Benefit-Cost Analysis of Initiative 502: Legalization of Marijuana in Washington

1. ABSTRACT

This benefit-cost analysis attempts to estimate the total value to Washington State of Initiative 502 (I-502), the legalization of marijuana. The law is globally unprecedented. Previously, marijuana has only been decriminalized or depenalized in a select few locations throughout the world. The paper begins by conducting an analysis of the current market for marijuana and estimating how demand will change after implementation of I-502. The paper considers how a legal, regulated market will compete with the current illegal market and produce tax revenue for the State of Washington. The analysis develops cost estimates and ranges for numerous categories to assess the breadth and uncertainty surrounding such an unprecedented societal change. Economic benefits include conversion of current black market risk to tax revenue and a reduction in justice system costs from no longer enforcing marijuana misdemeanor laws. Economic costs include the governmental cost of creating and implementing a regulatory structure and the impact of increased marijuana use on health costs and people driving under the influence of marijuana. Any existing effects of marijuana use that do not change as a result of legalization are beyond the scope of analysis. The analysis concludes that implementation of Initiative 502 will result in a net (total) present value of $2 billion (in 2012 dollars) for Washington State over the first six years of implementation (December 2012-December 2018). The paper concludes with a set of recommendations for Washington State to ensure the successful implementation of a regulatory structure and viable legal marijuana marketplace.

2. INTRODUCTION

On November 6, 2012, Washington State voters approved Initiative 502 (I-502) to legalize marijuana for recreational purposes. I-502 aims to shift non-medical marijuana out of the black market and into a state-sanctioned, regulate-and-tax model. In this benefit-cost analysis (BCA), we attempt to estimate and monetize the impact of this initiative on Washington State and its residents. The standing of this BCA is thus the entire state of Washington. We predominantly focus on three major tenants of the new law (I-502, 2011):

1. Depenalization: Starting with the new law’s implementation on December 6, 2012, it will no longer be a violation of Washington State law for persons 21 years of age and older to possess up to one ounce of usable marijuana.¹
2. Legalization: By December 1, 2013, the Washington State Liquor Control Board (WSLCB) must establish rules for the production, processing, and selling of marijuana, all of which activities will be subject to taxation.

3. Driving Under Influence (DUI): While driving under the influence of an intoxicating drug is already illegal under Washington State law, the initiative adds a new threshold for determining marijuana intoxication for DUI offenses, based on THC (the psychoactive component of marijuana) blood concentration.

In addition, the initiative contains a mandate for the WSLCB to consider the goal of discouraging purchases from the illegal market as the board develops the regulations. The initiative also requires the WSLCB to make regular reviews and recommendations to the Washington State legislature for adjusting tax levels to “further the goal of discouraging use while undercutting illegal market prices” (I-502, p. Sec 27.5). We thus assume that the initially established tax levels (25 percent on the value of each transaction among producers, processors, and retailers) meet this stated goal, which informs many of our assumptions about price, changes in usage, and the effects of both.

2.1 Depenalization versus Legalization

Many European countries and some US states have decriminalized or depenalized marijuana, defined generally as substantial reduction or removal of penalties for possession, usually of small amounts intended for personal use, while sale and production remains illegal (MacCoun & Reuter, 2001). However, this initiative (along with Colorado’s concurrent Amendment 64) is the first attempt in modern history to accomplish comprehensive depenalization and legalization of marijuana, which consists of regulated production and sales, similar to the manner in which alcohol is regulated in America (MacCoun & Reuter, 2001). Therefore, while there is empirical evidence and research providing plausible estimates of the effects of depenalization, there is no clear precedent for legalization. However, many researchers attempt to predict legalization’s effects, and we use these predictions to guide our analysis.

2.2 Federal Law

Despite the passing of Washington’s Initiative 502, marijuana remains an illegal substance in all its forms under federal law as a result of being classified as a Schedule I drug in the Controlled Substances Act of 1970 (Controlled Substances Act, 1970). Our analysis assumes I-502 will be implemented as passed by Washington voters and without federal interference. Our client is the Washington State Attorney General’s office, who can perhaps use this benefit-cost analysis as a tool to inform discussions with federal officials or to inform Washington State’s response to any federal challenges. It may also be informative to federal lawmakers considering changes to federal marijuana policy and to voters and lawmakers considering similar legislation in other states.

2.3 Medical Marijuana Market

Initiative 502 has no effect on existing medical marijuana laws in the State of Washington (DOH, 2012). Medical marijuana laws in Washington State allow patients over 18 years of age, with qualifying medical conditions, to cultivate their own marijuana or participate in small, collective grow operations (DOH, 2012). While medical marijuana dispensaries (small retail outlets that cater to medical marijuana patients) currently operate in Washington State, such dispensaries are not explicitly allowed by Washington State law (DOH, 2012). It is reasonable to assume that any existing medical marijuana dispensaries, operating with questionable legality, will shift their operations to the legalized market, which will bring them into legal compliance and also allow them to widen their customer base to include recreational users. There will surely be some medical marijuana patients who will begin or continue to cultivate their own marijuana. We assume, however, that the number of these users is not large enough to impact our analysis of the legalized market. Since Washington State does not require medical marijuana patients to register with the state, there is no readily available information regarding the number of patients who will continue to cultivate their own medical marijuana. We assume that current usage and growth estimates do not include these patients.

3 Market Analysis

3.1 Current Market

Currently marijuana is bought and sold in the black market. While medicinal marijuana has been legal for many years in Washington State, this has not eliminated the illegal drug trade. Not all individuals who wish to purchase marijuana can or choose to obtain a medical license. Because there is no precedent for a legal market anywhere worldwide, obtaining accurate information about supply and demand is difficult. The Washington State Office of Financial Management (OFM) estimated the current supply and demand of marijuana for the fiscal analysis of this initiative. We reviewed their analysis and compared it to other research we found in academic literature. This section describes the assumptions we made regarding supply and demand in the current market.

3.1.1 Current Demand

The OFM referenced US Department of Health survey data for Washington State to estimate that there are approximately 363,000 marijuana users in Washington State in 2013 (OFM, 2012). Further, the OFM consulted a 2006 United Nations (UN) Office on Drug and Crime report to determine frequency of consumption of users (OFM, 2012). The UN report estimated individuals consume 0.15 grams to 0.5 grams, depending on frequency of use. However, the OFM assumed all users consume two grams of marijuana per use. It is unclear why the OFM chose two grams, so we chose to calculate a range of total consumption using data directly from the UN report as the low end, and the OFM’s two grams as the high end (see Appendix, 15.13). In addition, in reproducing OFM’s calculations, we found a slight discrepancy in the total grams consumed, so we used our reproduction of the OFM calculations as the high end (72 million grams). Using the average of this range, we estimate current marijuana consumption in Washington State to be approximately 43 million grams per year in 2013.

3.1.2 Current Supply

The current price of medicinal marijuana is $12 per gram (OFM, 2012). This price is largely consistent with the black market price, which appears to range from $8-$12 per gram depending on quality and amount purchased. Since the black market price varies and is ultimately unknown, we are assuming that the black market equilibrium price is
at or below the price of medical marijuana. The selling price of marijuana is much higher than the cost to produce marijuana because it is an illegal good. Producers currently take on a heavy burden of risk by participating in the illegal market, and that risk is remunerated or “priced into” the final selling price. The OFM anticipates that producers will sell their product to processors for $3 per gram and processors will sell their product to retailers for $6 per gram, which provides some indication of the marginal cost of production (MCP), or the cost to produce one additional gram. It is difficult to predict the exact MCP of marijuana in the legal market, but we estimate it to be constant and between these two values at $5 per gram. We assume a linear supply curve reflective of the constant MCP.

3.1.3 Elasticity of Demand

We reviewed several journal articles to estimate the elasticity of demand (Mauer, 2006) (Becker, Murphy, & Grossman, 2004). As these estimates were all quite similar, we selected the estimate that we felt was best researched and also represented an average of the other ranges that we reviewed. For this reason, we used demand elasticity of -0.857, or for every percentage increase in selling price, quantity demanded will decrease 0.857 percent.

3.1.4 Current Market Summary

These data suggest that the pre-legalization market has the following consumer surplus, costs associated with risk, and resulting deadweight loss (DWL):  

<table>
<thead>
<tr>
<th>Consumer Surplus</th>
<th>Cost of Risk</th>
<th>Deadweight Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>$301,000,000</td>
<td>$301,000,000</td>
<td>$75,000,000</td>
</tr>
</tbody>
</table>

Consumer surplus represents the total difference between the selling price and the price consumers are willing to pay, totaled among all consumers in the market. Consumer surplus provides a measure of utility, or benefit, gained by consumers who purchase goods at the retail price. Deadweight loss represents the foregone utility that results from a selling price that is above the natural market equilibrium price (or in our case, a selling price that is above MCP).

3.2 Impact of Legalization on Supply & Demand

Because I-502 mandates that Washington State strive to minimize marijuana use while eliminating the illegal market, we expect the state will use taxation to keep the equilibrium price consistent with today’s black market price. Using taxation in this way will effectively replace the existing cost of risk with new taxes and fees. This approach serves two purposes. First, it generates a large amount of tax revenue for the state, which was one of the benefits advertised to voters. Second, maintaining the current market price helps to ensure the legal market will outcompete the black market while also reducing the increase in grams consumed (i.e. movement downward along the demand curve).^6

Assuming existing risk is eliminated and becomes government revenue in this new market, we consider this conversion a complete net benefit of I-502. However, tax revenue from new consumption (consumption that would not take place without I-502) is simply a transfer from Washington residents to the government, and thus we do not include that revenue as a net benefit.^7

3.2.1 Predicting How the Market Will Change

There is no convincing evidence that simply decriminalizing or depenalizing marijuana results in increased consumption. However, multiple researchers share the prediction that a fully legalized market will see at least some increase in consumption (MacCoun & Reuter, 2001). One can imagine that once the legal market is established, consumption will increase as the retail arena becomes more accessible and begins offering a wide array of consumable forms of marijuana. While the loss of marijuana’s appeal as a “forbidden fruit” may reduce its consumption, eliminating the legal deterrent and reducing the cultural stigma of participating in what was previously an illegal activity could more than outweigh this effect. We thus believe there will be a change in consumer preferences in the form of new entrants into the market and increased consumption, but it is difficult to predict the magnitude of such a shift.

3.2.3 New Demand Function

As previously discussed, we could find no historical evidence to aid in predicting the outward shift of the demand curve. No other state or country has previously modeled legalization. However, we do believe that consumption will increase, so we assumed a 20 percent increase in total consumption. Based on this analysis, the new quantity demanded would be 52,800,000 grams sold at a post-tax, equilibrium price of $12 (see Figure 1).

Figure 1 Market for marijuana before (left) and after (right) legalization

3.2.3 Legal Market Summary

Consumer surplus would increase slightly in this expanded market (the area between the demand curve and the market price). Tax revenue would include a) the taxes and fees that replace the black market risk of current consumption (as discussed in 3.2) and b) the taxes on new consumption. The current deadweight loss (DWL) associated with

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risk would remain the same; however, it would now be the DWL associated with taxes and fees. The legal market would incur a marginal excess tax burden (METB) of $0.21 per dollar of tax revenue raised.

<table>
<thead>
<tr>
<th>Consumer Surplus</th>
<th>Tax Revenue</th>
<th>Deadweight Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>$434,000,000</td>
<td>$370,000,000</td>
<td>$75,000,000</td>
</tr>
</tbody>
</table>

### 3.3 Summary
The following table summarizes the changes in surplus and deadweight loss that will occur in the market when marijuana transitions from a black market product to a legally taxed and regulated market. The increases in consumer and producer surpluses are net benefits. As discussed previously, we only count the portion of the tax revenue that is replacing risk (based on pre-legalization consumption patterns) as a net benefit.

<table>
<thead>
<tr>
<th>Status Quo</th>
<th>Risk</th>
<th>Tax Revenue</th>
<th>Dead Weight Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>$301,000,000</td>
<td>$301,000,000</td>
<td>$75,000,000</td>
<td></td>
</tr>
</tbody>
</table>

#### 4 Fiscal Impact
In the 2012 General Election Voters’ Guide, the OFM presented a five-year fiscal impact analysis, which included all revenue and public agency costs related to the initiative at the state and local levels (OFM, 2012). (The analysis did not include any social or economic benefits or costs.) In the calculation of the net present value of the initiative, we used OFM’s projections as a guideline for determining the fiscal benefits and costs.

#### 4.1 Fiscal Benefits
Legalization of marijuana will allow the State of Washington to tax all sales of the drug at each level of the supply chain; therefore the demand for marijuana is a key factor affecting the fiscal benefits of the initiative. Producers, processors, and retailers will each experience a 25 percent excise tax on their transactions, which revenue the state will deposit in the Dedicated Marijuana Fund for programs related to drug treatment and prevention. There are four additional levels of taxation by which state and local government will earn revenue: state sales, state business and occupation (B&O), local sales, and local B&O. The OFM assumed that there would be 100 marijuana producers, 55 processors, and 328 retailers. Licensing revenue will be another source of benefit to the state. The price for licensure through the Liquor Control Board is $250 per application and $1,000 per issuance and renewal. Since our analysis assumes all taxes and fees will, in sum, result in a market price equivalent to the black market price, it is not necessary to differentiate among the types of revenue state and local governments collect (permit fees, B&O taxes, etc.). We only include them here as fiscal benefits for reference.

#### 4.2 Fiscal Costs
In carrying out a strictly regulated and fully functioning marijuana market, Washington’s departmental service and regulatory agencies will incur implementation costs, as will state and local law enforcement bodies. State agencies are tasked with licensure, regulation, tax collection, and implementation of programs. For the purpose of our analysis, these costs are fixed because we are holding constant OFM’s assumptions around number of producers, processors, and retailers. In addition, I-502 defines a new THC blood concentration limit for drivers. We include OFM’s estimates of cost impacts to officer training and Washington’s Toxicology Laboratory Division for enforcing these new DUI provisions.

#### 5 Law Enforcement

#### 5.1 Misdemeanors
Prior to implementation of Initiative 502, possession of up to 40 grams of marijuana is considered a misdemeanor in Washington State, with convictions carrying a minimum penalty of one day in jail and a fine of $250 (RCW 69.50.425). I-502, however, depenalizes possession of up to one ounce, beginning at the end of 2012 for those 21 years of age and older.

In 2012, Evans School graduate Rachel Stoermer researched the costs of enforcing adult marijuana misdemeanor laws in Washington State for her degree project. Stoermer (2012) provides detailed and comprehensive estimates of the marginal costs of misdemeanor arrests, court filings, and convictions across ten years from 2001 to 2010, which were invaluable to our analysis. As acknowledged in a 2003 Washington State Institute of Public Policy (WSIPP) report on the criminal justice system, incarceration also carries some additional social collateral costs, such as the offender’s lost current and future employment, earnings, taxes, family impacts, and other community costs. The authors of this report roughly estimate these additional social costs to be equivalent to the state’s costs to incarcerate offenders (WSIPP, 2003). Therefore, in counting the benefits of eliminating marijuana misdemeanor enforcement, we double the incarceration cost savings.

We then used the average number of each activity (arrests, filings, convictions) across these ten years multiplied by the 2012 costs of each activity to determine the baseline cost savings to Washington State from no longer enforcing misdemeanor possession crimes (see Table 1). Since these benefits are a result of depenalization, they begin to accrue in year 0. For our sensitivity analysis, we used the minimum and maximum numbers of each activity from across these ten years, reflecting the varying levels of enforcement and prosecution.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Average cost per instance in 2012</th>
<th>Annual upper bound</th>
<th>Average annual instances (2001-2010)</th>
<th>Baseline annual cost savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convictions</td>
<td>$736 (state costs) + $736 [social costs (WSIPP, 2003)]</td>
<td>1,641 (2001)</td>
<td>5,091 (2008)</td>
<td>$4.8 million</td>
</tr>
<tr>
<td>Total costs savings</td>
<td>$13 million</td>
<td>$34.5 million</td>
<td>$23.7 million</td>
<td></td>
</tr>
</tbody>
</table>

While it will still be a misdemeanor to possess between one ounce (approximately 28...
increased marijuana use that will occur due to legalization. or medical marijuana users since we are only interested in the health costs associated to the number of marijuana grams consumed. We did not include current black market for health care costs, we used the number of new users to the market, as opposed to complete elimination of the black market in Washington State, the costs associated with enforcing felony activities would decrease or largely disappear.

However, to protect the legitimacy of the new regulatory structure, we recommend that law enforcement agencies in Washington continue to enforce felony activities with the same vigor that they do today. Doing so will keep the cost of production in the illegal market at its pre-legalization level (which is largely dependent on the cost of the willingness to accept risk), helping to ensure that the black market will not undercut the heavily taxed legal marijuana market. In addition, since production of marijuana will be legal only within state borders, the state will certainly be under pressure to minimize unlawful spillover into other states. Therefore, we assume the costs associated with enforcing marijuana felonies will remain unchanged and do not affect our analysis.

6 HEALTH COSTS

To evaluate the costs associated with increased adverse health impacts from legalization, we reviewed the medical literature. We concluded that there are two main health cost categories to consider as part of this health cost analysis: respiratory illnesses and emergency room visits.

We found journal articles that evaluated marijuana’s impact on a wide range of health problems, including lung cancer, head and neck cancers (Berthiller, et al., 2009), upper respiratory cancers, psychosis, bronchitis, emphysema, heart attack, depression, anxiety, reduced cognitive function, dependence and birth defects (Polen, Sidney, Tekawa, Sadler, & Friedman, 1993), (Hall & Degenhardt, 2009), (Sidney, Beck, Tekawa, Quenberry Jr., & Friedman, 1997), (Hall & Babor, 2000). In many cases the researchers found no increased risk attributable to marijuana use, or at least no conclusive evidence of such risk. For this reason, we chose to exclude many of these health risks in our analysis. However, if some of these health effects do occur, they may result in additional emergency room visits. By including costs associated with increased emergency room visits, we are not entirely ignoring these other health effects.

For health care costs, we used the number of new users to the market, as opposed to the number of marijuana grams consumed. We did not include current black market or medical marijuana users since we are only interested in the health costs associated with increased marijuana use that will occur due to legalization.

6.1 RESPIRATORY ILLNESS AND LUNG CANCER

The research associating marijuana consumption and respiratory illness is mixed. According to a 1993 study, heavy (daily) marijuana smokers had increased risk of respiratory illnesses (Polen, Sidney, Tekawa, Sadler, & Friedman, 1993). A systematic review of research by Mehra et al. was unable to find substantive evidence that marijuana smoking is associated with an increase in lung cancer (2006). And in a study of over 2,200 subjects, Hashibe et al. found no evidence of increased cancer risk from marijuana use (2006). While we were unable to find evidence associating marijuana use with increased lung cancer risk, we did not want to dismiss entirely the potential impact of marijuana use on respiratory health. To simplify our calculations we chose to use lung cancer as a “worst-case” proxy of respiratory illness.

To evaluate the associated costs of increases in respiratory illnesses, we multiplied the number of new marijuana users that we predict will enter the market, the increased probability of respiratory illness associated with marijuana consumption according to Polen et al., and the 10-year costs associated with additional lung cancer cases as estimated by the EPA (U.S. EPA, 2010). We counted the 10-year costs associated with lung cancer for each new lung cancer case at the point of diagnosis, inflated at eight percent annually.

Since only heavy users are likely to be at increased risk for respiratory illness and since we are using lung cancer as a proxy for respiratory illness, we are likely overestimating costs in this category. In addition, since the 10-year costs associated with contracting lung cancer would likely occur entirely outside our six-year horizon, we are being additionally conservative by including them.

6.2 EMERGENCY ROOM VISITS

To evaluate the costs of emergency room visits attributable to increased marijuana use, we used the number of ER visits related to marijuana nationwide, the percentage growth in new marijuana users, and the average cost of an ER visit.

According to the Substance Abuse and Mental Health Services Administration, there are 122.6 ER visits related to marijuana use for every 100,000 people in the United States (2011a). However, there is reason to think that these numbers may be inaccurate due to over-reporting. When an individual admitted to the ER discloses the use of marijuana, the visit may get identified as related to marijuana even if it is not directly related to the reason for the ER visit. We decided to take a conservative stance by using it, despite the fact that it may over-represent the true ER costs related to marijuana use.

According to Medical Expenditure Panel Survey (MEPS) data, the average ER cost in the United States West census region was $1,377 in 2010, (US Department of Health & Human Services, 2010) or $1,461 in 2012 dollars. Using US census data from 2010 with an annual growth of 6 percent, we predict the population of Washington State in 2012 to be 6.9 million. As such, the increase in emergency room costs related to legalization is approximately $2.49 million per year:

Increase in annual ER costs due to legalization =
(123 annual ER visits related to Marijuana) / (100,000 population) × 6.9 million WA residents × $1,460 per ER visit × 20% growth in marijuana users = $12.4 million
7 VEHICLE COLLISIONS

Despite the fact that Initiative 502 adds a new threshold for determining marijuana intoxication for DUI offenses based on THC blood concentration, it is conceivable that increased marijuana consumption may result in an increase in impaired driving and thus an increase in vehicle collisions.

In order to estimate these costs, we considered the following: current annual per capita cost of vehicle collisions, the percentage of users likely to drive under the influence of marijuana, the increased probability of having a collision while driving under the influence of marijuana, and the number of new marijuana users. For simplicity, we assume that legalization will not affect the driving patterns of pre-legalization consumers.

In 2004, Transportation Choices Coalition and Sightline Institute produced a fact sheet that used Washington State Department of Transportation (WSDOT) and US DOT data to estimate that the annual cost of car crashes in Washington State totaled $8 billion in 2004 dollars (Transportation Choices Coalition, Sightline Institute, 2004), or approximately $9.6 billion in 2012 dollars. This number includes property loss, medical costs, and fatalities. Rates of car crashes and fatalities in Washington State decreased by approximately 20 percent from 2007 to 2011 (Washington State Department of Transportation, 2012), so we estimate the total cost of vehicle crashes in 2012 to be about $8 billion. Assuming a state population of 6.9 million in 2012, this value translates to a cost of $1,200 per Washington resident in 2012.

It is difficult to estimate for the percentage of new marijuana users who are likely to drive while impaired. SAMHSA (2011b) found that 4.2 percent of the population (12 and older) reported driving while under the influence of any illicit drug in the past year. For the sake of our analysis we assume that 4.2 percent of new users will regularly drive under the influence of marijuana.

Research indicates that driving while under the influence of marijuana increases the risk for having a vehicle collision by two to three times (Hall & Degenhardt, 2009). For reference, driving while under the influence of alcohol increases the risk by as much as 6-15 times (Hall & Degenhardt, 2009).

As such, the increase in costs related to vehicle crashes after legalization is approximately $9.1 million per year:

\[
\text{Increase in annual cost of vehicle collisions due to legalization} = \\
\text{\$1,200 per capita cost of car crashes} \times 4.2\% \text{ of users that drive under the influence of marijuana} \times 2.5 \text{ increased risk of crashing} \times 72,600 \text{ new users} = \$9.1 \text{ million}
\]

8 UNQUANTIFIABLE COSTS AND BENEFITS

8.1 HEART ATTACKS AND PSYCHOSIS

We note two health risks that we considered special cases, although we did not include them in our analysis: heart attack and psychosis. There appears to be an increased risk (associated with concurrent use of marijuana) of heart attack, for individuals who have a history of heart disease (Polen et al., 1993). We trust that doctors would advise their heart patients against smoking marijuana, much like they would advise not to mix over-the-counter medications that might increase their risk of heart attack. We determined it would be difficult to estimate the percent of the population comprising heart patients who also might use marijuana, and thus we kept these effects out of our calculations.

In addition, psychosis stands out as a very unique case. A certain percentage of the population experiences a psychotic episode after using marijuana and some individuals experience future episodes of psychosis or schizophrenia after using (Polen et al., 1993) (Hall & Babor, 2000) (J Van Os, 2002). However, the medical literature has been unable to tease apart causation in these cases. While some attention has been paid to the theory that marijuana causes schizophrenia, other evidence suggests that individuals with signs of oncoming psychosis are attracted to using marijuana as a way to self-medicate. Due to the lack of conclusive evidence of causation, we also excluded these health effects from our calculations.

8.2 EXPENDITURES OF THE DEDICATED MARIJUANA FUND

All the marijuana license fees and excise taxes are deposited into the Dedicated Marijuana Fund. I-502 mandates that certain portions of this fund (after subtracting expenditures for implementing the law and regulatory structure) be spent on specific programs such as youth drug treatment (15 percent), marijuana health services and education (10 percent), state basic health plan (50 percent), and the state general fund (18 percent) (I-502, 2011). These expenditures could theoretically result in a social benefit to society, thereby adding to the net present value (NPV). However, we concluded that the net effect is unquantifiable so we treated these expenditures as simple transfers within Washington and did not count them as costs or benefits.

9 SENSITIVITY ANALYSIS

To account for the uncertainty surrounding such an unprecedented law, we conducted a sensitivity analysis on key parameters by using a Monte Carlo simulation, the results of which are displayed in Figure 2.10 For all parameters we used a uniform distribution within the range. In this section, we discuss the four categories whose variance had the most influence on the results of the simulation.

Figure 2 Results of Monte Carlo Simulation of Net Present Value (NPV) (x-axis is in 2012 dollars) Grams of Marijuana Consumed without I-502 passage

While we agree with the estimated number of users predicted by the OFM prior to legalization, we believe they overestimated the current number of grams consumed mostly due to their assumption that an average marijuana user consumes two grams per
use. The average marijuana cigarette or “joint” contains about 0.5 grams and in many cases is shared by several individuals (United Nations Office on Drugs and Crime, 2006). This information suggests that, while some individuals are likely to use two grams per use, it is not the norm. We expect that a greater number of individuals are using less than 0.5 grams per use. As described in Section 3.1.1 and illustrated in the Appendix (Section 13.1)\(^1\), we used a range of 15 million to 72 million total grams consumed per year.

### 9.1 Marginal Cost of Production

Marginal Cost of Production (MCP) has a large effect on our analysis because it influences the amount of risk-to-tax transfer discussed in Section 3.2. The OFM anticipates that producers will sell their product to processors for $3 per gram and processors will sell their product to retailers for $6 per gram (OFM, 2012), which provides some indication of the marginal cost of production. We chose to use a range of $4 to $6 in the sensitivity analysis.

### 9.2 Total Number of Court Filings

Misdemeanor court filings have many costs associated with them, including court, prosecution, and defense costs, totaling $1,396 per arrest filed in 2010 (in 2012 dollars). State and local governments will save this amount on enforcement costs with every court filing they forego due to depenalization. Stoeurner’s report revealed significant variation in filing activities over the last 10 years. To account for this variation, we used the lowest and highest annual caseloads from the past ten years (2,960 in 2001 and 12,628 in 2008) as the lower and upper bounds for the number of annual court filings avoided by depenalization, as described in Section 5.1.

### 9.3 New Consumers in the Market

For the sake of our analysis, we predicted legalization will result in a 20 percent increase in the number of marijuana consumers, or 72,600 new consumers as discussed in Section 3.2.2. To reflect our uncertainty of this value, we used a range of 5,000 and 100,000 new users in the Monte Carlo simulation. We held this number independent of grams consumed because we do not know the stratification of new customers’ rates of consumption. In other words, grams consumed may not change linearly with changes in number of consumers in the market. We used the change in consumers to determine the increase in health care costs (emergency room visits and lung cancer) and vehicle crash costs that arise from legalization.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original number of marijuana consumers (pre-I-502)</td>
<td>363,000</td>
</tr>
<tr>
<td>Lower Bound</td>
<td>250,000</td>
</tr>
<tr>
<td>Upper Bound</td>
<td>600,000</td>
</tr>
<tr>
<td>New marijuana consumers (post-I-502)</td>
<td>72,600</td>
</tr>
<tr>
<td>Lower Bound</td>
<td>5,000</td>
</tr>
<tr>
<td>Upper Bound</td>
<td>100,000</td>
</tr>
<tr>
<td>Grams of Marijuana consumed without I-502 passage</td>
<td>43,000,000</td>
</tr>
</tbody>
</table>

**Table 2 Parameters and Ranges (Annual Basis) used in Monte Carlo Sensitivity Analysis**

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provide a net benefit to Washington State of $2 billion. In fact, the act of depenalization
of marijuana (the only other calculable benefit) is large enough to result in a positive NPV, despite the state's fixed costs of legalization and increased health and vehicle collision costs.

Our analysis of Initiative 502 determines that the legalization of marijuana will increased health and vehicle collision costs.

To comply with the mandate outlined in I-502 (eliminate the black market while reducing consumption) and to ensure the integrity and competitiveness of the legal market, we recommend that Washington State prioritize the following activities:

- Closely monitor and continue to re-evaluate the tax rate to keep market prices at pre-legalization prices.
- Avoid creating additional barriers of entry into the legal market for marijuana suppliers (e.g. limiting the number of permits and/or limiting the quantities supplied).
- Continue to enforce felony marijuana activities with the same vigor as today.

Ensuring that market prices remain at or below the pre-legalization equilibrium price should be the state's top priority in order to ensure that the legal market can outcompete the black market while also limiting marijuana consumption growth.

However, any barrier to entry into the legal market will increase the cost of production, limiting the amount of tax Washington State is able to collect while still ensuring that market prices remain competitive with the black market. Further, this dynamic is only effective if the price of risk in the black market does not change. If illegal drug traders perceive a reduction in the current risk, we would expect black market prices to drop, which would allow the illegal market to remain competitive.

By approving Initiative 502, Washington voters demonstrated a desire to restructure the marijuana market, in the face of a complex history of criminalized drug use in the United States and around the world. As the first governments in modern history to create and regulate a market structure for the recreational consumption of marijuana, Washington and Colorado will blaze new trails in this arena. Drug law advocates and opponents around the world will follow closely the financial and social ramifications as Washington implements its legal marijuana market in 2013 and in the years that follow. We hope the results of our analysis can inform state leaders, regulators, and citizens in this ground breaking process.

### Table 3 Discounted Total of Benefits and Costs

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Undiscounted Totals, Years 0-5</th>
<th>Discounted Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversion of black market risk into government (taxes and fees) revenue</td>
<td>$1,500,000,000</td>
<td>$1,440,000,000</td>
</tr>
<tr>
<td>Increase in consumer surplus</td>
<td>$660,000,000</td>
<td>$640,000,000</td>
</tr>
<tr>
<td>Reduced Enforcement Costs</td>
<td>$180,000,000</td>
<td>$174,000,000</td>
</tr>
<tr>
<td>Reduced Incarceration Costs</td>
<td>$29,000,000</td>
<td>$28,000,000</td>
</tr>
<tr>
<td>Total Discounted Benefits (rounded)</td>
<td>$2,200,000,000</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Costs</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquor Control Board</td>
<td>$16,000,000</td>
<td></td>
</tr>
<tr>
<td>Dept. of Agriculture</td>
<td>$26,000</td>
<td></td>
</tr>
<tr>
<td>Washington State Patrol</td>
<td>$2,300,000</td>
<td></td>
</tr>
<tr>
<td>Office of Administrative Hearings</td>
<td>$50,000</td>
<td></td>
</tr>
<tr>
<td>Office of Attorney General</td>
<td>$480,000</td>
<td></td>
</tr>
<tr>
<td>Dept. of Revenue</td>
<td>$97,000</td>
<td></td>
</tr>
<tr>
<td>Health Care Authority</td>
<td>$50,000,000</td>
<td></td>
</tr>
<tr>
<td>Dept. of Social and Health Services</td>
<td>$5,000,000</td>
<td></td>
</tr>
<tr>
<td>Dept. of Health</td>
<td>$7,600,000</td>
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</tr>
<tr>
<td>Dept. of Licensing</td>
<td>$480,000</td>
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</tr>
<tr>
<td>Administrative Office of the Courts</td>
<td>$3,000</td>
<td></td>
</tr>
<tr>
<td>State Revenue Loss from Fed. Funding</td>
<td>$370,000</td>
<td></td>
</tr>
<tr>
<td>Emergency Room Costs</td>
<td>$12,000,000</td>
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</tr>
<tr>
<td>Lung cancer costs</td>
<td>$51,000,000</td>
<td></td>
</tr>
<tr>
<td>Impaired Driving Collisions</td>
<td>$46,000,000</td>
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</tr>
<tr>
<td>Total Discounted Costs (rounded)</td>
<td>$200,000,000</td>
<td></td>
</tr>
<tr>
<td>Total Net Present Value</td>
<td>$2,000,000,000</td>
<td></td>
</tr>
</tbody>
</table>

### 10 RESULTS

With a discount rate of 3.5 percent, the net present value of our analysis is $2 billion (see Table 3). Our assumptions are 100 percent likely to result in a positive NPV (see Figure 2). Even excluding the biggest contributors to the positive NPV—replacement of risk with taxes and the increase in consumer surplus—NPV is still positive: $19 million and 77 percent likely to result in a positive NPV. This result indicates that the annual justice system cost savings from depenalizing marijuana (the only other calculable benefit) is large enough to result in a positive NPV, despite the state's fixed costs of legalization and increased health and vehicle collision costs.

### 11 RECOMMENDATION AND CONCLUSION

Our analysis of Initiative 502 determines that the legalization of marijuana will provide a net benefit to Washington State of $2 billion. In fact, the act of depenalization alone will provide a net positive benefit simply by removing the criminal justice costs associated with enforcing marijuana laws and incarcerating marijuana users. To reiterate, our benefit-cost analysis did not include any federal penalization that could occur, impacts from “drug tourism”, certain health effects, or impacts on minors.

12 AUTHOR AFFILIATIONS

Michael Archambault (mikearch@uw.edu) is a Master of Public Administration (MPA) candidate at the Evans School and is expecting to graduate in 2013. He earned a Bachelor of Science in Computer Engineering from the University of Arizona. After spending eight years as an engineer in the private sector, he is exploring a career of public service with particular interests in urban issues, social justice, and economic policy.

Elizabeth McNeilly (mcneilly.elizabeth@gmail.com) is receiving her MPA with a certificate in International Development Policy and Management. During her second year in the MPA program, Elizabeth served as an Economic Research Analyst with the Seattle Board of the Federal Reserve Bank of San Francisco. She has a bachelor's degree in finance from the Robert H. Smith School of Business at the University of Maryland.

Pat Roe (pat.roe@me.com) will receive her MPA from the Evans School in June of 2013. She has an academic focus on policy analysis and evaluation, with particular interests in health and economic policy. Pat previously lived in Cambodia where she worked on micro-finance and
agricultural projects with rural landmine survivors.

13 BIBLIOGRAPHY

14 END NOTES
1. Or up to 16 ounces of marijuana-infused product in solid-form or 72 ounces in liquid for, and as-sociated paraphernalia. The reader should assume that future references to this one-ounce limit also include these equivalent alternatives.
2. All appendices are available at the end of this article online. Go to the publisher’s website and use the search engine to locate the article at https://depts.washington.edu/esreview/
4. Our analysis only includes the black market and medical marijuana in Washington State.
5. It is conceivable that the shape of the demand curve results in a “cost of risk” that is equivalent to the consumer surplus.
6. MacCoun and Reuter assert that consumers will actually pay a small price premium to purchase goods from a legal market (Drug War Heresies, 2001). Thus there is conceivably some leeway for the legal market price to exceed or overestimate the black market price while still outcompet-ing the black market.
7. It is conceivable that the legalized marijuana market will attract visitors from outside of Wash-ington, and all money spent by these “drug tourists” would be a positive net benefit of I-502. However, a legalized market may also turn away some potential visitors. With no reliable way to quantify these potential benefits or costs, we decided to ignore them for this analysis.
8. Single entities that are both producers and processors will not have to pay the 25 percent producer excise tax (I-502, 2011).
9. Since I-502 does not change the penalty of marijuana possession for those aged 21 and below, we did not include juveniles in our calculations. However, the information described in this sec-tion includes adults aged 18 and above.
10. Monte Carlo is a method of simulating an outcome by repeatedly and randomly calculating the numerical result, based on the assumptions and probabilities of the input variables. Figure 2 depicts the results of 10,000 such calculations.
11. All appendices are available at the end of this article online. Go to the publisher’s website and use the search engine to locate the article at https://depts.washington.edu/esreview/
### 15 APPENDICES

#### 15.1 Pre-I-502 estimates for marijuana consumption in Washington State in 2013

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
<th>g</th>
<th>h</th>
<th>i</th>
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<tbody>
<tr>
<td>Number of days cannabis used</td>
<td>Percent of respondents</td>
<td>Number of WA marijuana users</td>
<td>Grams per usage day</td>
<td>Calculations of total grams consumed per year</td>
<td></td>
<td></td>
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<tr>
<td><strong>Low</strong></td>
<td><strong>High</strong></td>
<td><strong>Average</strong></td>
<td><strong>Low (From 2006 UN Report)</strong></td>
<td><strong>High (From WA State's OFM estimate)</strong></td>
<td><strong>Low</strong></td>
<td><strong>High</strong></td>
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<td>360</td>
<td>365</td>
<td>362.5</td>
<td>7%</td>
<td>25,410</td>
<td>0.5</td>
<td>2</td>
<td>4,605,563</td>
<td>18,422,250</td>
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<tr>
<td>261</td>
<td>359</td>
<td>310</td>
<td>6%</td>
<td>21,780</td>
<td>0.5</td>
<td>2</td>
<td>3,375,900</td>
<td>13,503,600</td>
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<td>260</td>
<td>260</td>
<td>260</td>
<td>5%</td>
<td>18,150</td>
<td>0.5</td>
<td>2</td>
<td>2,359,500</td>
<td>9,438,000</td>
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<tr>
<td>158</td>
<td>259</td>
<td>208.5</td>
<td>6%</td>
<td>21,780</td>
<td>0.5</td>
<td>2</td>
<td>2,270,567</td>
<td>9,082,260</td>
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<td>157</td>
<td>156.5</td>
<td>5%</td>
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<td>0.15</td>
<td>2</td>
<td>426,071</td>
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<td>6%</td>
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<td>52</td>
<td>52</td>
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<td>5%</td>
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<td>141,570</td>
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<td>38</td>
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<td>165,528</td>
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<td>24</td>
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<td>65,340</td>
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<td>23</td>
<td>18</td>
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<td>29,403</td>
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<td>12</td>
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<td>0.15</td>
<td>2</td>
<td>32,670</td>
<td>435,600</td>
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<td>4</td>
<td>11</td>
<td>7.5</td>
<td>14%</td>
<td>50,820</td>
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<td>2</td>
<td>57,173</td>
<td>762,300</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>2</td>
<td>18%</td>
<td>65,340</td>
<td>0.15</td>
<td>2</td>
<td>19,602</td>
<td>261,360</td>
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<td></td>
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</tr>
<tr>
<td><strong>Approximate average of range:</strong></td>
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<td></td>
<td></td>
<td></td>
<td><strong>43,000,000</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Average annual grams per user:</strong></td>
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<td></td>
<td></td>
<td></td>
<td><strong>39</strong></td>
<td><strong>199</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Columns a, b, d: (United Nations Office on Drugs and Crime, 2006)
Columns c, h, i: Author calculations
Column e: Author calculations based on column d and 363,000 Washington marijuana users (OFM, 2012)
Column f: Author interpretation of (United Nations Office on Drugs and Crime, 2006)
Column g: (OFM, 2012)