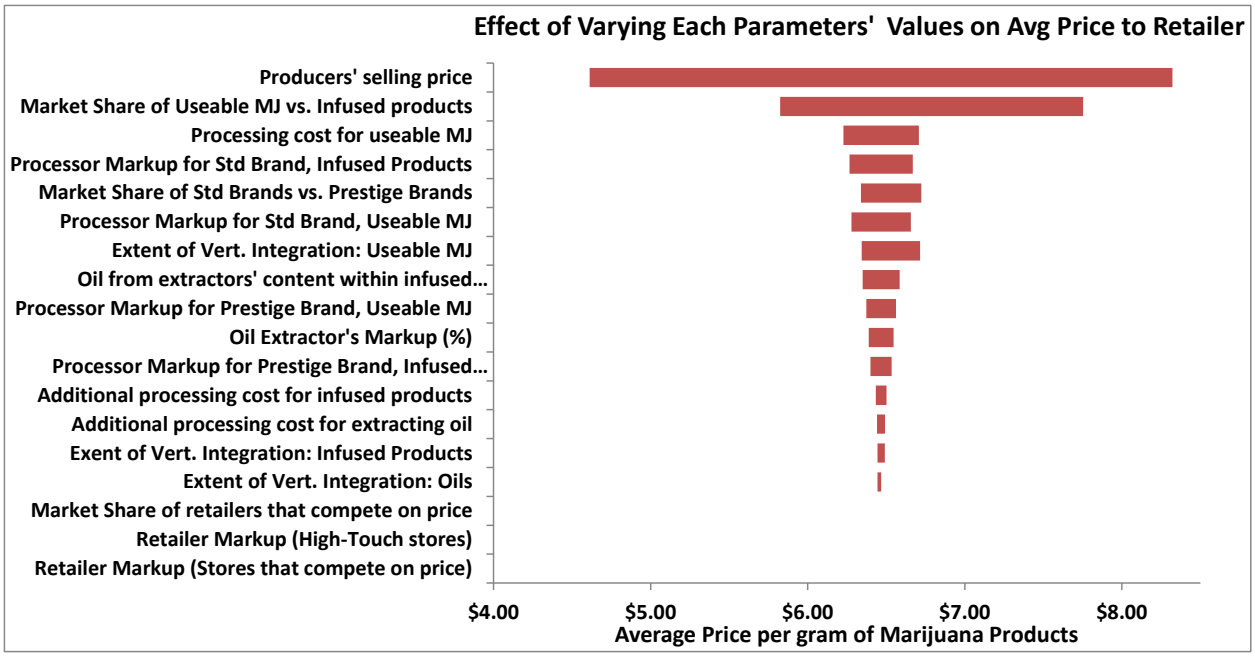
By contrast, variation in the bottom four parameters does not even sway the average retail price by as much as $0.25 per gram. The reason is that these parameter pertain to extraction and infused products, and we think most (80%) of marijuana will be consumed as useable marijuana.

The corresponding diagram for the average tax collected per gram sold at an I-502 store is very similar.



The diagram for the average price paid by retailers to processors is also similar – with one exception. Naturally neither the retail markups nor the market share of retail stores that compete on price vs. service has any bearing on the price retailers pay to

processors. So those three parameters – which had been among the top five in the previous diagrams – now have no bar at all.



The table below summarizes the percent change in the outcome variable produced by varying the parameter as described. It concisely highlights the commonality across outcome variables. Note: None of the parameters has a very large direct effect on taxes as a proportion of the retail price paid.

	Overall Average Retail Price	Avg Tax per Gram Consumed	Average Price to Retailer	Overall Avg Tax Burden
Base value	$ 12.97	$ 4.92	$ 6.47	38%
Producers' selling price	57%	58%	57%	0%
Market Share of Useable MJ	30%	31%	30%	1%
Market Share of Price Retailers	20%	14%	0%	5%
Retailer Markup (Touch)	11%	8%	0%	2%
Retailer Markup (Price)	10%	7%	0%	4%
Processing cost for useable MJ	7%	7%	7%	0%
Processor Markup (Std, Infused)	6%	6%	6%	0%
Market Share of Std Brands	6%	6%	6%	0%
Processor Markup (Std, Useable)	6%	6%	6%	0%
Vert. Int. Useable MJ	6%	10%	6%	5%
Oil from extractors' content within infused pr	4%	3%	4%	0%
Processor Markup (Prestige, Useable)	3%	3%	3%	0%
Oil Extractor's Markup (%)	2%	2%	2%	0%
Processor Markup (Prestige, Infused)	2%	2%	2%	0%
Additional processing cost for infused produc	1%	1%	1%	0%
Additional cost of extracting oil	1%	1%	1%	0%
Exent of Vert. Integration: Infused Products	1%	1%	1%	0%
Extent of Vert. Integration: Oils	0%	0%	0%	0%

II(c): Multivariate Sensitivity Analysis (Monte Carlo Simulation)

The previous section addressed scenarios that varied one parameter at a time, and identified which parameters are the most consequential.

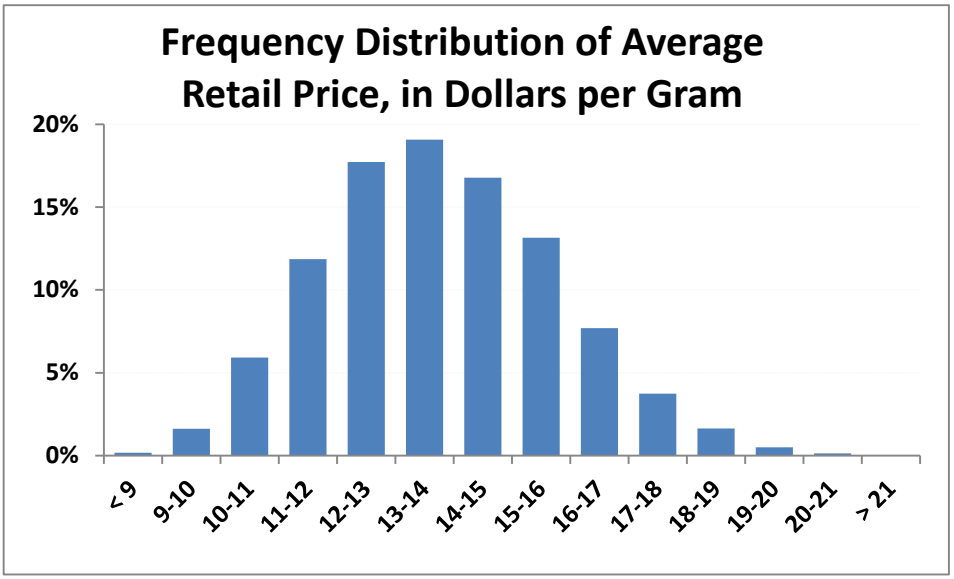
But in truth there is uncertainty created by all the parameters moving at once, rather than just one at a time. And we are interested not only in finding consequential parameters, but also in understanding the levels of uncertainty for tax revenues under scenarios that treat the uncertainty of all the parameters simultaneously.

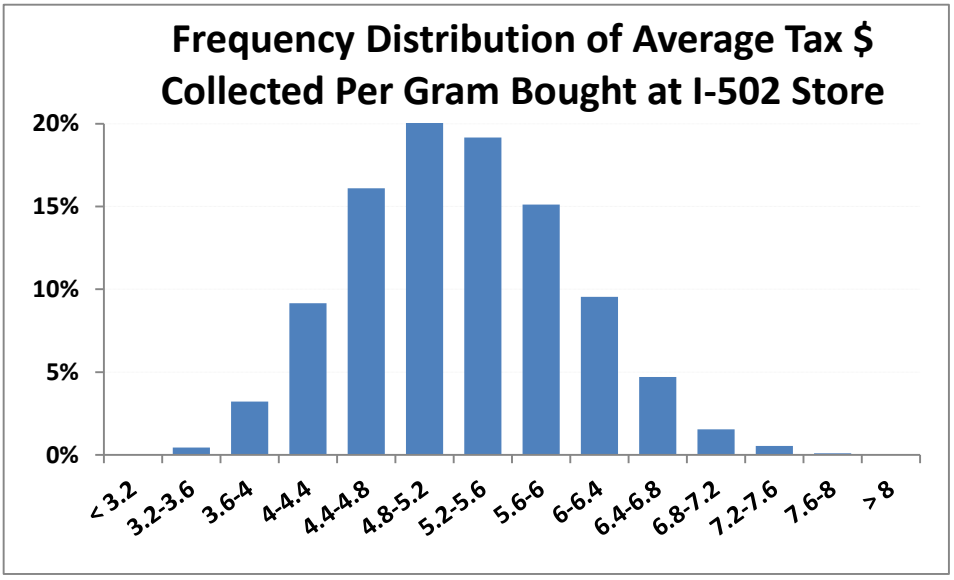
Monte Carlo simulation is a tool for answering that question. It asks the computer to repeatedly draw sets of random values for each parameter from within its range and then compute the resultant outcomes of interest. After the computer has done this 10,000 or 100,000 times, we can examine this distribution of outcome values to get a sense of how much those outcomes might vary.[8]

The figures below show the resulting distributions for the average retail price and the average tax collected per gram of marijuana purchased in an I-502 store. As in the

[8] One could draw parameter values completely at random from within their range – meaning all values are equally likely. Presumably, though, values close to the best guess are more likely than are values near the extremes. So instead we presume the uncertainty for each parameter follows something called a "triangle distribution" – which makes the base case the most likely value and the values nearing the endpoints of the parameter's range increasingly unlikely.

previous section, the averages are taken over all types of brands, stores, and marijuana products. For infused products, grams are based on equivalent amounts of marijuana, not on the literal weight of the brownie, candy bar, or other infused product.





The distributions are not literally normal (or "bell-shaped") because they have a bit of a skew, with somewhat longer tails to the right (high side) than the left (low side). But the skew is not pronounced, so one does not go too far wrong by looking at the usual descriptive statistics concerning a distribution: the average, standard deviation, and various percentiles of the distribution. These values for a range of outcomes are summarized below. For example, the shaded cells show that – to the extent that the model is accurate – the average retail price per gram will mostly likely fall (informally, has "9

chances out of 10" of falling) between $10.61 and $17.18.[9] Likewise, the 25% and 75% rows have the interpretation that it is as likely as not that the average price will fall between $12.36 and $15.10 per gram.

The corresponding ranges for just useable marijuana (computed in a similar fashion) are about $8.90 - $14.00 and $10.30 - $12.50.

		Average Prices		Retail Prices for Useable MJ		Retail Prices, Infused Products	
	Avg Tax per Gram Purchased	Average Price to Retailer	Average Retail Price	Std Brand, Store Competes on Price	Prestige Brand, High Touch Store	Std Brand, Store Competes on Price	Prestige Brand, High Touch Store
Simulation Output							
Mean	**$ 5.25**	**$ 6.76**	**$ 13.78**	**$ 9.54**	**$ 17.14**	**$ 17.82**	**$ 30.87**
Std Dev	**$ 0.74**	**$ 0.92**	**$ 1.99**	**$ 1.25**	**$ 2.51**	**$ 2.31**	**$ 4.53**
Percentiles							
5%	$ 4.06	$ 5.28	**$ 10.61**	$ 7.50	$ 13.19	$ 14.11	$ 23.74
10%	$ 4.29	$ 5.57	$ 11.22	$ 7.89	$ 13.93	$ 14.82	$ 25.06
25%	$ 4.72	$ 6.11	$ 12.36	$ 8.66	$ 15.32	$ 16.17	$ 27.65
50%	$ 5.23	$ 6.74	$ 13.69	$ 9.54	$ 17.08	$ 17.75	$ 30.67
75%	$ 5.75	$ 7.39	$ 15.10	$ 10.42	$ 18.82	$ 19.40	$ 33.88
90%	$ 6.24	$ 7.98	$ 16.42	$ 11.20	$ 20.46	$ 20.88	$ 36.86
95%	$ 6.51	$ 8.30	**$ 17.18**	$ 11.63	$ 21.44	$ 21.78	$ 38.66

It is important to stress that these uncertainty bands account only for the model's parameters. Qualitative shocks that upset the entire system are an additional source of uncertainty, not included within these Monte Carlo calculations.

II(d): Vary the product mix from downscale to upscale

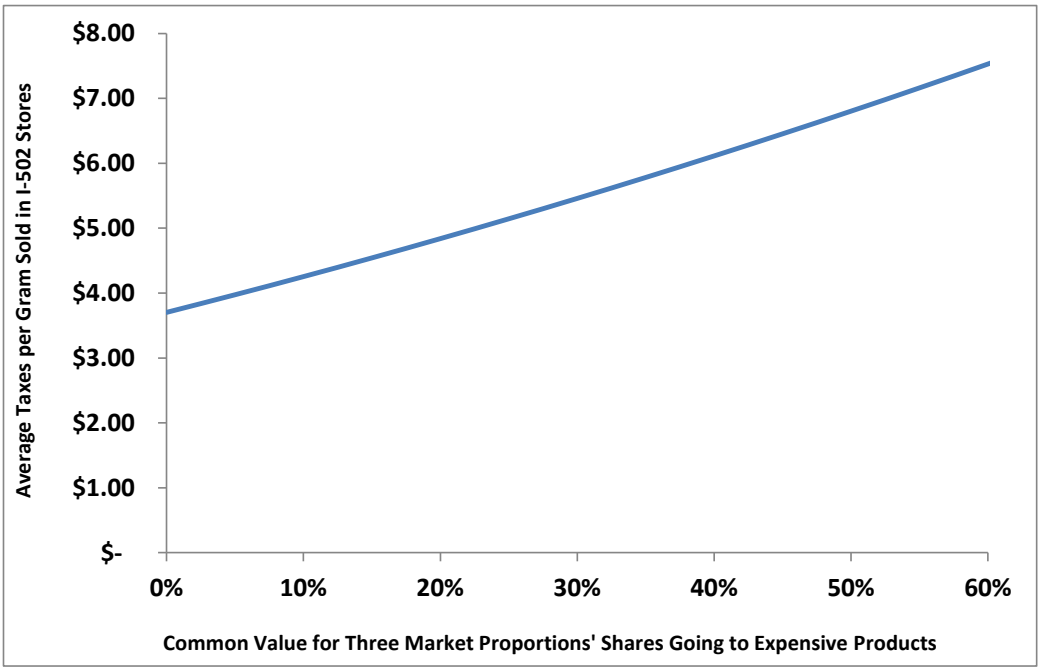
The base case analysis assumes that consumption would be mostly useable marijuana (80%), mostly standard rather than prestige brands (80%), and mostly at retailers competing on price (75%) rather than high-touch service. In terms of taxes collected per gram sold, these are all consequential assumptions. It is hard to graph independent variation over three parameters, so to illustrate their collective importance the figure below shows what happens if they all have the same value. More precisely, the horizontal axis is one minus the value of these parameters; that is, it is the proportion of that market split going to the *more* expensive product: infused vs. useable, prestige vs. standard brand, and sold at high-touch stores vs. those that compete on price (Nordstrom's vs. K-Mart, if you will).

The simple and unsurprising point is that since the taxes are all proportions of value, the more the I-502 market leans toward high-priced product forms, the greater the tax collected per gram sold. The only surprise may be the extent to which this is true: under

[9] We cite the $10.61 and $17.18 to the nearest penny only to clarify how to read the table; none of the figures should be viewed as having precision to the nearest penny because the results vary from one simulation run to the next.

this model, as the market share of high-priced product forms swing from 0% up to 60%, taxes per gram could double, from as low as $3.70 up to $7.53 per gram.

Tax Collected per Gram Sold Increases as the Three Market Share Parameters' Portion Going to High-Priced Products Increases (All Other Parameters at Base Case Values)



Of course there is no free lunch. Not only does the LCB not get to decide these market proportions, even if it somehow had that power, one could not assume that the quantity sold would be the same. Moving those high-priced market shares from 0% to 60% would also – under this model – increase the average price per gram sold from $9.41 to $20.67 per gram. Prices under $10 per gram would be competitive with prices at medical access points today; prices over $20 per gram are not. Regular use at those prices might only appeal to the wealthy (paying $20 per gram for a 1-gram-per-day habit costs $7,300 per year).

So one might guess – as with most projections about a market that does not yet exist, this is only a guess – that Washington's market could develop into either low-priced or high-priced scenarios. One possibility is that I-502 stores supply a good chunk of all marijuana consumption, but most of those sales are of standard brand useable marijuana at stores that compete on price. Another possibility is that the I-502 stores fail to compete successfully for that mass market, and are confined primarily to a boutique market segment catering to a clientele affluent enough not to be very price sensitive (or of users who use so little cannabis that spending more per gram has only a negligible impact on their household budgets), in which case perhaps a substantial share of its much lower volume of sales could be high- end products. But it is hard to imagine that Washington could enjoy both the high sales volume of the low-price scenario and the high revenues of the high-price scenario. Such an outcome would require Washington collecting $6, or even $8, per gram in taxes on the bulk of marijuana consumption, despite current illicit prices often under $9 per gram (for half ounce and ounce purchases).

II(e): Modify taxes to simulate Colorado and states' legalization

We did not vary the tax rates above because they are clearly defined in I-502 (and sales taxes are unlikely to change dramatically). The model can of course explore the effects of alternative tax rates and we do that briefly here for two reasons: (1) To get a sense of the price advantage that might be enjoyed by Colorado or some other state that legalizes in the future and (2) Washington might alter its rates in the future, either in response to other states legalizing with lower tax structures or to help the I-502 market compete more effectively with the purely illegal market in the early years (perhaps to speed its growth to more competitive economies of scale).

Colorado's proposition originally called for the General Assembly to assess a tax "at a rate not to exceed fifteen percent prior to January 1, 2017" on marijuana sold by a cultivation facility. In other words, whereas I-502 had a 25/25/25 tax structure, Colorado's Regulate Marijuana Like Wine Act of 2012 called for a <15/0/0 structure. However, Colorado's Constitution requires all new taxes to be approved by the voters, and the affirmative vote on Amendment 64 did not meet that test. So in one sense, that <15/0/0 rate is moot. (But it is not moot in the sense that it was sufficiently appealing to voters to win at the ballot, and thus may signal what future voters in other states will vote into law.)

In May 2013, the Colorado legislature passed an alternative that would impose not only a 15% excise tax but also a 10% sales tax on retail sales[10], although it still needs to be approved by the voters in November. For simplicity, suppose that plan passes and ends up being essentially a 0/0/25 plan. (And suppose that Colorado's other sales taxes, on average, match Washington's at a rate of 8.75%[11].)

As one further foil, we consider a 0/0/0 tax plan with a sales tax of 6%. Although interest in generating tax revenues is an important driver of support for legalization, several of the legalization proposals advanced in 2012 did not include any tax provisions, including those in Missouri and Michigan.[12]

The model's projections of the prices of the various products under these different tax structures are as follows.

Type of Product	Useable Marijuana				Infused Products			
Type of Brand	Standard		Prestige		Standard		Prestige	
Type of Retailer	Price	Touch	Price	Touch	Price	Touch	Price	Touch
25 / 25 / 25 + 8.75% sales tax	$ 9.41	$ 14.48	$ 10.98	$ 16.89	$ 17.80	$ 27.39	$ 20.03	$ 30.82
15 / 0 / 0 + 8.75% sales tax	$ 5.92	$ 9.11	$ 6.91	$ 10.63	$ 10.78	$ 16.59	$ 12.13	$ 18.66
0 / 0 / 25 + 8.75% sales tax	$ 7.21	$ 11.09	$ 8.41	$ 12.94	$ 12.33	$ 18.98	$ 13.88	$ 21.35
0 / 0 / 0 + 6% sales tax	$ 5.62	$ 8.65	$ 6.56	$ 10.09	$ 9.62	$ 14.80	$ 10.82	$ 16.65

The punch line is obvious: taxes matter, as is perhaps even easier to see when taking averages across product types (with the baseline assumptions about the three market

[10] http://www.reuters.com/article/2013/05/09/us-usa-colorado-marijuana-idUSBRE94805T20130509

[11] Both states' sales taxes vary by locality but 8.75% is about right, on average, and any differences are not large relative to the general point under consideration.

[12] Michigan's sales tax rate is 6% statewide. Missouri's is more complicated because it varies by jurisdiction, which is why we use the 6% rate in this illustration.

shares). The low- and no-tax options allow prices that are at or below current black market prices for production cost assumptions that generate above-current-market prices with I-502's tax structure.

Tax Structure	Avg Price (All Forms)	Avg Price (Useable MJ)	Avg Tax (All Forms)
25 / 25 / 25 + 8.75% sales tax	$ 12.97	$ 11.03	$ 4.92
15 / 0 / 0 + 8.75% sales tax	$ 8.06	$ 6.94	$ 0.77
0 / 0 / 25 + 8.75% sales tax	$ 9.63	$ 8.45	$ 2.55
0 / 0 / 0 + 6% sales tax	$ 7.51	$ 6.59	$ 0.43

II(f): Reverse-engineer parameters to hit a $10 per gram benchmark price

Taxes are by no means the only driver of retail prices. Production costs and markups also figure prominently, and it is far from clear what the correct values for those parameters are (as was discussed in the Task 8(a) report). So it is of interest to ask, "How low would such parameters have to be in order to bring the average price down to some target value?" such as $10 per gram of useable marijuana, which is a typical price at medical access points.

The general answer is: "Perhaps not so much." This table shows how much producers' selling prices would have to fall in order to bring the average price of useable marijuana down to certain target levels – assuming all the downstream markups stay the same in percentage terms. That is an important caveat; with fixed markups, lower upstream prices imply lower markups per gram at the processor and retailer level.

Subject to that caveat, by the model's numbers, a decline reducing the producers' selling price from $3 per gram to $2.07 would allow the average price of retail marijuana to fall from $11.03 – which is above average for medical access points – to $8 per gram, which is competitive with black market prices.

Target Avg Price per Gram (Useable)	Required Producers' Selling Price	Tax per Gram (Useable)
$11.03	$3.00	$4.17
$11	$2.99	$4.15
$10	$2.68	$3.78
$9	$2.38	$3.40
$8	$2.07	$3.02
$7.77	$2.00	$2.93
$7	$1.76	$2.64
$6	$1.46	$2.26
$5	$1.15	$1.88

Naturally the tax collected per gram sold in I-502 stores declines when prices fall (seen in the right hand column). However, in some cases, lower producer prices could generate more revenue. For instance, if a $3 per gram producer price implied retail prices so high that they would limit the I-502 stores to a market share akin to what medical access points enjoy today (say 15% - elaborated in Section IV(c)), and a $2 per gram producer price implied retail prices ($7.77) low enough to let the I-502 stores outcompete both access points and the black market and achieve dominant market share overall (say 80%). Comparing those two scenarios, a lower per gram tax ($2.93) on 80% of a given level of in-state consumption would produce more revenue than a higher tax ($4.17) on 15% of that same consumption. Indeed, the low tax-per-gram, low price scenario would produce 3.75 times as much revenue; and presumably a lower I-502 store price might also increase the total quantity consumed, further increasing the possible gain in revenues.

Even if producers' prices do not fall, smaller markups (in percentage terms) could also lead to lower retail prices. For example, the average price of useable marijuana would fall to $9.92 per gram if all the relevant markups were four-fifths as large (so price and touch stores markup by 24% and 80% not 30% and 100%; standard and prestige brands of useable marijuana markup by 16% and 32% not 20% and 40%).

III. COMPARE PRICE SCENARIOS TO MEDICAL AND BLACK MARKET PRICES

The analysis above suggests that if producers sell at $3 per gram, the average prices in I-502 stores are as likely as not to be something like $10.30 - $12.50 for useable marijuana and $12.35 - $15.10 per gram overall, including infused products (with infused product prices expressed per unit of marijuana).

At these prices, taxes per gram sold in I-502 stores average around $5 per gram of marijuana, but tax revenues depend not only on tax per gram, but also on what proportion of marijuana is obtained from I-502 stores; obviously the average tax paid on marijuana purchased from the purely illegal market is effectively $0.

So tax revenues depend crucially not just on the price in I-502 stores, but also on how those prices compare to prices at the I-502 stores' competitors, namely medical access points and the black market, both in state and nearby. The next section attempts to explicitly combine price, supply, demand, and competition; here we lay the groundwork for that exercise by summarizing some evidence concerning prices for marijuana in the medical market and black markets. More details are found in the appendices.

Medical market prices are based primarily on site visits that BOTEC team members made while in Seattle. In addition, the website Cannabis Price Index claims to report the average advertised price over the last 90 days for Seattle only, not the rest of the state. These data are based on public advertisements, and thus likely represent medical market prices. (See Appendix A.)

The law enforcement prices are based on personal communication with law enforcement officers in Washington State concerning prices in Bellingham, Olympia and Seattle, as well as Grant, Skagit, Spokane, Whitman, and Yakima Counties. (See Appendix B.)

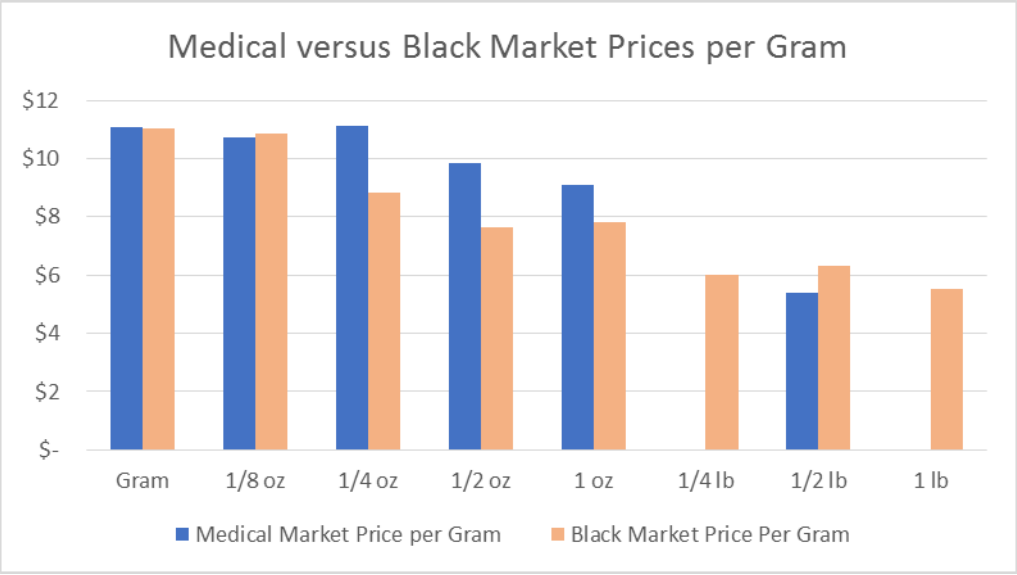
The Price of Weed figures are based on our analysis of a year's worth of price information downloaded from PriceOfWeed.com. (See Appendix A.)

		Gram	1/8 oz	1/4 oz	1/2 oz	1 oz	1/4 lb	1/2 lb	1 lb
Medical Market	Location #1 Average	$ 10.0							
	Location #2 Average	$ 10.1	$ 34.0	$ 67.5	$ 134.8	$ 235.7			
	Location #3 Average	$ 12.2	$ 30.0						
	Location #4 Average							$ 1,225	
	Cannabis Price Index	$ 12.0	$ 50.0	$ 90.0	$ 145.0	$ 280.0			
Black Market	Law Enforcement Average	$ 11.8				$255.0	$681.3	$1,438	$2,514
	Price of Weed Average	$ 10.3	$ 38.4	$ 62.5	$ 108.6	$ 188.7			

An overall average is calculated using the five sources for the medical market and the two sources for the black market. A percentage is provided showing how much more or less expensive the black market is than the medical market. For the most common amounts sold in black markets (1/4 to 1 ounce), the black market prices are 14% – 22% below the medical market prices. On a per gram basis, black market prices in those quantity ranges are $7.80 to $8.80 per gram.

	Gram	1/8 oz	1/4 oz	1/2 oz	1 oz	1/4 lb	1/2 lb	1 lb
Medical Market Average	$ 11.1	$ 38.0	$ 78.8	$ 139.9	$ 257.8		$ 1,225	
Black Market Average	$ 11.1	$ 38.4	$ 62.5	$ 108.6	$221.8	$681.3	$1,438	$2,514
Black Market Price Higher/Lower than Medical Market Price	-0.2%	1.1%	-20.7%	-22.4%	-14.0%		17.3%	

The information in the table is also presented graphically below, with prices converted to prices per gram to show how the price per gram falls as the quantity purchased increases. Some of these numbers are contradictory (for example, the price per gram for medical marijuana increases from 1/8oz to 1/4oz), perhaps because of a low number of observations for both the medical and black markets.



IV. QUANTITY SCENARIOS

Estimates of quantities consumed in Washington today necessarily form the foundation for estimates of quantities that will be taxed under I-502 in the future; however two sets of adjustments must be made. First, quantities consumed in the post-legalization future may differ from current consumption. Second, quantities taxed may differ from quantities consumed – due to a combination of various additions and subtractions of taxed sales against the base of consumed marijuana. The next subsection takes up the first set of issues. The second set is addressed in the subsequent subsections.

IV(a): Quantity Consumed in Washington in the Future Relative Today

Preliminary estimates based on work done for Tasks 430 Ra – Rd suggest that Washington State residents currently (in 2013) consume about 165 metric tons (MT) of cannabis a year, with a plausible range running from 120 to 220 MT. When looking forward to future consumption (and tax revenues), that quantity could be adjusted by four factors:

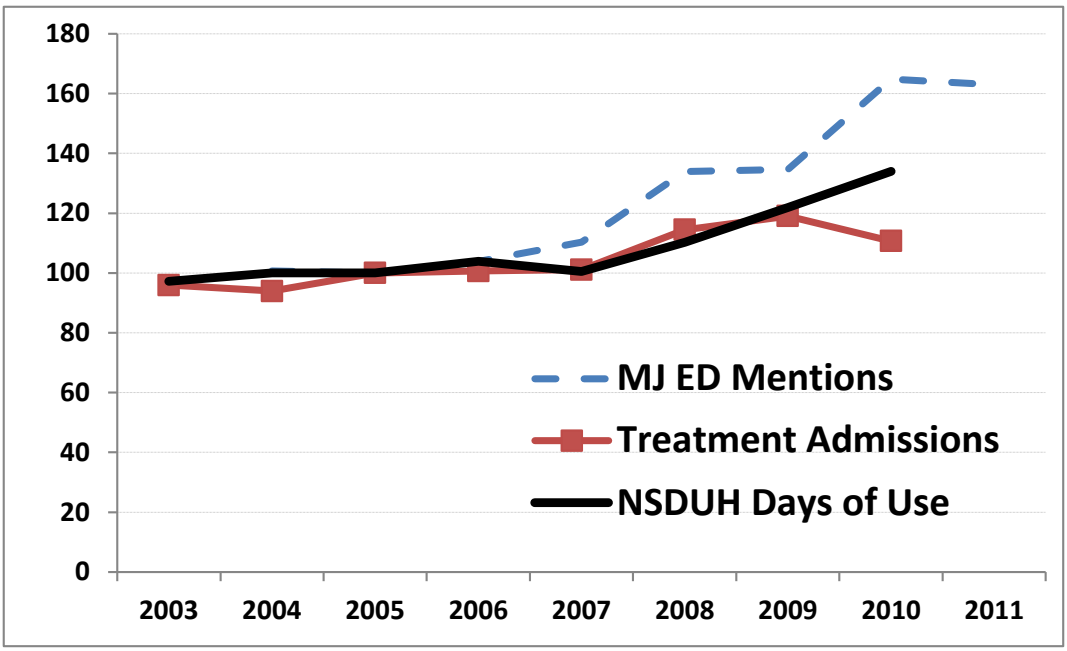
1. Background trends: Cannabis consumption has been increasing in the U.S. since the mid 2000's (Kilmer et al., 2013). It seems plausible that some such trend applies to Washington as well and could continue. I.e., there would be a tendency for Washington State consumption to rise even if I-502 had not passed.
2. Legalization-induced increase in demand. Rob MacCoun (2010) grappled with this issue vis a vis California's Proposition 19; having examined various historical and international comparisons, he suggested that non-price factors associated with California's Proposition 19 might have increased consumption by 5% to 50%, if the proposition had passed. Given that medical access points were already quasi-legal before I-502, he guesstimates that the effect may be smaller for I-502, perhaps 5-35% with a best guess of 20%.[13]
3. Price responsiveness: Marijuana consumption tends to increase when prices fall (Pacula, 2010; Gallet, 2013), as is explained further in Section V(a).
4. Changing product mix: Legalization may alter the mix of cannabis products consumed. Since different marijuana products supply more or less intoxicant to the brain per gram consumed, the current consumption estimate perhaps should be adjusted for this product mix effect.

We elaborate on the first and fourth items here. The graph below shows growth in three indicators of (national) marijuana use: emergency department mentions of marijuana, treatment admissions for which marijuana was the primary substance of abuse, and household-survey-reported days of use.[14] The average annual increases in these indicators over this time period were 10%, 3%, and 4%, respectively.

[13] Rob MacCoun, personal communications, June 18, 2013.

[14] Emergency department mentions are those recorded by the Drug Abuse Warning Network (DAWN) system. The Treatment Episode Data Set (TEDS) counts admissions to agencies that receive funding from the states or from federal block grants must participate, so TEDS cover the majority of treatment centers, but not all. Days-of-use reported in the National Survey on Drug Use and Health (NSDUH) is preferred to prevalence

Growth in Three Marijuana-Related Indicators (Scaled so 1985 Levels = 100)



The product mix issue is multifaceted. One aspect concerns the type of marijuana produced (Kilmer et al., 2010a,b). Legal production will likely be almost entirely more potent forms (in terms of THC content), whereas currently there is a mixture of high-potency indoor-grown, medium potency outdoor domestic, and a modest amount of Mexican "commercial grade" imported marijuana (mostly in the Yakima Valley).[15] Assuming that legalization shifts production towards more high-potency strains, then fewer grams will be consumed per unit of intoxication or per person-year of a habit of a given intensity.

This may be less of a concern for Washington in 2013 than it was for Kilmer et al. (2010) studying Proposition 19 in 2010, since more marijuana users in Washington already use relatively high potency product. For example, of 133 law enforcement-derived samples analyzed quantitatively for THC content by the University of Mississippi lab from 2008 and 2009, only one-quarter (28 of 113) had THC potencies less than ten percent.[16] However, it is still possible that average potency of legal sinsemilla grown in Washington will exceed the current average potency.

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of use because it captures changes in average intensity of use, not just the number of users; much of the increase in U.S. marijuana use in recent years stems from increases in the number of daily and near-daily users, not big changes in the total number of users.

[15] An exception would be strains grown for their CBD, which can have quite low THC content.

[16] THC potency may well have increased further since 2008 (the year of the majority of the data), and these samples may not be completely indicative of the market. These observations tend to be of bulk quantities, which may imply that not all were bound for the Washington State market.

Another issue is that inhaling through vaporization and ingesting marijuana (through infused products) appear to be less efficient means of getting THC into the bloodstream. Leggett (2006, p.42) reports that "The amount consumed is related to the method of consumption. Vaporization is said to require twice as much cannabis and eating four times as much to produce the same effect". So if vaporization and/or eating become more common, then the quantity produced, sold, and taxed per unit of intoxication may go up.

IV(b): Quantity Taxed Relative to Quantity Consumed

The aforementioned adjustments would yield an estimate of the quantity consumed by Washington State residents, but not necessarily the quantity produced, not the quantity taxed. Starting from an estimate of consumption, one needs to subtract quantities provided by other sources (medical market, black market, and home growing) and add consumption by non-residents and scrappage (items discarded prior to use).

Taxed production = Consumption by WA residents

- Home growing
- Supply from WA medical market
- Supply from black market
- Supply from other states' legal markets
+ Consumption by non-residents
+ Scrappage

The first and last adjustments are minor and so are briefly discussed here. The others could be larger and so merit their own sections, which follow.

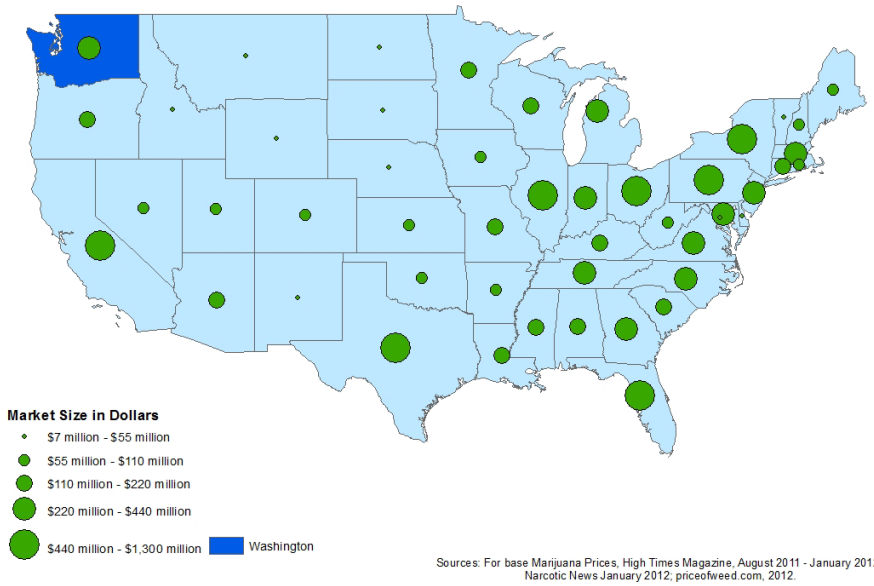
Home growing is a small part of the market currently. The household survey (NSDUH) asks "Now think about the last time you used marijuana. How did you get this marijuana?" In 2011, only 1.4% of those responding to this question (MMGETMJ) said they grew it themselves. Most got it for free or shared someone else's (51.4%) or bought it (45.9%), with the residual (1.3%) trading something for it.

Scrappage includes material that failed a quality control test after some taxes have been collected (e.g., material that fails a quality test at the processor stage after it has been purchased from a producer) and material that is discarded for other reasons (e.g., edibles that have gone stale before the retailer was able to sell them). We obtained no empirical data relevant to estimating scrappage, so that parameter value is left at 0% below, but we include it as a place holder and reminder that it is a logical possibility and could be accounted for as evidence becomes available from actual industry operations.

Consumption by non-residents includes both drug tourism (people driving to Washington to buy marijuana) and organized exports (e.g., from smurf and aggregate

operations), as well as consumption in Washington by residents of other states (college students, visitors who came for other reasons, etc.) It is important to remember that Washington accounts for a quite small proportion of the national marijuana market. (See figure below.) So even if Washington remains a minor source of supply to other states, such "exports" might constitute a relatively large quantity compared with Washingtonians' own consumption.

Number of Past Month Marijuana Users by State Indicated by Size of Circles in Each State (Based on Household Survey Data)



IV(c): Competition from the Medical and Black Market

The market share of I-502 stores will be a key driver of I-502 tax revenues. One can think of the WA market as being divided across three sources of supply: I-502 stores, medical dispensaries (access points), and the purely illegal market.

If the medical market were dominating the overall Washington market today, I-502 stores would only have to compete with the medical market to gain a very high market share. On one hand, that would be an uphill battle, since I-502 stores will offer roughly comparable products[17] but at higher prices (because of the taxes). On the other hand, the medical market could be given a comparative disadvantage with legislative intervention (e.g., restricting untaxed medical sale to people with one of a narrow set of specific medical conditions).

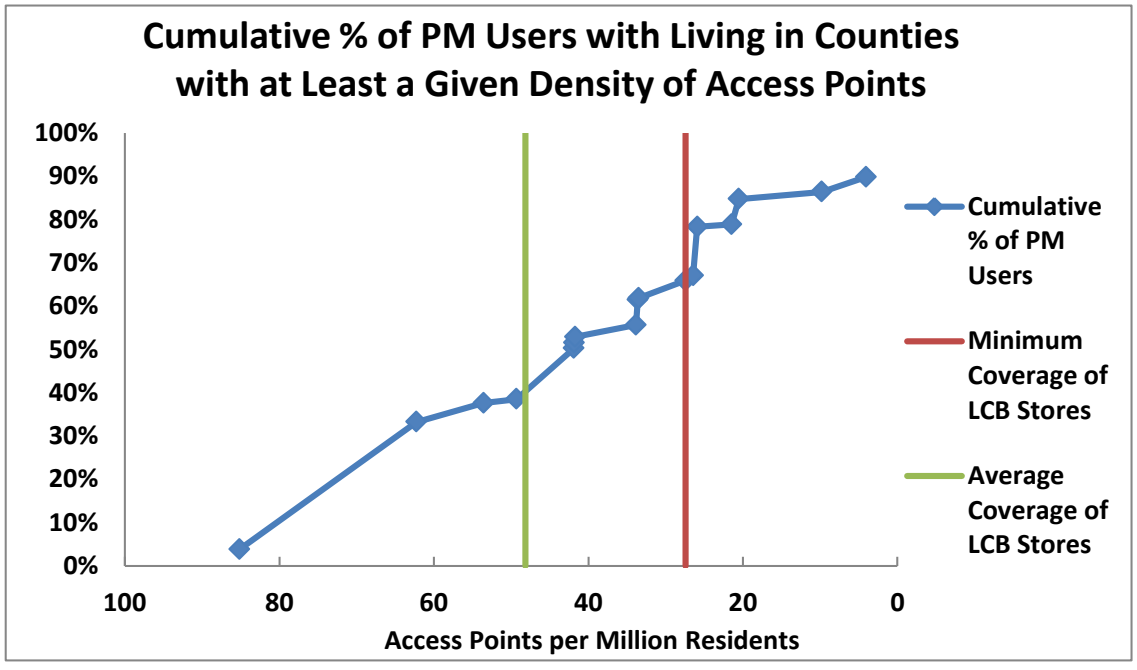
Unfortunately, it may be unrealistic to assume such a large market share for the medical market. Some rough calculations described below – admittedly tenuous – suggest

[17] I-502 stores would have the advantage of better regulated and more consistent product testing and labeling, although at this point they cannot offer the full range of products (specifically extracts for retail sale). But the key point is that both are bricks & mortar retail outlets selling marijuana with essentially zero arrest risk for customers.

that access points now account for less than one-fifth of Washington's marijuana consumption. Furthermore, both media accounts and law enforcement (in documents and interviews) describe robust large-scale purely-illegal production within Washington borders that serves the *national* wholesale market. There is no apparent reason why I-502 would impede or reduce that activity. So one might expect purely illegal marijuana to remain available in Washington.[18]

Unless I-502 production costs turn out to be lower than our base case values, it is not clear what characteristic of I-502 stores would enable them to compete with the black market much more effectively than the medical market has. At least in some parts of Washington – it is relatively easy to obtain a medical recommendation (or to have a friend who has one). I-502 stores will not necessarily be much more convenient or provide much wider access. There are several hundred medical marijuana dispensaries and they serve about half of Washington's past-month users with facility densities equal to the statewide average density of LCB liquor stores, as the figure below shows.

The figure plots the cumulative proportion of past month (PM) marijuana users living in a county whose density of medical dispensaries per capita is at least as great as the rate indicated on the horizontal axis.[19] The vertical bar at 48 outlets per million people indicates the statewide average density of LCB stores. Since the curve intersects that line at a level of about 40%, that means 40% of PM users already enjoy a greater density of dispensaries in their county than that service benchmark.



[18] As a rule, most source countries for illegal drugs "enjoy" ready retail access to their products.
[19] This curve is likely conservative inasmuch as it is based on the 262 dispensaries identified by the legaldispensaries.com website, and the Marijuana Factbook (2013, p.83) estimates that there are 300-350 dispensaries in Washington.

The vertical bar to the right, at 27 outlets per million residents, indicates the lowest density of LCB stores in any county in 2012. Hence, 80% of PM marijuana users are now served by a density of dispensaries that essentially matches of exceeds the low end of the service level provided by LCB stores. In short, although the density of dispensaries may not match what I-502 stores could achieve, it is hard to blame all of medical marijuana's weak penetration on insufficient outlet density.

We return now to the (rough) estimate of access points' current market share. We start by estimating the average annual revenues for dispensaries. The Marijuana Business Factbook 2013 conducted a national online survey of marijuana cultivators, dispensaries, edibles/infused products manufacturers, and other cannabis-related businesses. There were 134 respondents from 22 states and DC (with the largest number of respondents from AZ, CA, CO, MI, and WA). One-quarter of respondents were dispensaries.

The Factbook (pp.116) describes the proportions of dispensaries with revenues falling within certain ranges. These are reproduced below along with (our) point estimates of revenues within those ranges. Taking the weighted sum of those point estimates suggests average annual revenue per dispensary of $632,000.

Annual Revenue	(Point Estimate)	Market Share
Under 100,000	$ 75,000	15%
$100,00-250,000	$ 175,000	27%
$250,000-500,000	$ 375,000	15%
$500,000-1,000,000	$ 750,000	15%
More than $1,000,000	$ 1,500,000	27%
Weight Average for Revenue		$ 632,250

This weighted sum is consistent with what we observed first-hand in Washington[20] and a similarly rough calculation for Colorado.[21] However, it is sensitive to the point estimate used for the "more than $1,000,000" category. If the point estimate for the largest category is increased to $2,000,000, instead of $1,500,000, then revenue per dispensary rises to $767,250.[22]

[20] One small proprietor described 30 customers per day most often buying eighths of an ounce which typically sold for about $35, or about $1,000 in revenue per day. That implies annual revenues of about $350,000. The proprietor of a high-end facility said he had about 75 customers per day, which at $35 per customer could produce close to $1,000,000 per year in revenue.

[21] Vekshin (2013) states that Colorado "collected $5.4 million in sales taxes on $199.1 million in medical marijuana sales in fiscal 2012, according to its Revenue Department." Legaldispensaries.com's weedmaps lists 383 dispensaries in CO today. Dividing $199.1M by 383 would suggest $520,000 in taxed sales per dispensary.

[22] Certainly there are larger facilities, including some whose financial books other members of the team analyzed for other tasks. But one might guess that there are more small dispensaries than there are high-volume operations (even if the high-volume places like Harborside Health Center in Oakland attract the most media coverage).

The Marijuana Factbook (p.83) estimates there are 300-350 marijuana stores in Washington State.[23] Multiplying that by $630,000 or $750,000 per store suggests average annual revenues of $190-260 million for medical dispensaries statewide in Washington.

One rough estimate of the total current market would be Washington's share of PM users in the country (3.1%) times a national marijuana market estimate of $35 billion, or about $1.1B. Another would multiply the estimate of total consumption (165 MT) by an average price per gram of $7.5 or $9, or $1.25 - $1.5B.

Taking midpoints suggests that access points' currently enjoy about $225M / $1.3B = 17% market share by value (and perhaps less by weight), with a corresponding uncertainty range of 12 – 24%.

The implication of this is clear and of great importance. Even if I-502 stores completely displace medical access points, they'd still have to outcompete the purely illegal market in order to dominate overall state consumption.

Note: There are at least three ways Washington policy makers could intervene to improve the competitiveness of I-502 stores relative to the black market: (1) Cutting I-502 taxes, (2) Easing I-502's regulatory burden, and (3) Arresting and prosecuting black market growers more aggressively to drive up their costs of doing business.[24]

IV(d): Supply from Other States?: Example of Tobacco Tax Evasion

Currently Washington has the second-most liberal state policy concerning marijuana availability (after Colorado), so initially one might expect any cross-border flows to go from Washington out to other states. However, in the future these cross-border flows might reverse, for instance if other states legalize marijuana, and particularly if they do so with taxes lesser than I-502's.

There is no empirical data on gray market smuggling of otherwise legal marijuana to evade taxes, because there are not yet any states with functional legal marijuana markets, let alone data describing flows between pairs of such states.

At present the most relevant data may be those pertaining to cross-border purchase and transport of tobacco. Cigarettes are a different product in many ways, but they are similarly dependence inducing and subject to relatively high excise taxes.

LaFaive and Nesbit (2010) estimated the amount of cigarettes being smuggled in the U.S. by state. Their paper differentiates between casual smuggling which "involves smaller

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[23] On June 19th, 2013 the website https://legalmarijuanadispensary.com/dispensaries/in reported that Washington hda 243 dispensaries with 262 instances in particular counties (a few dispensaries operate in multiple counties). We are not clear on what the website's methodology is, but it may not be comprehensive, so we view the 243/262 figures as broadly consistent with a 300-350 estimate.

[24] Examples of regulations that could be relaxed would be allowing outdoor growing (meaning outside of greenhouses) or allowing standard greenhouses vs. those with solid walls. The idea of ratcheting up enforcement on black market producers may seem antithetical to the spirit motivating passage of I-502, but the logic can be summed up as, "If you can't raise the bridge, then lower the river." What matters for I-502's market share is not its price per se, but its price relative to the black market (and medical market) prices, and it may be easier at first to drive those up than to drive I-502 prices down.

purchases, usually for personal use," and commercial smuggling, which "involves large-scale, long-distance transport, [and] also plays a major role in cigarette trafficking."

They estimate that a little over one-third of cigarettes consumed in Washington State had evaded Washington State taxes (19.7% via commercial, and 14.5% via casual buying), while 4.2% of sales were to Canadians coming to Washington. The reason for this presumably is that the tax on cigarettes in Washington was $2.03 in 2009, while it was only $1.18 in Oregon, $0.57 in Idaho, and $1.70 in nearby Montana (State Cigarette Excise Tax Rates). So a pack a day smoker in Washington could save from $120-$530 per year by sourcing from an adjacent state, depending on the state.

The method used by LaFaive and Nesbit (2010) does not identify flows between pairs of states; it only identifies total flows in and out of each state. Therefore, it does not say which state Washingtonians go to in order to purchase cheaper cigarettes. However, we might conclude that when the potential savings are somewhere between $120 and $530 per year, then something like 1 out of 7 regular smokers are willing to take individual actions to obtain cheaper cigarettes (casual smuggling), and another 1 in 5 were willing to purchase from in-state commercial suppliers profiting from price arbitrage and tax evasion.

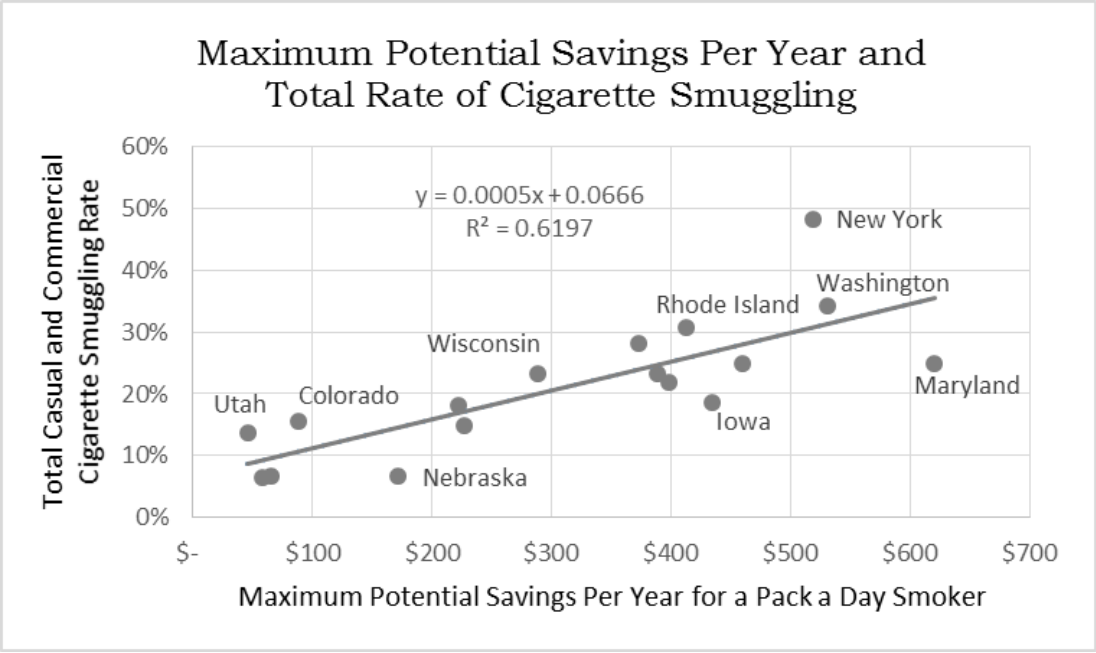
Parallel phenomena can be observed in other states. For example, the tax in Wisconsin is $1.77 per pack, compared to taxes in neighboring and nearby states of Michigan ($2.00), Minnesota ($1.50), Iowa ($1.36), Illinois ($0.98), and Indiana ($1.00). (Michigan's rate is not really relevant since it is higher, but is mentioned in order to be comprehensive.) The potential savings are from $100 to $280 per year for a pack a day smoker, and LaFaive and Nesbit (2010) estimated that 1 in 10 people smuggled cigarettes into Wisconsin from other states.

The table below summarizes such analysis for all states that had net casual smuggling into the state in 2009, except that Arizona, California, and New Mexico were excluded because of the large amount of smuggling into those states from Mexico.[25] The average differential is the average of differentials only for surrounding states that have a lower excise tax, since one would not expect cigarette buyers to go to a state that has a higher excise tax.

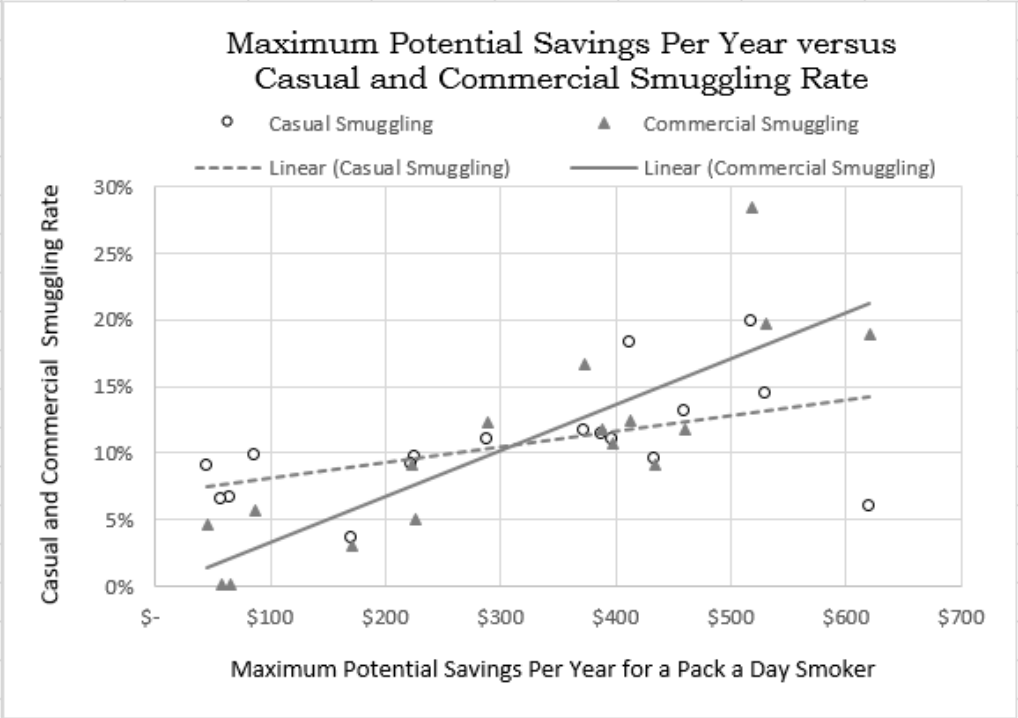
[25] The comparison groups always include all directly adjacent states. For states such as Rhode Island, New York is also selected because of its close proximity, even though the two states do not share a border. Similar exceptions are made for Colorado, Florida, Kansas, Louisiana, Maryland, Montana, New York, and Washington.

State	Potential Savings Per Year			Casual Smuggling Rate into the State	Commercial Smuggling Rate into the State	Total of Casual and Commercial Smuggling Rate
	Max	Min	Average			
Maryland	$ 621	$ 237	$ 424	5.97%	18.92%	24.89%
Washington	$ 531	$ 119	$ 319	14.45%	19.74%	34.19%
New York	$ 518	$ 64	$ 263	19.87%	28.46%	48.33%
Montana	$ 460	$ 62	$ 334	13.16%	11.84%	25.00%
Iowa	$ 434	$ 139	$ 261	9.47%	9.07%	18.54%
Rhode Island	$ 412	$ 168	$ 251	18.23%	12.39%	30.62%
South Dakota	$ 398	$ 9	$ 227	10.98%	10.78%	21.76%
Minnesota	$ 388	$ 53	$ 220	11.38%	11.79%	23.17%
Michigan	$ 372	$ 84	$ 274	11.64%	16.62%	28.26%
Wisconsin	$ 288	$ 97	$ 204	10.96%	12.36%	23.32%
Kansas	$ 226	$ 55	$ 118	9.67%	5.10%	14.77%
Oregon	$ 223	$ 113	$ 158	9.07%	9.09%	18.16%
Nebraska	$ 172	$ 15	$ 93	3.58%	3.08%	6.66%
Colorado	$ 88	$ 18	$ 58	9.80%	5.74%	15.54%
Lousiana	$ 66	$ 66	$ 66	6.62%	0.10%	6.72%
Florida	$ 58	$ 58	$ 58	6.47%	0.10%	6.57%
Utah	$ 46	$ 35	$ 40	8.96%	4.69%	13.65%
Sources: LaFaive and Nesbit, "State Cigarette Excise Tax Rates."						

The scatter plot below shows the maximum potential savings for each state and the total smuggling rate. As expected, as the potential savings increase, the total rate of smuggling increases as well.



The next figure is similar, but breaks down total smuggling into its the casual and commercial components. When the maximum potential savings is under $300, then casual smuggling is more prevalent than commercial smuggling and vice versa.



This analysis was replicated using the average rather than the maximum potential savings. All of the graphs suggest that as potential savings increase, so does the smuggling rate, as indicated in the following summary table.[26]

Model		Slope (in %)	R-Squared
Potential Savings	Smuggling Rate		
Maximum	Total	0.05	0.62
Maximum	Casual Only	0.01	0.27
Maximum	Commercial Only	0.03	0.72
Average	Total	0.07	0.50
Average	Casual Only	0.02	0.18
Average	Commercial Only	0.05	0.62

Potential savings do not explain much of the variation in casual smuggling, although it does explain more variation in total and commercial smuggling rates. This makes sense inasmuch as commercial smugglers' raison d'etre is to take advantage of price differentials.

The upshot of the graphs and table is that if the potential savings are on the order of $500 per year, then tax-evading smuggling could be a significant problem. Most marijuana

[26] The slope is a very small number because it measures the percentage change in smuggling associated with a single dollar increase in potential savings. An easier way to think about it, for example, is that a $100 increase in the maximum potential savings is associated with an increase of 5% in the total smuggling rate.

use infrequently, but most of the demand comes from the minority who consume heavily, such as a gram-a-day marijuana user. So price differentials of $1.50 per gram might be sufficient to induce significant cross-border smuggling to evade taxes.

As was discussed in Section III(e), Washington may plausibly see tax-induced marijuana price differentials larger than $1.50. For example, the calculations there suggested that the differences in taxes between Washington and Colorado could generate an average price difference of $2.58 per gram of useable marijuana. Likewise, changing the 25/25/25 tax rates to 17/17/17 in the model above reduces the average price per gram of useable marijuana by $1.50.

We cannot predict the amount of cross-border smuggling, but the evidence assembled here suggests that such activity could occur on a significant scale, depending on the actions of other states.

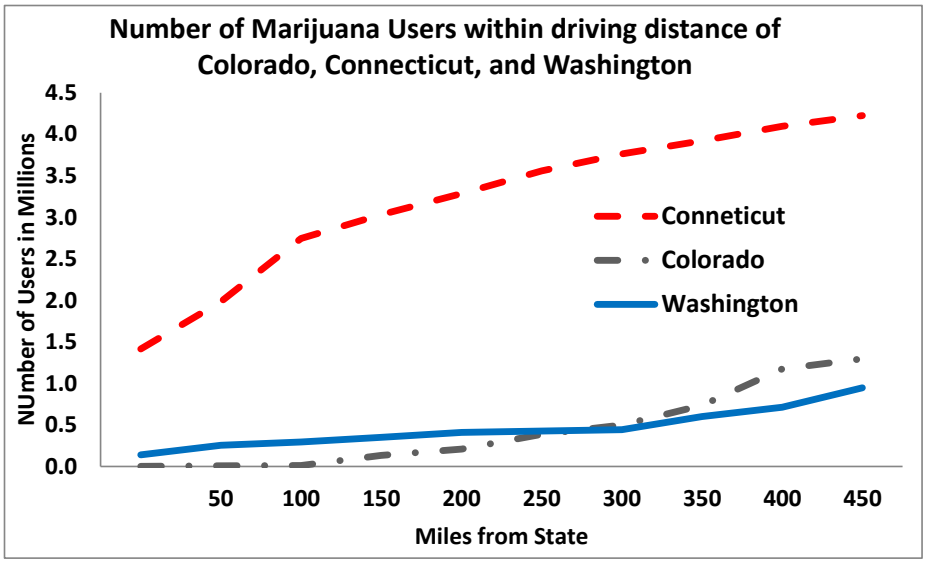
IV(e): Drug Tourism

Drug tourism and other forms of supply to non-resident consumers may significantly affect tax revenues. On the positive side, such "leakage" expands Washington's tax base, allowing it to tax the consumption of residents of other states. On the negative side, it might trigger a federal response that disrupts the legal Washington market.

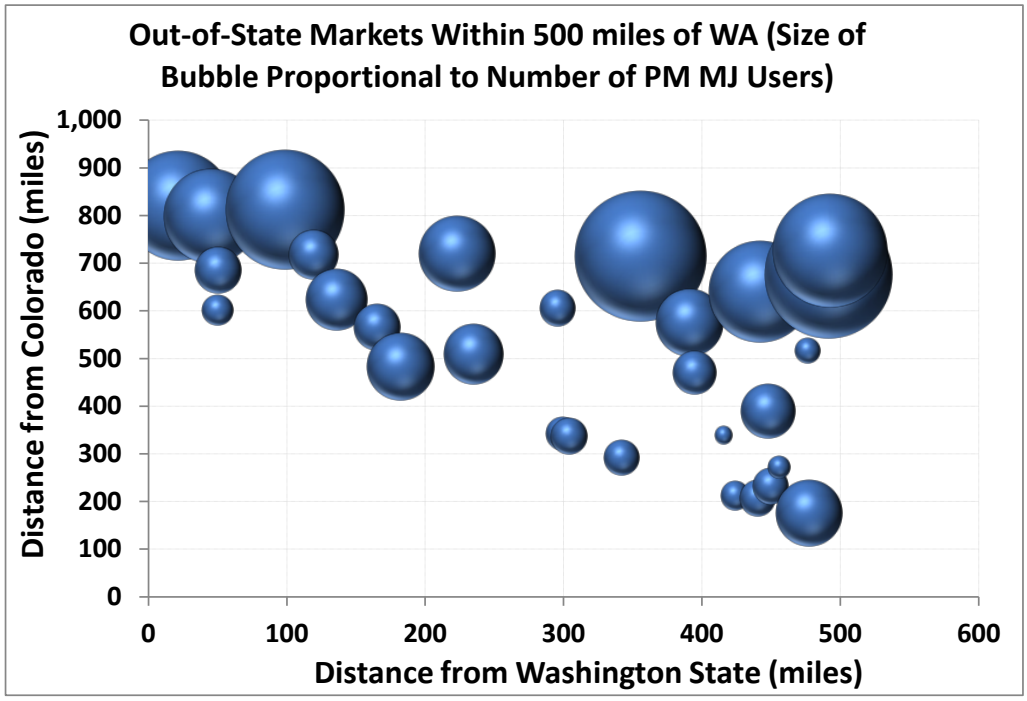
Drug tourism exists or has existed in a variety of countries – Morocco, Thailand, etc., but the situation in the Netherlands is perhaps best studied and most relevant. Tourists were thought to account for a not unimportant minority of total coffee shop sales before the Netherlands took steps to curb it (e.g., reducing the allowed purchase size from 28 to 5 grams, reducing the number of stores along its borders with Belgium and Germany, etc.). MacCoun (2011) "estimated that a quarter of the 4–5 million tourists who visit Amsterdam visit a coffeeshop, and that 10% of them cite that as a reason why they came."

Drug tourism does not include only significant trips taken for the purpose of obtaining marijuana. There are also minor trips taken to purchase marijuana, such as driving from Portland Oregon to Vancouver Washington. There can be trips taken for other purposes but for which the availability of legal marijuana tips the choice of destination to Washington, and purchases by tourists who would have come to Washington anyhow.

Four factors may combine to limit the scale of drug tourism to Washington State: (1) Initiative 502's relatively high tax structure, (2) the presence of a competing jurisdiction in Colorado, (3) the likelihood that other states will also legalize within relevant planning horizons, and (4) Washington's geographical distance from much of the national market, relative to Colorado and other potential source states. Far fewer past-month marijuana users live within driving distance of Washington – or for that matter Colorado – than live within driving distance of a typical state in the Northeast, such as Connecticut.



However, to at least roughly quantify the potential for drug tourism in WA, we used SAMHSA data to estimate the number of past-month users living within 500 miles of Washington borders, and then considered how many of those individuals live closer to Washington than to Colorado. Those 860,000 PM users have the following distribution in terms of distances from the two states.



Simply looking at distance probably overstates Washington's appeal to these potential drug tourists; someone equidistant from Washington and Colorado might still prefer sourcing from Colorado, given its lower taxes. Moreover, many of these past month users live in California, whose medical dispensaries might compete effectively with I-502 stores. (The 200,000 past-month users belonging to the two big circles in the upper right

of the figure live in or near Sacramento, and the large circle at 350 miles from Washington is also in California.)

Washington's likely market for drug tourists are the 420,000 PM users for whom the distance to Washington is less than half the distance to Colorado, and who do not live in California; this group is roughly represented by the blue dots inside of the 300-mile mark from Washington.[27]

IV(f): Smurfing scenarios

Smurfing refers to making many small contraband transactions, rather than one large one, in order to fly beneath the radar of enforcement.

For example, cough medicine used to contain pseudoephedrine, which is a key component for one of the procedures for "cooking" meth. Individuals, called smurfs, used to purchase small amounts of cough medicine at a time, so as not to draw attention, from a number of different stores until they amassed enough to make meth. The smurfs could either use the pseudoephredine themselves or sell it to other illegal producers of meth.

Under I-502, the same concept allows essentially any adult in Washington to become a fairly large scale "producer" of marijuana. In contrast with the Netherlands today, I-502 would allow individuals in Washington to buy as much as an ounce of useable marijuana at a time, or 16 ounces of solid infused products, or 72 ounces of liquid infused products. If practiced by multiple people in a group at multiple stores per day, such smurfing could easily amass large and potentially profitable amounts of easily exportable marijuana. For example, if four people each buy from two different retail locations each day, the group could get 240 ounces (15 pounds) of useable marijuana per month.[28] Although moving the product out of the state would be illegal, the individual purchases would not, and the actual crime of trafficking would be difficult to detect: 15 pounds of marijuana fits in the trunk of a sedan, where police would require probable cause to search.

So the question is: could smurfs sell pounds of marijuana at a high enough price out of state to cover their costs of time and transportation, while yielding a reasonable profit?

Superficially, that might seem completely implausible. We are forecasting standard retail prices at I-502 stores that are substantially *higher than the current retail price* for illegal marijuana, let alone the wholesale price. Furthermore, however appealing it might

[27] These are approximate numbers. There are details of geography that we did not consider. We looked only at distances from centers of regions to the border of the two states, but people cannot drive as the crow flies, and the Northwest corner of Colorado is quite sparsely populated. Furthermore, individual circumstances can matter. Presumably some drug tourism would piggy back on already planned trips, not travel solely for the purpose of obtaining marijuana.

[28] Based on packaging methods we observed in Washington, half-pound units of marijuana in shrink-wrapped soft packages have a volume of about ½ cubic foot, suggesting that a gray market tax-evader could easily carry 15 pounds of marijuana in the trunk of a typical full size sedan.

be to smurf out of Washington, Colorado's lower taxes ought to make it an even more appealing smurfing source.[29]

There are three possible caveats to this logic. First, if Washington producers develop a popular edible, and Colorado dispensaries do not produce something comparable, then smurfing and smuggling that product out of the state might be a viable enterprise. Since most states do not have medical dispensaries, and therefore have very bare markets for edibles, an innovative Washington edible producer could possibly discover a very large market.

Second, some out-of-state markets are closer to Washington than Colorado. (See drug tourism discussion.)

The third scenario involves extracts such as BHO. As a rough rule of thumb, 50% of the THC in a marijuana plant is in the flowers. The other 50% exists in lower concentrations in other parts of the plant, such as the leaves and trim. Since the total weight of the plant parts that are not flowers substantially exceeds the weight of the flowers, the larger mass at a lower concentration adds up to about the same amount of THC.

Where marijuana production is entirely illegal, much of the THC and other cannabinoids outside of the flowers is simply discarded. However, extraction may become more established and more economical after legalization (e.g., because of economies of scale and/or technological innovation). That might leave Washington (and Colorado) with a surplus of cannabinoids available in the form of oils and extracts, since there seems to be greater demand for useable marijuana than for oils or infused products, on a THC-adjusted basis. Oils and extracts are even more compact than useable marijuana, so they are even easier to smuggle, and out of state prices are fairly high, precisely because it is harder to operate extraction processes at scale where it illegal under state law.

At this time is it impossible to estimate the quantity – if any – of useable marijuana, extracts, or infused products that may be smurfed or otherwise smuggled out of Washington after being purchased in taxed transactions. So we do not include smurfing in any of the calculations below. However, it is important to understand that this is something that could happen, at least in theory. And if the LCB wanted to make a priority of limiting leakage of Washington-taxed and -branded marijuana products into other states, it might wish to take steps to discourage smurfing, such as limiting purchase sizes, discouraging repeat purchases, or banning discounts for repeat customers.

V. COMBINING PRICE & QUANTITY: SCENARIOS FOR THE ELASTICITY OF DEMAND

V(a). Brief Literature Review

Elasticity of demand measures how consumption changes in response to a change in price. The elasticity is the percent change in consumption that is associated with a 1% change in price (Pacula, 2010). Typically, the elasticity of demand is a negative number because of

[29] Colorado's Amendment 64 also has a "smurf protection clause" that forbids stores from retaining information about the identities of purchasers.

the inverse relationship between price and quantity. As price increases, the quantity purchased usually decreases. The question that arises is by how much does consumption change with a small change in the price. If the price of marijuana increases by $0.10, then does consumption decrease by 5%? 10%? Similarly, if there is a $0.10 decrease in the price of marijuana, how does consumption change?

Researchers have been trying to determine the elasticity of demand for marijuana at least since the early 1970s. Fortunately, two recent papers performed a meta-analysis of the previous studies.

The first paper (Pacula, 2010) drew the following conclusions:

- Consumption is expected to increase after legalization due to: (1) increases in new users, (2) increases in regular and heavy users, and (3) increases in the duration (as a portion of his lifespan) of the marijuana habit for the average user.
- If marijuana prices decrease by 10%, there could be an increase of 3-5% of new marijuana users under the age of 18 along with an increase of 2.5% in regular users.
- Best guess for a total elasticity of demand is -0.525.

Drawing on Pacula's review, RAND's work on Proposition 19 (Kilmer et al., 2010a) used for its base case an elasticity of demand of -0.54, slightly greater, in absolute value than the -0.525 to include income elasticity effects. However, in recognition of the considerably uncertainty concerning this parameter, Kilmer et al. also considered values ranging all the way from -0.4 to -1.26.

The second paper (Gallett, 2013) addressed a variety of illicit drugs, including marijuana, heroin, and cocaine, but states results for marijuana separately. Gallett developed a meta-regression model to synthesize many studies results into a point estimate. The conclusions are:

- Marijuana is less responsive to price changes than heroin or cocaine.
- Depending on whether or not an ordinary least squares or random effects regression was used, the price elasticity of demand for marijuana ranged from -0.41 to -0.15. But the final predicted price elasticity was -0.23.

It is important to note that there is an extra wrinkle in the present context. The elasticity of demand customarily pertains to situations in which all prices go up by a certain proportion, but, as discussed above, I-502 stores will not account for the entire market. However, I-502 create a new source of supply, not (directly) change the overall price level.

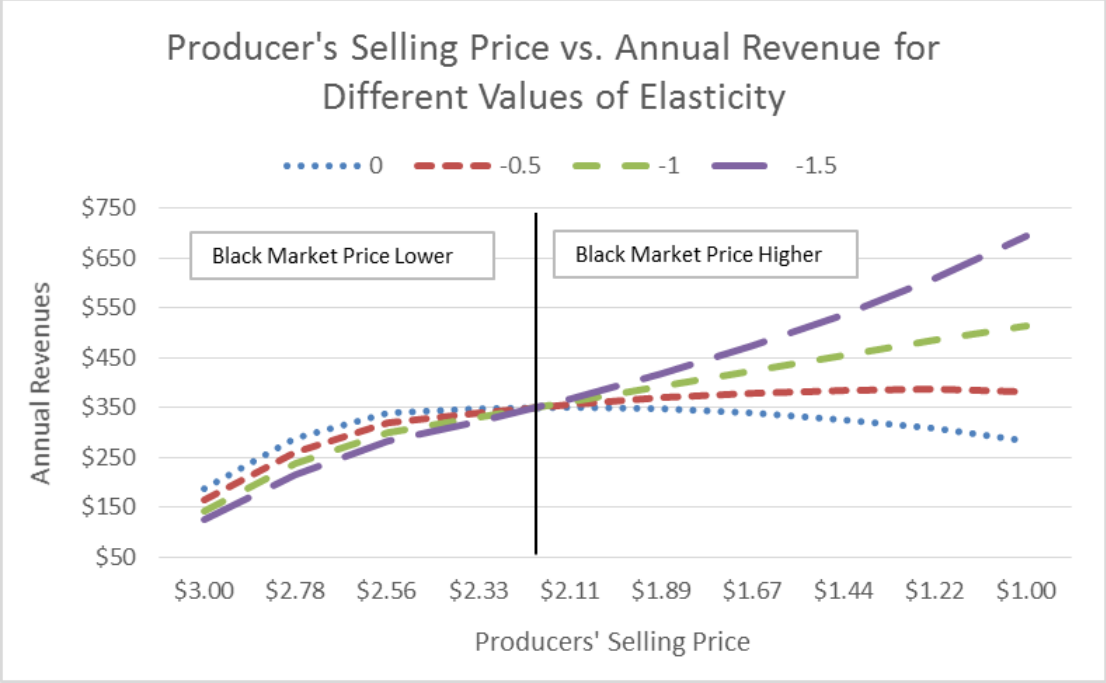
V(b). Plot tax revenues versus price

We can combine the price and quantity models to explore how various values for the elasticity of demand affects annual tax revenues. The graph below shows how decreases in producers' selling price affect annual tax revenues based for various values for the elasticity of demand concerning overall marijuana consumption.

As the producer price decreases, the average price per gram in the legal market falls. The black line in the graph below marks the turning point when the black market price ceases to be lower than the I-502 market price.

In the graph, as the legal market price decreases, the medical and black markets' shares are reduced. In particular, we set the medical market's share at 15% and the black market's share at 70% of the total market when the producer's selling price is $3.00. The medical market share then decreases by 10% and the black market decreases by 5% for every $0.22 decrease in producers' selling price. The medical market then is eliminated when the producers' selling price is $2.78. Those values pertain for each of the four curves corresponding to different values for the elasticity of demand. That is, the different elasticities pertain to how total consumption changes, not to I-502 stores' ability to capture market share.

Since I-502 stores capture a larger share of the market as price falls, tax revenues increase as the producers' selling price falls, even though that reduces the tax collected per gram sold in an I-502 store. The only exception is that if the elasticity of demand is zero, so lower prices do not induce any greater consumption, then the greater market share does not offset the decline in tax revenue per gram, so the dotted line for elasticity of zero bends back down as producers' selling prices fall below $2 or so per gram.



The graph shows annual revenues based on four different elasticities of demand for the overall market. When the elasticity of demand is -0.5, consumption and annual revenues are lower than they are when the elasticity is zero and the black market price is lower than the legal market price. However, when the legal price drops below the black market price, then consumption and revenues are higher when the elasticity is -0.5. A similar argument can be made when comparing -0.5 to -1, and -1 to -1.5.

VI. DYNAMIC SIMULATION SCENARIOS

The analyses above were mostly "comparative statics" – exploring how the market equilibria would differ with a larger or smaller value for one parameter or another. Here we explore scenarios concerning how tax revenues and other market outcomes might evolve over time.

The first issue we address is cumulative tax revenues. Voters in Washington heard that I-502 would result in up to $2 billion in tax revenue over the next five years (Johnson, 2012). Is this realistic? The answer developed here is that while this is not necessarily unrealistic – if one starts the five-year clock after the I-502 market has had a chance to get established – it is also far from certain. Tax revenue depends on a variety of assumptions including those concerning markup rates, annual consumption, and the market share of the I-502 market.

The subsequent exercises produce several other important takeaways. First, depending on the initial assumptions, the total revenue over ten years could easily be anywhere from $650 million to $3.2 billion. Second, in many scenarios, there is not steady annual growth. If the annual revenue for one year is $250 million, it is naïve to assume that the revenue for the next year must necessarily match or exceed that number.

The scenarios described here should not be considered to be forecasts, in the usual sense of predictions of what *will* happen. Rather, they are projections that illustrate various things that *could* happen. The emphasis is on qualitative insights – such as that several years of increasing revenues do not imply that revenues could not later decline – and insights that come from contrasting related pairs of scenarios.

The Model

Although the scenarios provided here may ultimately not occur, as is perhaps true of the vast majority of forecasts, they reflect a moderately sophisticated model and a serious attempt to find realistic estimates. This model combines the price and quantity models described in Sections II and IV.

The model starts with fiscal year (FY) 2015 (July 1, 2014 to June 30, 2015) – the first fiscal year during which I-502 stores will be operating for the entire year. This is seen as a better starting point than FY 2013. Even if stores open during the first half of 2014, they would only be in operation for a minority of FY 2013. Including a part-year start up could create a misleading impression of rapid growth at the outset. Furthermore, any estimates for a brand new market would be plagued by even greater than usual uncertainty.

We end the projection window in FY 2024 because that is long enough to illustrate certain dynamic patterns; choosing an end date further into the future increases the chance that unforeseen events will fundamentally alter the situation (e.g., a national legalization prompting a fundamental revision of I-502). Indeed, even figures from the latter part of this ten-year horizon should be viewed as tentative, due to the significant likelihood of qualitative shocks of the sort discussed in Section I.

For each year, the model outputs include the quantity of marijuana (in metric tons) that is sold and taxed in the I-502 market, the average price in that legal market, the tax per gram, and the total tax revenue.

The Parameters

The model here uses the same parameters as in the price and quantity models, but now those parameters' value can be increased or decreased over time. For example, the initial producers' selling price is $3.00/gram, but in Scenario 1 we decrease that figure by $0.15 per year based on the idea that competition and innovation may drive production costs down over time. Parameters can be assigned a minimum or maximum, so that such a linear trend does not carry it into an implausible range. For example, the producer's selling price could be set to decline by $0.15 per year down to a minimum of $1.50 per gram, after which it ceases to fall.

Likewise, there is an option to have the changes in a parameter start in a later year. The table below shows starting values for all of the parameters. If at any time better or more precise values become available, they can be changed in the spreadsheet.

Parmater	Starting Value
Producers' selling price	$3.00
Processing Cost: Gram of Useable MJ (primarily covers testing and QC)	$0.40
Additional processing cost per gram	$0.25
Additional cost of extracting oil, per gram processed	$0.50
Proportion of production from ver. Integrated processors: Useable MJ	80%
Proportion of production from ver. Integrated processors: Oils	0%
Proportion of production from ver. Integrated processors: Infused Prod.	30%
Prop of MJ-content in infused products bought from oil extractors	25%
Oil Extractor's Markup (%)	50%
Useable MJ, Standard Brand	20%
"" Prestige Brand	40%
Infused Products, Standard Brand	60%
"" Prestige Brand	80%
Retailer Markup by retailer type: Price	30%
Retailer Markup by retailer type: Touch	100%
MJ Sold as Useable MJ vs. Infused Product	80%
% of product sold as Std vs. Prestige brands	80%
Proportion of retailers competing on Price vs. Touch	75%
Quantity of MJ consumed in WA in 2015 (MT)	165
Annual growth rate in MJ demand across country	5%
Legalization induced bump up in consumption	20%
Current Price of MJ	$10.00
Elasticity of Demand	0
Market share of competing sources of supply: Medical Market	15%
Market share of competing sources of supply: Black Market	70%
Market share of competing sources of supply: Homegrowing	2%
Market share of competing sources of supply: Other state's legal market	0%
Consumption by drug tourists (as % of WA consumption)	5%
Scrappage adjustment (tax collected on material not consumed)	0%

The reasoning behind most of these values can be found earlier in this document, or in the Task 430-8a report. However, a few parameters merit explanation.

As described above, marijuana consumption has been trending upward, so we build in some growth in demand in Washington. Given the data above, 5% might be a reasonable increase initially, but it is not clear this rate would be sustained. (After all, ten years of 5% growth would is an increase of over 60%, with compounding.) So the annual grow rate of marijuana demand is set to start at 5%, but decreases 1% each year, with a minimum of 0%. Therefore, by 2024 the cumulative effect is 16% growth.

For reasons discussed above, the market share for the medical market starts at 15%, and home-growing at 2%. In Section IV(b) above, the estimate for home growing nationwide is 1.5%, but since Washington may have more growing than average, and those

who grow may self-supply and/or supply their laborers, for this model we round that parameter up to 2%.[30] [31]

In our base case, we credit the I-502 market with initially achieving 13% market share by taking further market share away from the black market (which then gets the rest, or 70%, of the market). As suggested above, these market share assumptions are highly consequential and highly uncertain, and so are good parameters for LCB staff to adjust as better information becomes available.

Consumption from I-502 stores by drug tourists is set to be 5% as great as total Washington consumption in 2015. 400,000 PM marijuana users live outside of Washington but within 250 miles. If one-quarter would prefer (somewhat expensive) legal marijuana to illegal marijuana and one-third of those were willing to source from I-502 stores, those potential drug tourists may represent about 5% as many PM users as there are in Washington.

What Market Share Would It Take to Realize $2B in Tax Revenues in 5 Years?

In August 2012, the Washington Office of Financial Management (OFM) reported that in five years I-502 could yield revenues of $1.94 billion of which $1.59 million is excise and sales taxes (with the rest being license fees and the state business and occupation tax). The OFM assumed that the I-502 market completely replaced the illegal market. However, based on the analysis above and conversations with the LCB, it seems unrealistic that the I-502 market will be able to replace the illegal market any time soon. The earliest that stores would open would be early 2014. There is also a concern that the legal market will not be able to meet all of the demand in Washington and that prices will be higher than in the illegal market.

On the other hand, the OFM report assumes total annual consumption of only 85 metric tons, whereas RAND's preliminary analysis places that figure around 165 metric tons, or almost twice as much.

The model demonstrates what would need to happen in order to produce $1.59 billion in excise and sales tax revenue in the first five years. If we take the five years literally to mean five years from passage of I-502, the $1.59B target seems entirely unrealistic. If I-502 stores start at only 13% of the market, and in order to accumulate $1.59 billion in revenue by 2017, the medical market would have to be eliminated in the first year and the black market would have to decrease by 23% a year and so disappear by 2017. That seems unlikely.

The prospects are considerably brighter if the five-year clock is not started until FY 2015. In that case, assuming the medical market is again gone after a year, the black

[30] On the other hand, Washington's share of indoor grow sites eradicated in 2012 as reported by the DEA (http://www. justice. gov/dea/ops/cannabis_2012. pdf), and the corresponding share of indoor plans eradicated (2.9% and 3.5% respectively), are not out of line with Washington's share of past-month users (3.1%).

[31] Bouchard reports that marijuana growers in Quebec pay part of their staff's wages in kind rather than in cash.

market only needs to decrease by 1% a year to generate $1.59 billion in five years. There is such a stark difference in these two scenarios because by adding two more years, there is an additional $800 million in revenues, so meeting the $1.59 figure is easier.

Effects of Declines in Production Cost

It is expected that as the market develops, the producers' selling price will decrease for a variety of reasons: simple competition as production capacity scales up, realization of greater economies of scale, technological innovation, a shift toward lower-cost sunlight rather than artificial light based production, and so on.

Falling producer costs is normally a good thing, at least for consumers, but it has conflicting effects on tax revenue. The immediate effect is negative, inasmuch as the I-502 taxes are essentially ad valorem taxes. Lower prices means lower tax revenue per gram. On the other hand, lower I-502 prices might increase statewide consumption, at least somewhat, and perhaps more importantly let I-502 stores win a larger share of the total market, at the expense of other sources of supply, notably the black market.

We explore these effects in turn. In scenario 1, the producers' selling price starts at $3.00 per gram and decreases by $0.15 annually.[32] With this change, the ten-year revenue decreases by 20%, from the base case (when none of the parameters change over time), to $1.57 billion.

In addition to decreasing production costs, it is also possible that the processor and retail markups will decrease. So in scenario 2[33] all of the markups are also cut in half over the ten year period. These changes result in a total ten-year revenue of $1.40 billion.

Price decreases are not all bad, from a tax revenue perspective, because consumers can be expected to respond to the decline in price by buying more. As discussed in Section V above, the elasticity of demand should capture any increases in consumption as a result of decreasing prices in the I-502 market. In scenario 3 the elasticity of demand is set at -0.525.[34] The ten-year total for scenario 3 is $1.47 billion.[35]

Although the last three scenarios result in lower total revenue than the base case, there are also scenarios that result in a higher number. For example, suppose the medical market decreases by 10% annually, resulting in the elimination of the market by 2017, and the black market decreases by only 2% annually.[36] In this fourth scenario, the total ten-year revenue is $3.23 billion. If the black market instead decreases by 4% a year, then the revenues could be even higher at $3.93 billion over ten years.

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[32] The minimum for producers' selling price is $1.50

[33] In Scenario 2, the producers' selling price still decreases by $0.15 annually, with a minimum of $1.50.

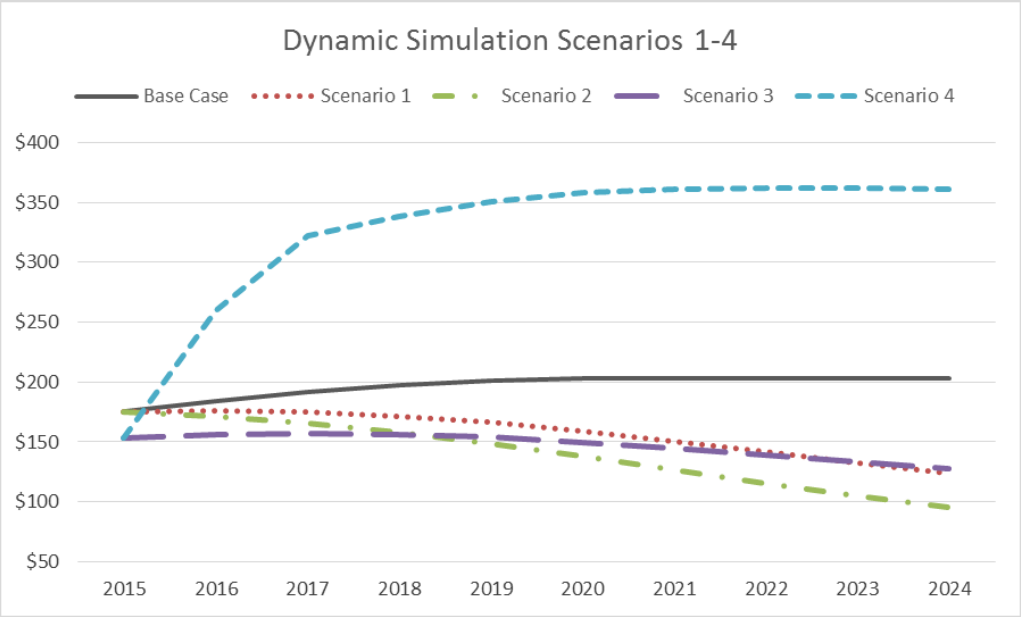
[34] In Scenario 3, the changes from Scenarios 1 and 2 are still present. The elasticity of demand will be set at -0.525 for all future scenarios.

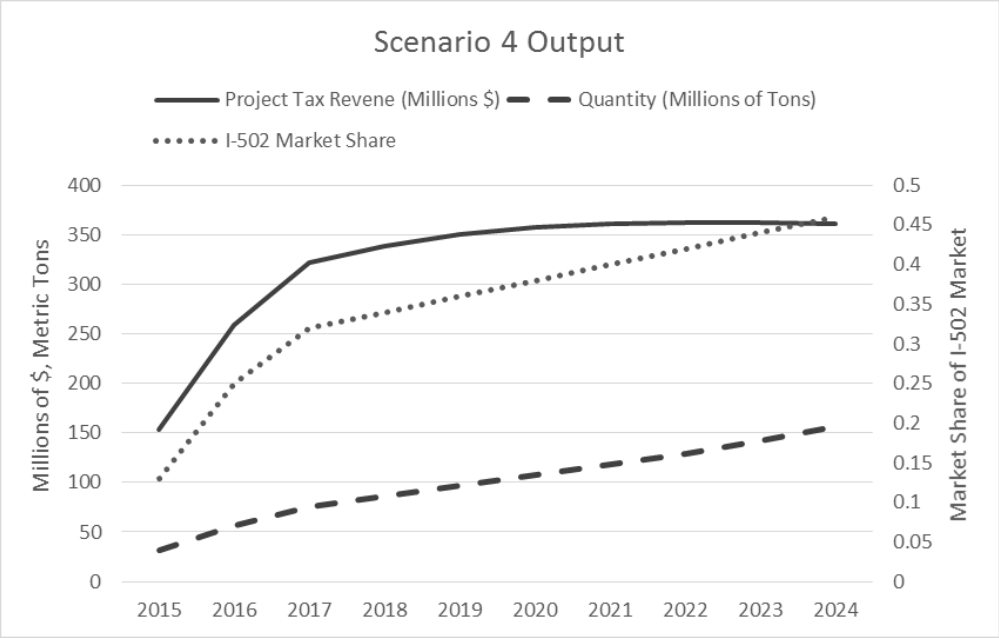
[35] It is interesting to compare Scenario 2 and 3. Scenario 2 has higher revenues from 2015 to 2018. But after 2018, the effects of including the elasticity can be seen, when the revenues from Scenario 3 are higher than Scenario 2. The total ten-year revenue is 5% higher for Scenario 3 when compared to Scenario 2.

[36] The 2% annual decrease in the black market share is driven by the average annual decrease in legal prices of 9%.

This fourth scenario includes both a decrease in the producers' selling price, which is shown in the tornado diagrams to be a key parameter of the model, and decreases in the medical and black market, making this scenario particularly interesting. Below is a graph that shows multiple outcomes for just this scenario. The projected tax revenues increases by 110% in two years, caused mainly by the decrease in the medical market. After 2017, I-502 prices are falling, so I-502 market share increases faster than the annual revenues. Although the market share is increasing, as does consumption in total, the fact that the producers' selling price is decreasing dampens the annual revenues.

Below we graph of the projected tax revenues for the four scenarios described, including the base case scenario, and a range of outcomes for the 4th scenario in particular.





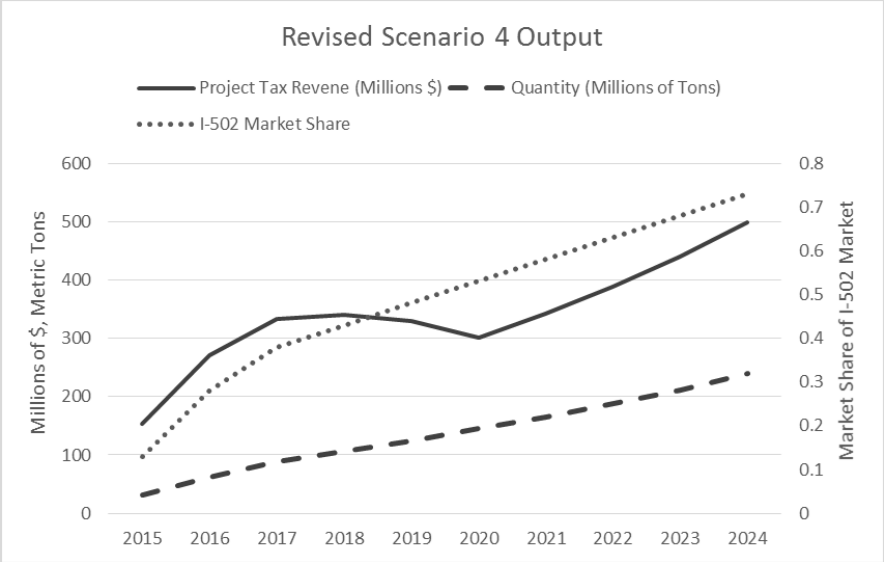
The scenarios above cut the producers' selling price to $1.65 over ten years, but it is possible prices could fall even farther. Even though $3 per gram seems to be the right parameters value for the typical modest-sized (e.g., 100 pounds per year) supplier to the medical market today, there are hints that substantially larger operations (1,000 or more pounds per year) might be able to achieve production costs as low as $1 per gram (Kilmer et al., 2010a), for example by leveraging expensive high-skilled labor with a greater number of less skilled and, hence, lower wage employees. So we consider a variant or alternate fourth scenario that cuts the producers' selling price to $1 over five years.[37] That would be consistent with the idea that low production costs are already technically possible, they just have not been achieved because the threat of enforcement has forced producers to remain small and, hence, relatively less efficient.

As before, we phase out the medical market after the first year, but in this alternate scenario we leave the markups constant in percentage terms. Just reducing the producers' selling price shrinks markups per gram because the fixed percentage markup is applied to a smaller base price. Shrinking the percentage markup in addition may not be realistic, as it would make markups per gram very small.

Also as in the original scenario #4, the black market's market share is decreased by 5% a year. That means the black market will continue to decrease in years 6 – 10 even though the I-502 prices bottom out in year 5. An argument for this is that consumer behavior can be slow to change, and some marijuana consumer purchasing in the black market may not convert over to the I-502 market immediately after the price falls.

The result, as show below, is sustained growth in I-502 market share and sales, but not in tax revenues. In years 3 – 5, prices – and hence taxes based on a percentage of value – have already come down, but market share has not yet achieved its final value.

[37] The producers' selling price decreases by $0.40 a year with a minimum of $1.00, which is reached by FY 2020. The elasticity is still set at -0.525.



The Possibility that Other States Will Legalize At Prices that Outcompete Washington

One threat to the revenue stream described in scenario 4 is that other states could legalize in more industry-friendly ways, producing cheaper marijuana, which others might smuggle into Washington State and sell to Washington residents untaxed. As the longstanding existence of the entire marijuana market before medical marijuana and I-502 attests, there is some willingness to break laws pertaining to marijuana supply and use. For that matter, as noted above, LaFaive and Nesbit (2010) estimate that a little over a third of cigarettes consumed in Washington evaded Washington state taxes.

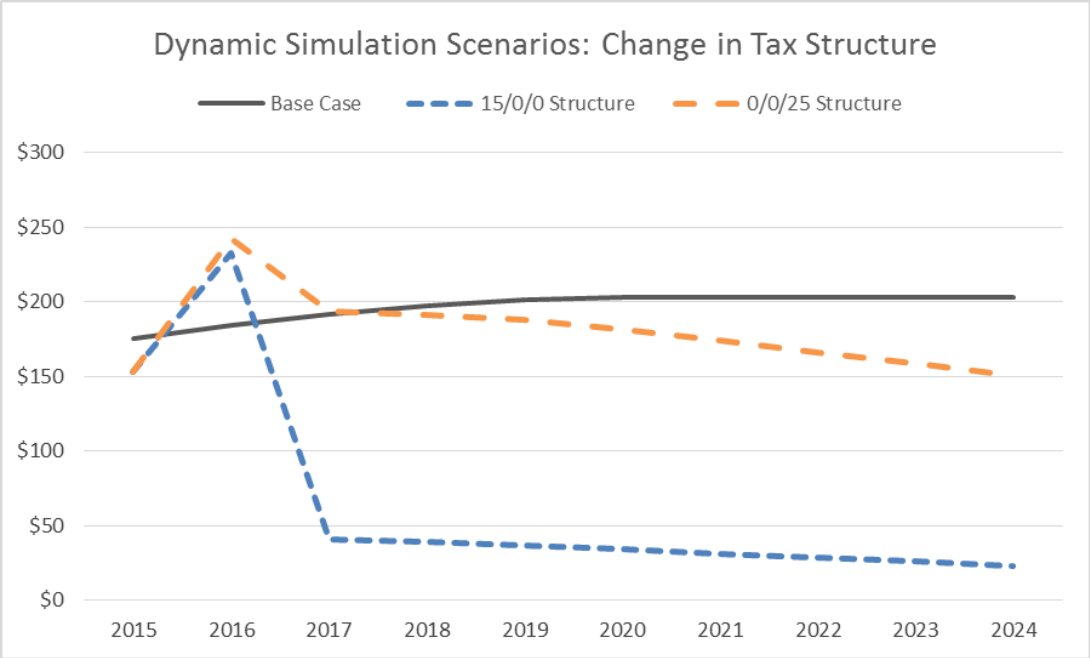
In scenario five, the total ten-year revenue is $1.46 billion, when there is a 5% annual increase in market share of marijuana coming in from other states. From 2015 to 2017 the revenues increase, but once other states export marijuana into Washington, the revenue decreases by an increasing rate.[38]

Change in Tax Structure

The final scenarios presented here show how a change in the tax structure can affect annual revenues. If other states are legalizing, as in scenario 5, it might make sense for Washington to relax its tax structure in order to reduce prices and become more competitive with other states, and with the black market.

[38] One could argue that other states, even if they legalize today, will not affect the Washington market until 2018, for example. That is where the functionality of the option to set the year the effect takes place comes into play. If we run this scenario again with the delayed affect starting in 2018, then the total ten-year revenue is $2.15 billion, but there is the same increase and then dramatic decrease in annual revenues.

In scenario 6, all the parameter changes will be kept from the previous scenarios, but the tax structure will change in 2017[39] and the black market decreases by 5% a year. The new tax structure is set at 15/0/0,similar to Section II(3). In this scenario, the total ten-year tax revenue is $646 million. Revenue increases until the change in the tax structure. If instead the tax structure is changed to 0/0/25 (scenario 7, there is still a decrease in revenues when the tax structure is changed, but with a less dramatic decline later. The graph below shows the results of the two different tax structures, in addition to the base case scenario.



Summary of Dynamic Scenarios

Below is a summary table and graph of the yearly and total ten-year revenue for the various dynamic scenarios presented above. It is important to remember that these numbers reflect only eight of the myriad possible scenarios that could be explored. One should use these scenarios as guides to generally understand the consequences of specific changes in the market. .

[39] This year was chosen because it is unlikely that that a change will be in place for the January – April 2014 legislative session. The next opportunity for the LCB to prose a change would be in early 2015, but maybe not until 2016. If it is approved in early 2016, it would affect fiscal year 2017.

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Appendix A. MEDICAL MARIJUANA PRICES

Individuals associated with the project visited several medical marijuana dispensaries and recorded the posted prices for their products. The table below lists prices advertised at Location #1 in northern Seattle. All useable marijuana was priced at $10 per gram because the owner thought it was "unfair" if someone had to pay $12 per gram for a strain to help with their ailment when someone else would only need to pay $8 per gram for the strain that helps them the most.

Location #1					
Type	Price	Weight	Type	Price	Weight
Useable Marijuana	$10	gram	Other		
Treats			Olive Oil	$15	small
Brownies	$5		Olive Oil	$20	large
Choice Snack Mix	$5		Peanut Butter	$16	
Pretzel Lover's Mix	$5		Honey	$20	
Granola	$5		Tea (2-pack)	$10	
Greenfish	$5		Bubble Hash	$30	gram
Cinnamon Sugar Almonds	$5		Rick Simpson Oil	$27	1/2 gram
Savord Almonds	$5		Rick Simpson Oil	$50	gram
Ice Cream	$8				
Topicals					
Migrane Balm	$5	large			
Arthritis Balm	$25	large			
Muscle Balm	$20	large			
Lip Balm	$7	stick			
Ultimate Lotion	$25	large			
Bath Soaks	$18				

Location #2 was a relatively small medical marijuana producer and retailer. This organization does differentiate prices by strain, and allows observation of quantity discounts. While the ½ oz price is usually just double the ¼ oz price, the 1 oz price is only 70% higher, on average, than the ½oz price.

Location #2					
	Gram	1/8 oz	1/4 oz	1/2 oz	1 oz
Indicas					
Skywalker	$ 12	$ 40	$ 80	$ 160	$270
Frosty Colada	$ 10	$ 35	$ 70	$ 140	$250
Midnight Bean	$ 10	$ 35	$ 70	$ 140	$250
Harlequin	$ 9	$ 30	$ 60	$ 120	$200
GDP	$ 12	$ 40	$ 80	$ 160	$270
Misty	$ 10	$ 35	$ 70	$ 140	$250
Afgooey	$ 10	$ 35	$ 70	$ 140	$250
Sativas					
Pineapple	$ 14	$ 49	$ 90	$ 175	$320
Diesel	$ 13	$ 45	$ 85	$ 170	$300
Sage	$ 10	$ 35	$ 70	$ 140	$250
Willie Nelson	$ 10	$ 35	$ 70	$ 140	$250
Jellibean	$ 10	$ 35	$ 70	$ 140	$250
Mr. Nice	$ 7	$ 20	$ 40	$ 80	$150
ATF	$ 7	$ 20	$ 40	$ 80	$150
Hybrids					
White Cloud	$ 12	$ 40	$ 80	$ 160	$270
Purple Erkle	$ 12	$ 40	$ 80	$ 160	$270
Obama	$ 12	$ 40	$ 80	$ 160	$270
Cripple Rhino	$ 10	$ 35	$ 70	$ 140	$240
Fortune Cookies	$ 9	$ 30	$ 60	$ 120	$200
Mani Purp	$ 9	$ 30	$ 60	$ 120	$200
Tahoe	$ 8	$ 25	$ 50	$ 100	$175
SFV OG	$ 7	$ 20	$ 40	$ 80	$150

Prices for extracts/concentrates, consumables and topicals are shown in the table below.

Location #2		
	Price	Weight
Extracts/Concentrates		
Maple Leaf Shatter	$ 30	1/2 g
Strawberry Diesel BHO	$ 30	1/2 g
Isopropel Oil	$ 30	100 mL
CO2 Oil	$ 40	50 mL
All Hash	$ 15	gram
	$100	1/4 oz
WAM Pens	$ 45	
Pen Refill	$ 50	
Gold Oil	$ 40	
Consumables		
Power Up Capsules	$ 40	30 count
Happy Cakes	$ 9	
Wownies	$ 6	
Peanut Bud 'R' Cups	$ 6	
Mini Brownies	$ 2	
Ganja Goop	$ 30	
Ganja Gobs	$ 6	
Leaded Sodas	$ 9	
Green Dragon Tincture	$ 25	
Dark Horse Capsules	$ 5	
Mary Jane Tincture	$ 40	
Doc Rupert's Snake Oil	$ 20	
Cold Stoned Ice Cream	$ 20	
Monkey Frog Ice Cream	$ 10	
Topicals		
Reefer Rub	$ 20	30 mL
	$ 40	100 mL
	$ 75	200 mL
Kush Cream (Triple Infused)	$ 20	
Kush Cream (Ice Hot)	$ 25	

Location #3 was a large (70-80 customers per day) dispensary with substantial investment in built infrastructure, e.g., for security. Below are selected prices at that location.

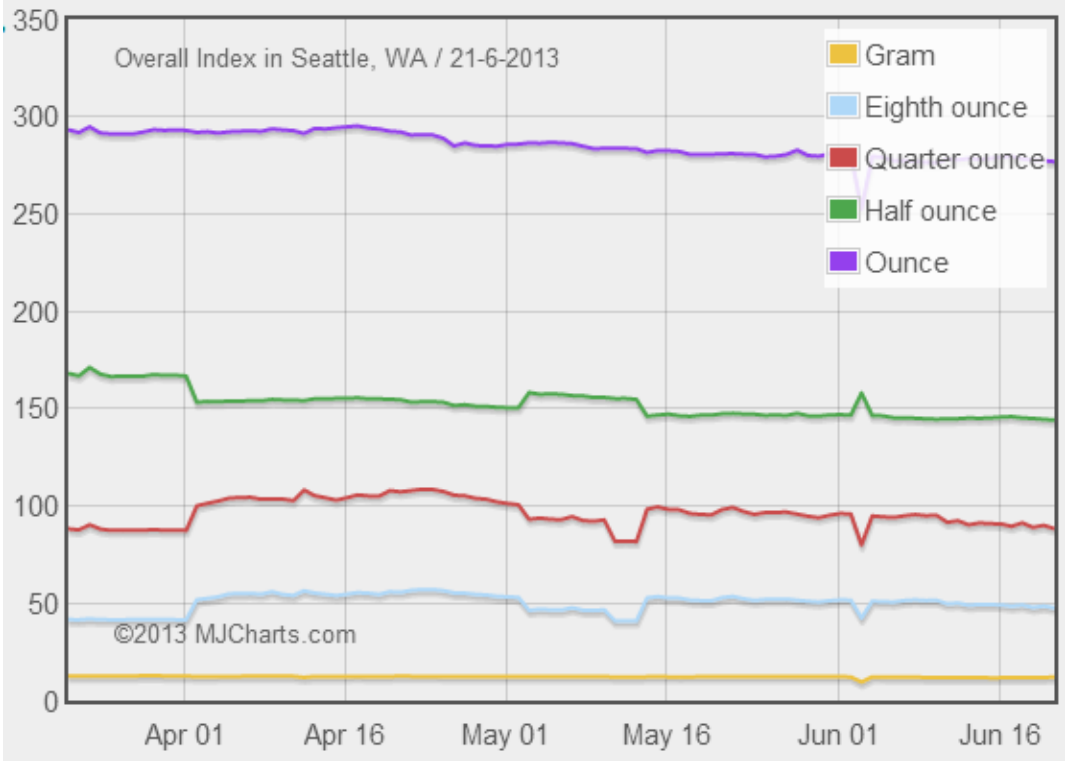
Location #3		
Type	Price	Weight
Lemon Kush	$12	gram
Blackberry Kush	$13	gram
Euphoria	$12	gram
Diesel Berry	$12	gram
Grape Romulan	$12	gram
Magic Touch	$8	gram
Blueberry Cheesecake	$15	gram
Lemon Kush	$12	gram
Sour Tsunami	$15	gram
Blue Cheese	$12	gram
Tangelo	$14	gram
Widows Peak	$12	gram
Space Jill	$12	gram
Harlequin	$10	gram
Maui Waui	$12	gram
Tangerine Dream	$12	gram
God Bud	$30	an eighth
iHit Cartridge	$50	
Kief	$25	

Location #4 is a large indoor collective garden, which acts as a producer and processor of useable marijuana and sells directly to access points. The table below shows prices based on how much marijuana is being purchased. If an access points buys between 15-20 kg, then the prices are reduced by $100 per half pound. The price also varies on the grade of the marijuana.

Location #4					
	Grade	**Donation Rate**	**Donation Rate/g**	**MSRP**	**Access Point**
Standard	A Grade	$ 1,400	$ 6.22	$ 13.00	109.00%
	B Grade	$ 1,300	$ 5.78	$ 12.00	107.61%
	C Grade	$ 1,200	$ 5.33	$ 11.00	106.38%
Silver (10 kg)	A Grade	$ 1,350	$ 6.00	$ 13.00	116.67%
	B Grade	$ 1,250	$ 5.56	$ 12.00	115.83%
	C Grade	$ 1,150	$ 5.11	$ 11.00	115.26%
Gold (15 kg)	A Grade	$ 1,300	$ 5.78	$ 13.00	124.91%
	B Grade	$ 1,200	$ 5.33	$ 12.00	125.14%
	C Grade	$ 1,100	$ 4.89	$ 11.00	124.95%
Platinum (20 kg)	A Grade	$ 1,250	$ 5.56	$ 13.00	133.81%
	B Grade	$ 1,150	$ 5.11	$ 12.00	134.83%
	C Grade	$ 1,050	$ 4.67	$ 11.00	135.55%

Grade A	Grade B	Grade C
Blueberry Cheesecake	Grand Daddy Purple	Afgooey
Dutch Treat	Headband	Blueberry Mr. Nice Guy
Fire OG	Infinite Euphoria	Harlequin
Jesus	Island Sweet Skunk	Sage
Sour Tsunami #3	Lemon Kush	Sweet Afgoo Delicious
Tangelo	Maui Wowie	Thai Cinderella
The White	Pineapple Thai	

In addition to these direct observations, CannabisPriceIndex.com is a website that develops a price index for useable marijuana and infused products. The site claims the indices are based on public advertisements, implying that the prices are from medical marijuana dispensaries, but we are unable to document or audit their data collection and analysis methods. Prices are given for Seattle, not the state . Below is the graph of the last 90 days (the total number of days provided) for various quantities.



Eyeballing the graph suggests average prices roughly as follows.

Cannabis Price Index	
Gram	$12
1/8 oz	$50
1/4 oz	$90
1/2 oz	$145
1 oz	$280

References

CannabisPriceIndex.com. “Overall Index in Seattle, Washington." Web. 21 June 2013. <http://www.cannabispriceindex.com/charts/seattle-wa/overall-index/>.

Appendix B. INFORMATION FROM LAW ENFORCEMENT ABOUT BLACK MARKET MARIJUANA PRICES

Law enforcement officials from Washington State provided us with the (black market) prices of marijuana based on their experience. Sergeant Mark Hazard from the Seattle Police Narcotics Section, Squad B, provided information about Seattle, and Detective Sergeant Chris Coglizer from the Skagit County Interlocal Drug Enforcement Unit provided the rest of the information.

County/City	1 gram	1 ounce	1/4 pound	1/2 pound	1 pound
Bellingham	$10				$2,400
Grant	$10	$250-300	$800-1,000	$1,600-1,800	$2,500-3,000
Olympia	$8-15				
Seattle	$10	$250-350			$1,500-3,000
Skagit		$180-220	$500-650	$1,000-1,200	$2,200
Spokane		$240-280			$2,400-2,800
Whitman	$15-20	$220	$650	$1,200	$2,400
Yakima		$250-300	$500-700	$1,500-2,000	$2,500-3,500
Source: Coglizer, Hazard					

There is variation in prices across these eight locations. Below are some descriptive statistics concerning that cross-sectional variation. If there is a range for a specific weight and location, the average of the range is taken before calculating the median and overall average for the weight.

Statistics	1 gram	1 ounce	1/4 pound	1/2 pound	1 pound
Min	$ 8	$ 180	$ 500	$ 1,000	$ 1,500
Median	$ 10	$ 268	$ 625	$ 1,450	$ 2,400
Average	$ 12	$ 255	$ 681	$ 1,438	$ 2,514
Max	$ 20	$ 350	$ 1,000	$ 2,000	$ 3,500

The price per gram at each purchase size shows the discounts that sellers provide to customers buying large quantities. There is a general trend towards cheaper prices per ounce when larger quantities are purchased. However, in some cases the quoted prices suggest minimal, if any, quantity discounts. For example in Grant County the per gram price range for an ounce is $8.80 to $10.60 while the gram price is only $10. It seems odd that people would pay $10.60 per gram when buying an ounce if it is cheaper to buy 28 one-gram packages separately, suggesting that perhaps there are quality differences between the sorts of marijuana typically purchased a gram at a time as opposed to that which is customarily purchased in ounces.

Price Per Gram Based on Purchase Amount					
County/City	1 gram	1 ounce	1/4 pound	1/2 pound	1 pound
Bellingham	$10				$5.30
Grant	$10	$8.80-10.60	$7.05-8.80	$7.05-7.95	$5.50-6.60
Olympia	$8-15				
Seattle	$10	$8.82-12.35			$3.30-6.60
Skagit		$6.35-7.75	$4.40-5.70	$4.40-5.30	$4.85
Spokane		$8.45-9.90			$5.30-6.20
Whitman	$15-20	$7.75	$5.70	$5.30	$5.30
Yakima		$8.80-10.60	$4.40-6.20	$6.60-8.80	$5.50-7.70

References

Coglizer, Chris. Detective Sergeant at the Skagit County Interlocal Drug Enforcement Unit. 5 June 2013. Personal Communication.

Hazard, Mark. Sergeant at the Seattle Police Narcotics Section, Squad B. 30 May 2013. Personal Communication.

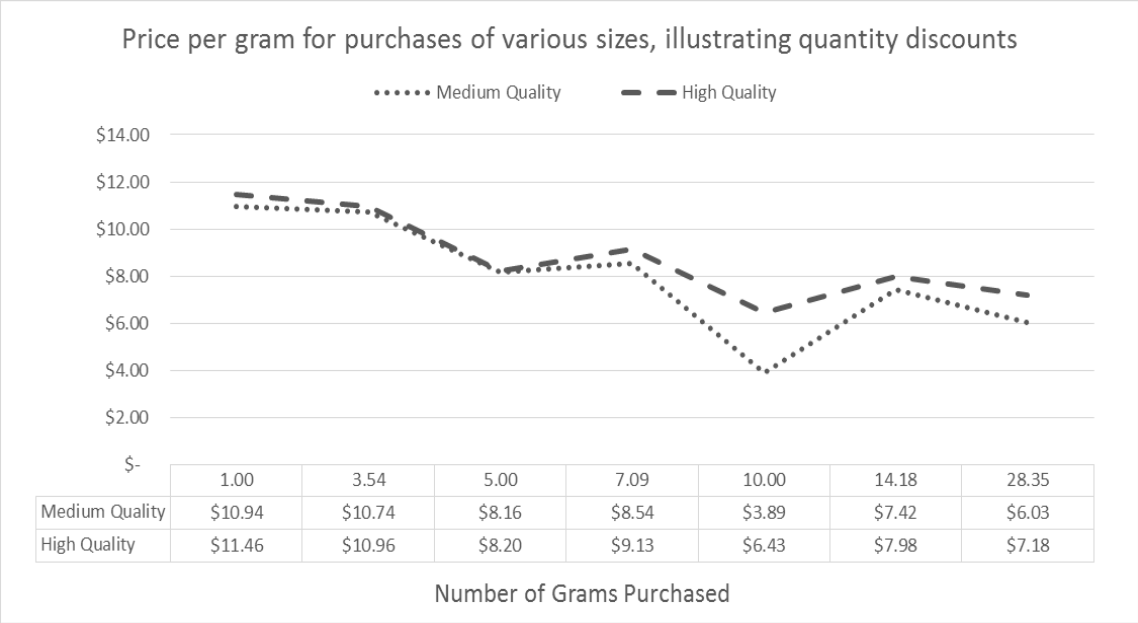
Appendix C: PRICE OF WEED DATA

C. 1 Introduction

PriceOfWeed.com is a crowdsourcing website that allows the public to enter the price, quantity, quality, and location of their marijuana purchases. We downloaded a year's worth of observations (May 2012-May 2013) from the site for Washington State, resulting in 2,116 observations.

Each observation includes the location of the purchase, price, weight (1 gram, 10 grams, half an ounce, etc.), quality (low, medium, high), and date. Thirty-six of Washington State's 39 counties are represented, with the greatest number of observations in King County (location of Seattle), Pierce (just south of King County), and Snohomish (just north of King County). Just over half (52%) of the purchases were of an ounce of marijuana. Almost all observations were described as being of medium quality (50.5% of the observations) or high quality (46.9%); we do little analysis with the relative handful described as being of low quality (54 observations or 2.6% of the data).

Not surprisingly, prices are generally higher for high quality marijuana, and lower per unit weight when buying larger quantities.



	1.00	3.54	5.00	7.09	10.00	14.18	28.35
Medium Quality	$10.94	$10.74	$8.16	$8.54	$3.89	$7.42	$6.03
High Quality	$11.46	$10.96	$8.20	$9.13	$6.43	$7.98	$7.18

After I-502 passed, there were more reports, but no significant changes in price or composition of high and medium quality marijuana. There were also no significant differences between eastern and western parts of the state in reported price or quality.

C. 2 Data Cleaning

The quality of these data is suspect, because one could report prices in Washington State when actually living in Florida or, for that matter, submit entirely fictitious reports. Hence, we attempted to delete suspicious observations. Sixteen of the 2,116 observations were deleted at the outset:

- 1 deleted because city was in Oregon
- 15 deleted because the price given was $0

The greater challenge was deciding which additional observations are sufficiently implausible that they should also be removed before analysis. For example, there were four different observations claiming to have purchased an ounce of medium quality marijuana for $1, which is only about 1% of the average price. It seems likely that such observations are typos (person meant to type $100), gags, or the result of transactions among friends rather than a typical dealer-client relationship.

These data do not show enormous variation in prices around the state. For example, Table 1 gives the median price and 1st and 3rd quartiles for an ounce of marijuana for all medium and high quality observations in King, Pierce, and Snohomish Counties and for the rest of the state in aggregate. Since the disparities are not large, we identified outliers by comparing suspect observations to prices seen in the state overall, not in individual jurisdictions.

Table 1:

	Median	1st quartile	3rd quartile
King	$ 200	$ 100	$ 250
Pierce	$ 175	$ 129	$ 200
Snohomish	$ 200	$ 100	$ 240
Rest of State	$ 190	$ 100	$ 220

The basic strategy used was to compute the mean and standard deviation of price for groupings based on quantity and quality. This information is provided below in Tables 2 and 3, along with the number of observations in each of the 30 categories for the 2,100 remaining data points.

Table 2:

PRICE	Weight (in grams)	Low Quality		Medium Quality		High Quality	
		Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
gram	1.00	$ 15.00	$ 7.07	$ 12.60	$ 5.71	$ 15.15	$ 13.75
eighth	3.54	$ 30.00	$ 11.18	$ 37.22	$ 10.38	$ 59.33	$ 127.53
5 grams	5.00	$ 38.50	$ 24.27	$ 41.47	$ 18.79	$ 47.47	$ 26.78
quarter	7.09	$ 70.00	$ -	$ 72.87	$ 100.25	$ 101.80	$ 166.63
10 grams	10.00	$ 55.00	$ 63.64	$ 46.25	$ 42.10	$ 79.86	$ 91.76
half ounce	14.18	$ 21.25	$ 13.15	$ 110.65	$ 51.14	$ 115.49	$ 42.27
15 grams	15.00	$ 30.00	$ -	$ 46.60	$ 40.49	$ 20.71	$ 1.89
20 grams	20.00	$ 20.00	$ -	$ 24.66	$ 16.47	$ 45.24	$ 53.37
25 grams	25.00	N/A	N/A	$ 85.00	$ 121.14	$ 260.00	$ 339.41
ounce	28.35	$ 120.83	$ 125.55	$ 154.27	$ 121.21	$ 209.89	$ 111.55

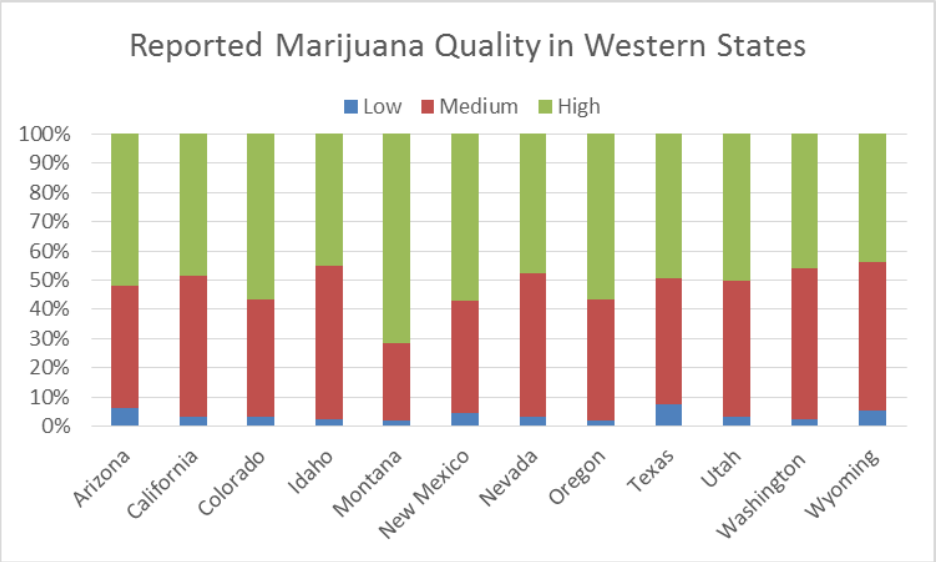
Table 3:

Count of Observations	Low Quality	Medium Quality	High Quality
gram	2	20	26
eighth	7	130	102
5 grams	10	107	77
quarter	1	87	79
10 grams	2	40	28
half ounce	4	107	84
15 grams	1	15	7
20 grams	3	29	21
25 grams	0	5	2
ounce	24	521	559
TOTAL	54	1061	985
%	2.6%	50.5%	46.9%

We did not further analyze the seven 25-gram purchase observations or the 54 observations of low quality marijuana because there are so few such data points.

The paucity of low quality observations is not unique to Washington State. As Graph 4 shows, none of the western states had many observations described as "low quality," and the greatest numbers seemed to come predominantly in states along the Southwest Border. For example, Oregon and California have a comparably small number of low quality observations at 3.2% and 2.2%, respectively.

Graph 4:



We eliminated values that are not within two standard deviations of the mean price for each of the remaining 18 categories, which left 1,851 observations.

We then recalculated the standard deviations and means and again eliminated observations outside of two standard deviations. After this third round of eliminations, 1,759 data points remained. Graph 5 shows the price per gram based on the number of grams purchased. There is a general downward trend, which makes sense; as purchase size increases, the buyer gets a discount and pays less per gram. In these data, the prices per gram for 15 and 20-gram purchases are extremely low, nearing $1 per gram. It is unclear why prices for these weights should be so unusual, so those transactions sizes are omitted from further analysis.

Graph 5:

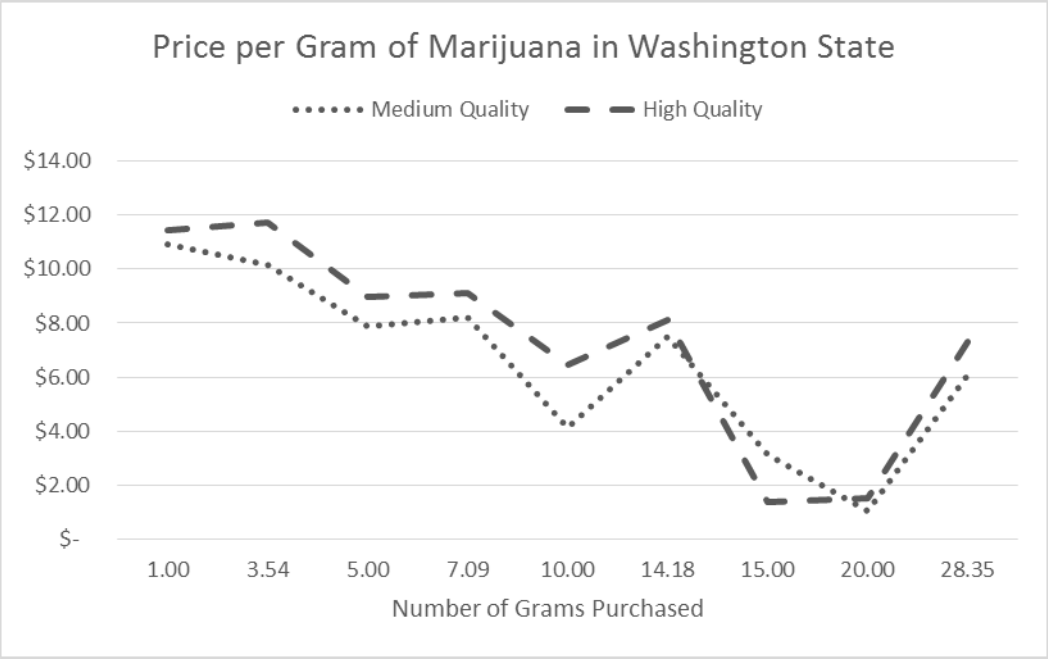


Table 6 describes the remaining, final 1,694 observations.

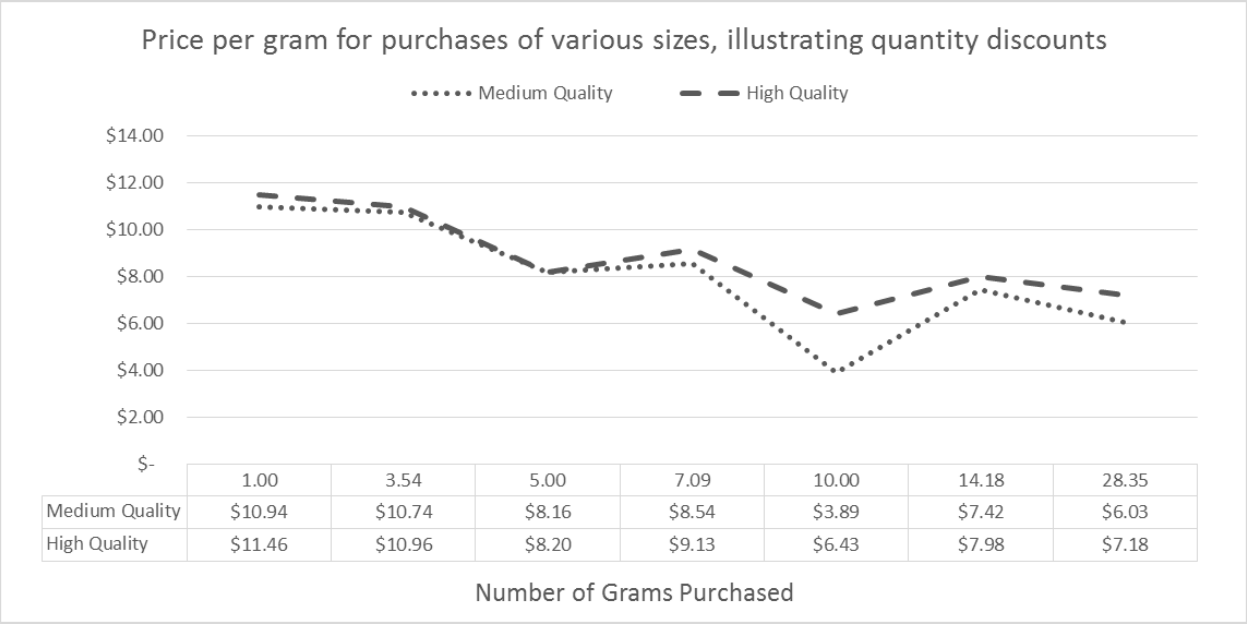
Table 6:

	Weight (in grams)	Medium Quality			High Quality		
		Mean	Std. Dev.	Obs.	Mean	Std. Dev.	Obs.
a gram	1.00	$ 10.41	$ 1.28	17	$ 10.24	$ 1.37	21
an eighth	3.54	$ 38.06	$ 5.44	109	$ 38.85	$ 9.12	94
5 grams	5.00	$ 40.78	$ 14.40	99	$ 41.00	$ 16.63	70
a quarter	7.09	$ 60.56	$ 19.04	81	$ 64.71	$ 15.40	70
10 grams	10.00	$ 38.92	$ 34.22	37	$ 64.30	$ 41.27	27
a half ounce	14.18	$ 105.16	$ 27.61	94	$ 113.18	$ 19.79	71
an ounce	28.35	$ 171.08	$ 70.15	415	$ 203.55	$ 58.66	489

C. 3 Price and Quality of Marijuana in Washington State

Graph 7 shows how the quantity purchased effects the price per gram. There is a general downward trend in prices, implying quantity discounts.

Graph 7:



	1.00	3.54	5.00	7.09	10.00	14.18	28.35
Medium Quality	$10.94	$10.74	$8.16	$8.54	$3.89	$7.42	$6.03
High Quality	$11.46	$10.96	$8.20	$9.13	$6.43	$7.98	$7.18

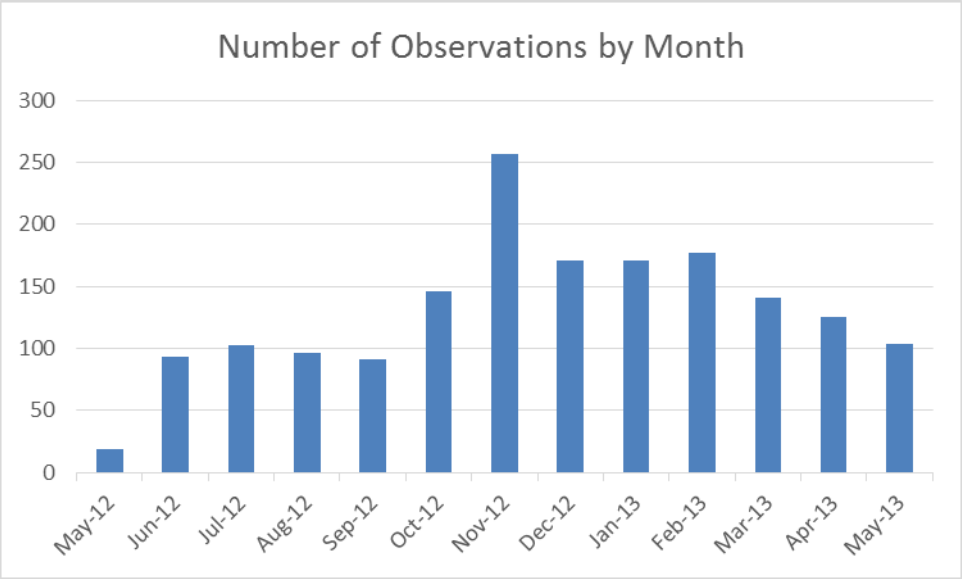
There is only a modest difference in the price based on the reported quality of the marijuana. Of course, the reports about quality are subjective. Since marijuana affects people in so many different ways, one strain may be rated as high quality by one person and as medium quality by another. The price difference between high and medium quality are consistent, except for 10 grams. For every other purchase size, the prices are quite similar, with the price for high quality being on average only 7% more than for medium quality. By contrast, the high quality costs 65% more than the medium quality for 10 grams. It is unclear why the difference is so great for 10 grams, but data from 15 and 20 grams was eliminated based on the fact the observations did not make sense. All of these problems were with the gram data, versus the half an ounce, ounce, etc. data; perhaps buying in ounce denominations is more common, so reports in grams are less reliable.

Effects of I-502

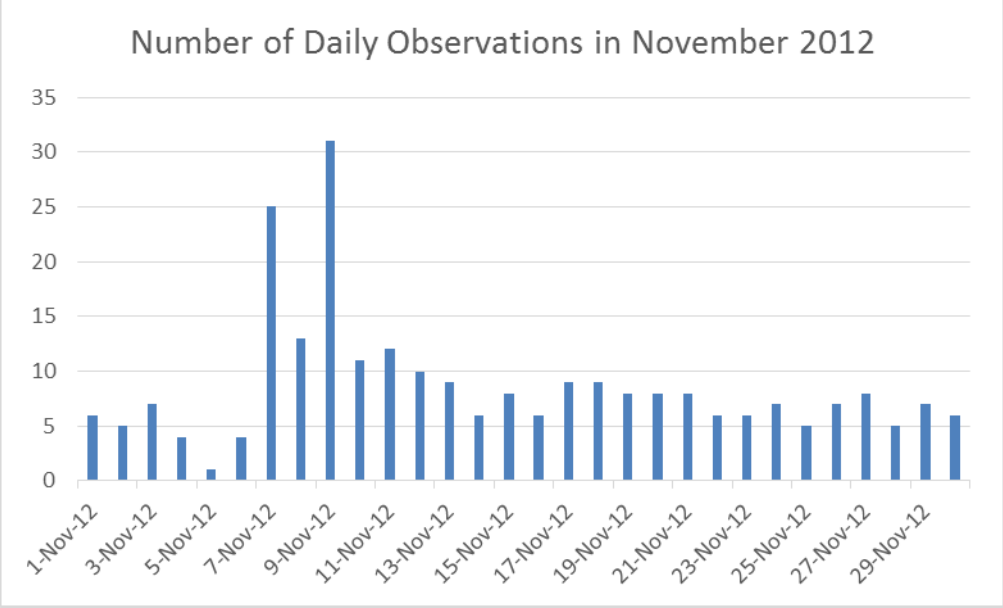
The data straddle the date when I-502 passed in November 2012. Graph 8 below shows the number of observations by month. The number of observations in November is nearly three times the average of 91 observations for the previous months. After November, the average number of observations from December 2012 through May 2013 is 148. (There is a possibility that there was a similar jump in surrounding states, but that has yet to be analyzed.)

Graph 9 shows the number of daily observations in November 2012. On the day of the election, November 6, there were only four observations. On November 7, there were 25. Either more people were purchasing the day after it passed, or more people were willing to report online.

Graph 8:



Graph 9:



There were not comparably dramatic differences in price or quality before and after I-502 passed.[40] Before I-502 the average price was $123, while the average price after was $129. As for the quality, high quality observations made up 50.9% of the observations before I-502, and 49.9% after I-502. Overall, there is not a statistically significant difference in terms of price or quality before and after I-502.

Differences Between Eastern and Westerns Parts of Washington

There are major differences in socio-demographics and marijuana use between the eastern and western parts of the state. Each side of the state also has a different U.S. Attorney, with the eastern one seen as stricter with respect to marijuana enforcement. This raises the question of whether there are significant differences between the two sides of the state in price and quality as reflected in PriceofWeed data.

Table 10 shows prices based on location as well as quality. There are four times as many observations in the west, but that is not altogether surprising as eastern Washington has one-third the population of the west. The high quality marijuana costs more in the east, but only $6 more on average for all quantities, whereas medium quality marijuana is less expensive in the east. One possible explanation – assuming the medium quality marijuana is outdoor grown – is that marijuana is cheaper closer to where it is grown, since outdoor growing is concentrated in the east, whereas the west typically grows indoor, higher quality marijuana. However, the prices are highly variable, and by a Student's t-Test, the difference are not statistically significant.

Table 10:

		East (n=315)	West (n=1,379)
High Quality	1st quartile	$ 98	$ 55
	Median	$ 156	$ 150
	3rd quartile	$ 200	$ 200
Medium Quality	1st quartile	$ 40	$ 50
	Median	$ 70	$ 100
	3rd quartile	$ 160	$ 181

C. 4 Conclusions

These data are not of the highest quality because of the self-reporting nature of PriceOfWeed.com, but we tentatively draw three conclusions about marijuana prices in Washington State.

1. There is evidence of pricing discounts when a higher quantity is purchased.
2. There is no evidence that I-502's passage had an immediate effect on prices.

[40] Data from 5/25/2012 to 11/6/2012 are considered "before" and data from 11/7/2012 to 5/24/2013 are considered "after".

3. There is little evidence of significant difference between the market in the eastern versus western half of the state.

References

PriceOfWeed.com. “Washington Weed Prices." 2013. 29 May 2013. < http://www.priceofweed.com/prices/United-States/Washington.html>.