

Tax Policies for Legalized Marijuana in California

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This November, the citizens of California will be called to the polls to decide on a referendum which would legalize, regulate, and tax marijuana. How this regulatory and tax framework will be imposed has yet to be decided. The lure of new revenues from marijuana taxes are often cited in the debate; however, studies measuring the magnitude of tax revenues lack the methodology for proper estimation and fail to examine the effects of different tax structures given the specific nature of the marijuana market. In this paper, we propose and analyze the effects of two alternative tax structures on the California marijuana market. The first, where marijuana would be taxed at 50% of the post-legalization purchase price on the first \$100 per ounce (or ounce equivalent), and 100% of the price for amounts above \$100 per ounce, would generate tax revenues for California of approximately \$1.6 billion annually. At the same time, this tax mechanism would stabilize consumption, as prices would not decline substantially from current levels, and limit the continuance of an illegal black market by providing consumers a reasonably priced and legal alternative. If California chose instead to establish state-run marijuana stores, it could generate up to \$2.4 billion in profits for the state.

We do not suppose to have designed the “perfect” post-legalization structure for marijuana use, nor are we supporting or condemning the legalization of marijuana itself. However, in the event that California chooses to legalize marijuana this November, it is imperative that discussion happens now to decide what the policy goals of taxation and regulation are, and design solutions that are ready to satisfy these goals. We hope that the issues addressed in this paper motivate further discussion on critical aspects which must be addressed before marijuana is legalized.

I. Introduction

In 1937, the United States Congress passed the Marijuana Tax Act, entering into a period where the government tried to control consumption of marijuana through the imposition of criminal sanctions. Similar to the prohibition of alcohol in the U.S. from 1920 to 1933, the prohibition of marijuana appears to have had a minimal effect in limiting its accessibility and use. According to the 2008 National Survey on Drug Use and Health, over 100 million people in the U.S. had tried marijuana in their lifetime, 25 million of whom had used it in the past year, and 15 million of whom had used it in the past month.¹ Even those statistics may likely under-report overall marijuana use.² Like the black market which grew as a result of alcohol prohibition, the black market for the illegal distribution of marijuana has generated large amounts of crime.³

¹ “2008 National Survey on Drug Use and Health”, *Office of Applied Sciences*, 2008
<<http://www.oas.samhsa.gov/NSDUH/2K8NSDUH/tabs/Section1to46.htm#Tab1.1A> >

² Nelson, Ariel, “How Big is the Marijuana Market,” April 20 2010,
<http://www.cnbc.com/id/36179677/How_Big_Is_The_Marijuana_Market>.

³ Moore, Solomon, “Tougher Border Can’t Stop Mexican Cartels,” *New York Times*, February 1 2009,
<http://www.nytimes.com/2009/02/02/us/02pot.html?_r=1>. “Mexican Drug Trafficking,” *New York Times*, March 24 2010, <http://topics.nytimes.com/top/news/international/countriesandterritories/mexico/drug_trafficking/index.html>

President Barack Obama announced that the federal government would not prosecute medical marijuana users under federal law. This, combined with the increasingly open purchase of marijuana under California's 1996 medical marijuana proposition, helps explain why this November, Californians will vote on a proposition to legalize marijuana for general consumption. Concurrent with legalization will be the imposition of a tax on the sale of all marijuana.⁴ While it seems (at least initially) that this tax will be implemented piecemeal on a city-by-city basis, it is imperative that the initial tax structure as a whole be widely accepted. If not, the current infrastructure which has so successfully aided in the evasion of enforcement will be deployed to evade the California tax authorities.

Historically, the U.S. has spent billions of dollars annually at both the local and federal level on the enforcement of the prohibition of marijuana.⁵ Simple economic analysis shows that government expenditure on enforcement of the marijuana prohibition benefits black market participants by increasing the revenue and profit that can be earned through the sale of marijuana. Only by understanding and analyzing these dynamics can we make more informed decisions with regard to the status of marijuana.

Certain proponents of a regulated marijuana market have proposed a fixed \$50 per ounce tax, irrespective of the per-ounce cost of the marijuana itself.⁶ This tax structure fails to appropriately consider the segmentation of the marijuana market, which is comprised of a variety of grades of marijuana at different price points.⁷ A fixed tax amount per ounce will have undesirable effects, including the continuance of a black market for the lower grades of marijuana, and little curb on consumption for higher grades. A tax on total dollars spent on marijuana will allow for a balance on all three goals of legalization and regulation – minimizing consumption and eliminating the black market under a tax system which otherwise maximizes revenue to the state.

While we could imagine a percentage tax on all marijuana accomplishing some of these goals, a flat percentage tax fails to accurately consider the stratification of the market. Thus, after looking at various options,⁸ we propose that California institute a tax of 50% of the post-

⁴ See <http://www.taxcannabis.org> for more details on the "Regulate, Control and Tax Cannabis Act of 2010" voter referendum.

⁵ Miron, Jeffrey, "The Budgetary Implications of Marijuana Prohibition," June 2005, pp. 2-3.

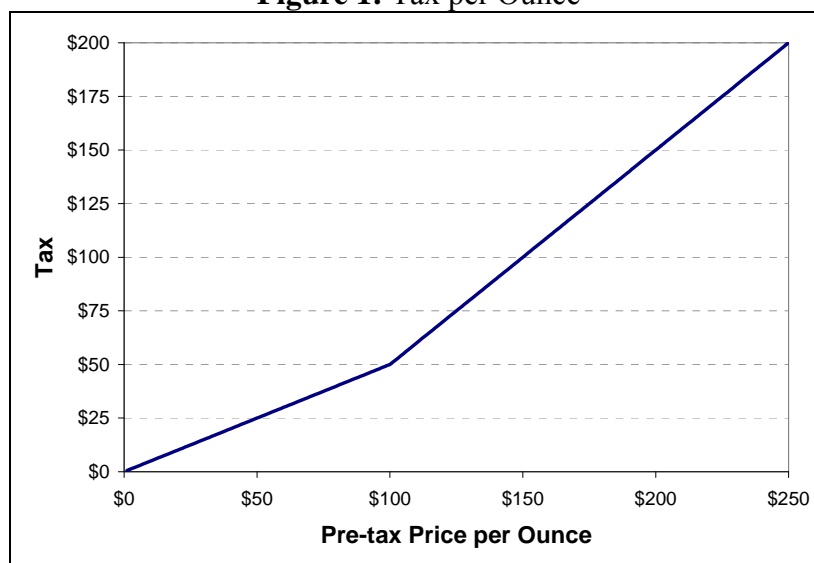
⁶ "Prepared Testimony of Robert Ingenito" *Board of Equalization*, October 28 2009.

⁷ In order to get detailed knowledge of the marijuana market, we have interviewed multiple individuals who are familiar with the marijuana market, including several individuals active in the recently successful movement in Massachusetts to decriminalize marijuana. These conversations have given us a good sense of the overall market and how participants perceive pricing and supply intricacies. Much of the discussion of the market in this paper relies on these conversations. We confirmed these discussions with more formal sources, such as Stevens, Lindy, "How is the street value of marijuana determined?" *The Michigan Daily*, March 6 2008 <<http://www.michigandaily.com/content/how-street-value-marijuana-determined>>; Gettman, John, "Lost Taxes and Other Costs of Marijuana Laws," September 5 2007, p 22-23. Samuels, David, "Dr. Kush: How medical marijuana is transforming the pot industry," *The New Yorker*, July 28 2008 <http://www.newyorker.com/reporting/2008/07/28/080728fa_fact_samuels?currentPage=all>.

⁸ We tried to balance three factors when deriving an optimal tax policy. The first was post-taxation consumption, trying to minimize any increase. Second, we looked at post-taxation revenues, trying to maximize state revenues for any given market size. The final factor was the post-taxation prices, subjectively attempting to minimize any remaining black market for marijuana.

legalization purchase price on the first \$100 per ounce (or ounce equivalent⁹), and 100% of the price for amounts above that threshold. This would generate tax revenues of approximately \$1.6 billion annually, and at the same time properly balance stabilizing consumption and minimizing continuance of a black market. Figure 1 below illustrates the proposed tax structure per ounce of marijuana.

Figure 1: Tax per Ounce



As an alternative, California could become the first “marijuana control state,” the equivalent of the 18 alcoholic beverage control states which hold a monopoly over the wholesaling, and in some cases, the retailing of liquor. California could establish state-run marijuana stores instead of just taxing at the point of sale, generating up to \$2.4 billion in additional revenues for the state.¹⁰

In this paper, we provide background information on the economics of prohibition as it relates to marijuana. We also analyze previous attempts to estimate tax revenue from the sale of marijuana. We discuss different tax policies and their effects, and then estimate California tax revenue from our two preferred tax policies.

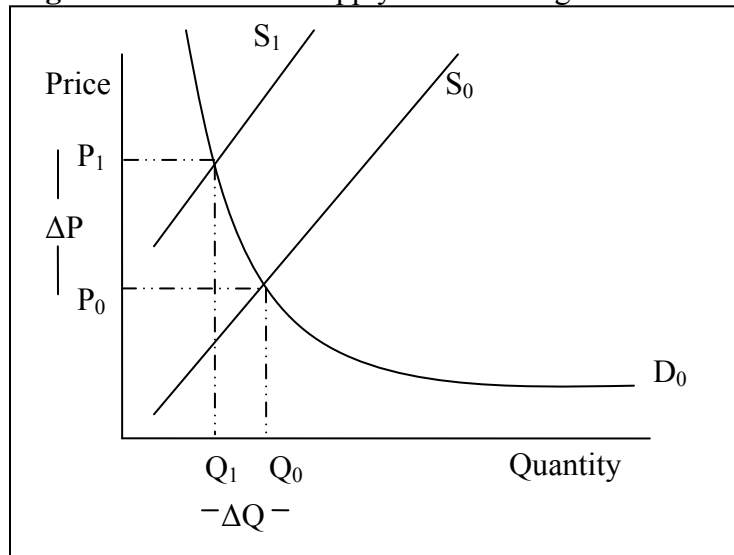
⁹ Ounce equivalent means that, for example, if a customer purchased half an ounce for \$100, the per-ounce price would be \$200. The tax would be calculated by calculating the tax on a per-ounce basis, then multiplying the total price by amount purchased. For example, if the half ounce were \$200, the per-ounce price would be \$400. The tax on a \$400 ounce would be 50% of the first \$100, and 100% of the next \$300, for a total tax of \$350, and a total per-ounce price of \$750. It follows that half an ounce should cost \$375 after taxes.

¹⁰ The \$800 million difference between a purely taxed environment and state-run stores is the value to California of exercising its monopsony purchasing power. California would be free to pay more for the product and share part of that difference with others in the supply chain.

II. The Economics of Prohibitions as it Relates to Marijuana

As mentioned above, despite various prevention and enforcement programs, marijuana use continues. In fact, the economics of prohibition dictate its failure to regulate consumption; assuming a competitive supply, its unintended consequence is to increase the size of the marijuana market. A simple economic model, seen below in Figure 2, can explain this phenomenon.

Figure 2: Shift of the Supply Curve through Prohibition



The enforcement of prohibition causes the supply curve to shift in from S_0 to S_1 , lowering the quantity supplied to the market, but increasing the price. The notion of how much the quantity demanded decreases relative to the increase in price is known as the price elasticity of demand.¹¹ If the relative change in quantity demanded is greater than the change in price, demand is said to be elastic. If the opposite is true, demand is said to be inelastic. The elasticity of demand is typically a negative number, reflecting the fact that quantity changes in the opposite direction of price. However, a more intuitive way of looking at elasticity is by taking its absolute value. Thus, the higher the absolute value of the elasticity of demand, the more elastic the demand.

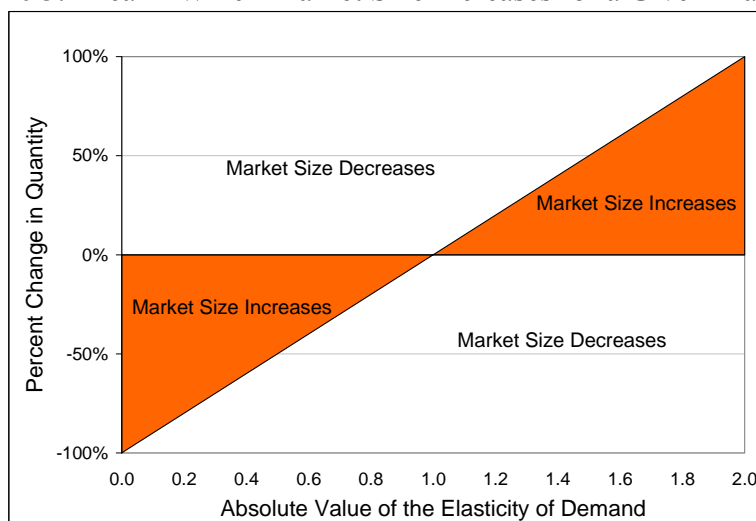
Total revenue earned is equal to price (P) times quantity (Q), represented by the rectangles in Figure 2, where revenue pre-prohibition is P_0 times Q_0 , and post-prohibition is P_1 times Q_1 . It is important to note that, because the market is inelastic, post-prohibition revenue is typically *greater* than pre-prohibition revenue, which occurs when the following condition is true:

$$\text{Absolute Value of Elasticity of Demand} < -(1 + \% \Delta Q)$$

¹¹
$$\text{Elasticity} = \frac{\Delta Q / Q_0}{\Delta P / P_0} = \frac{\% \Delta Q}{\% \Delta P}$$

The price elasticity of demand is the percent change in quantity for given change in price at a particular point on the demand curve.¹² This condition will be satisfied under a variety of scenarios. However, in order for the market size to increase for a particular elasticity of demand, both the size *and* direction of the change in quantity supplied to the market are relevant.¹³ As can be seen in Figure 3, for inelastic markets (i.e. for markets in which the absolute value of elasticity of demand is between 0 and 1), a decrease in quantity supplied to the market oftentimes increases the total revenue generated in the market (price times quantity).

Figure 3: Area in Which Market Size Increases for a Given Elasticity



It is of further note that in markets where the demand is always inelastic, an increase in quantity supplied will always lead to a decrease in the market size regardless of the degree of inelasticity. Thus, assuming that the market for marijuana is inelastic (as shown in Cohen (1997)),¹⁴ and that prices fall post-legalization,¹⁵ the removal of prohibition in the marijuana market without any other tax or policy changes will lead to an overall decrease in the revenue generated by the

¹² This analysis effectively linearizes a demand curve based on a single point on the demand curve, and does not consider the shape of the demand curve itself. If the demand curve is concave, the percentage decrease in quantity required for market size to decrease would be much larger.

¹³ Elasticity of demand is defined as the percentage change in quantity divided by an infinitesimally small percentage change in price, and measures how sensitive a market is to changes in the price. However, different equilibrium prices in the market can have different elasticities. For example, if the price of marijuana shifts from \$50 to \$100, the change in elasticity between the two points may be significant. Because elasticities change as price changes, it is difficult to measure the effect of a large change in price using the elasticity at only one particular point, since the farther away the price is from that point, the less reliable the elasticity estimate. For more information, see, for example, Mankiw, N. Gregory, *Principles of Economics* (Mason: South-Western Cengage Learning, 2009), Ch 5.

¹⁴ Cohen, Evan, "Survey of Marijuana Use at Cornell University," *The Michigan Journal of Economics*, Vol. 13, No 1, 1997, p 72-79.

¹⁵ The notion of prices falling post-legalization can already be shown to be accurate by looking at the effects of the legalization of medical marijuana in California. See Samuels, David, "Dr. Kush: How medical marijuana is transforming the pot industry," *The New Yorker*, July 28 2008 <http://www.newyorker.com/reporting/2008/07/28/080728fa_fact_samuels?currentPage=all>. Also see Montgomery, Michael, "Pot prices plummet in state, putting growers in a bind," *California Watch*, May 15 2010, <<http://californiawatch.org/watchblog/pot-growers-worry-over-falling-prices>>.

marijuana market. Prior work in Cohen (1997) estimates the elasticity of demand for marijuana to be approximately -0.3. Using this value, we see that a 1% *decrease* in quantity of marijuana in the market will *increase* the total revenue of the marijuana market by just over 2%.

The high prices that buyers are willing to pay for marijuana motivate sellers to participate in an illicit market despite the risks imposed by prohibition enforcement. Similar to the rise in mobs and organized crime under alcohol prohibition, we have also seen a rise in gangs and cartels under marijuana prohibition.¹⁶

The Noble Experiment – The Prohibition of Alcohol from 1920 to 1933

In the early 1900's, the Prohibitionist movement, capitalizing on the public's fear of political corruption and moral decay associated with saloons,¹⁷ helped to ratify the 18th Amendment. Also known as the Volstead Act, it banned the manufacture, sale, import, export, and possession of any intoxicating liquors. This began a period known as the "Noble Experiment".

The Actual Effects of the 18th Amendment:

- The amount of alcohol produced annually at industrial alcohol plants increased from 19 million gallons in 1920, to 85 million gallons in 1921, and to 202 million gallons in 1926.¹⁸
- Per capita consumption of alcoholic beverages was unchanged or increased from 1918 levels throughout prohibition.¹⁹
- Alcohol consumption moved from saloons, the scorn of high society, to speakeasies, the clubs of high society.
- The U.S. Government lost tax revenue and incurred high enforcement costs, together amounting to almost a billion dollars in 1931 alone.²⁰
- Prohibition led to a rise in the black markets and organized crime, such as Al Capone's group in Chicago, resulting in spiking homicide rates which did not decline until 1933, when the 18th Amendment was repealed by the 21st Amendment.²¹

After prohibition was repealed, homicide, burglary, and assault, all of which had grown during prohibition, began to decrease back to the pre-prohibition levels.²² Despite alcohol's sales tax post-legalization, alcohol production and sale shifted from the illegal markets to the legal markets.²³ Consumption of alcohol did not change immediately after prohibition's repeal, but slowly reverted to its pre-prohibition levels within the next decade.²⁴

¹⁶ See for example Campo-Florez, Adrian and Monica Campbell, "Bloodshed on the Border," *Newsweek*, December 8 2008 <<http://www.newsweek.com/id/171251>>. See also Quinones, Sam, "Mexico Under Siege," *Los Angeles Times*, February 12 2009 <<http://articles.latimes.com/2009/feb/12/nation/na-drug-kidnappings12>>.

¹⁷ Thornton, Mark, *The Economics of Prohibition* (Salt Lake City: University of Utah Press, 1991) pp 52-53.

¹⁸ United States Treasury Department, Bureau of Industrial Alcohol, *Statistics Concerning Intoxicating Liquors* (Washington D.C.: U.S. Government Printing Office, Dec., 1933) p 24.

¹⁹ Thornton, Mark, "Alcohol Prohibition was a Failure," July 17 1991, <http://www.cato.org/pub_display.php?pub_id=1017&full=1>.

²⁰ Reeves, Ira, *Ol' Rum River* (Chicago: Thomas S. Rockwell Co., 1931), p. 372-373.

²¹ Thornton, Mark, "Alcohol Prohibition was a Failure," July 17 1991, <http://www.cato.org/pub_display.php?pub_id=1017&full=1>.

²² Thornton, Mark, "Alcohol Prohibition was a Failure," July 17 1991, <http://www.cato.org/pub_display.php?pub_id=1017&full=1>.

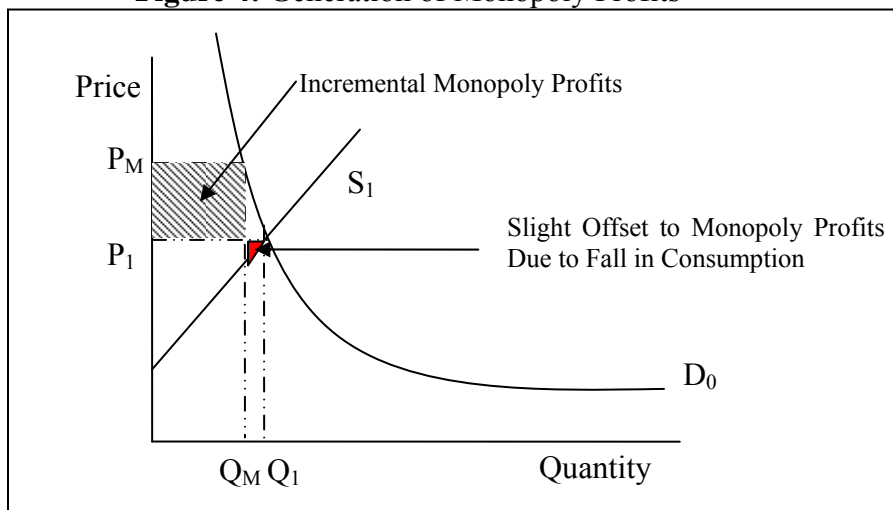
²³ Miron, Jeffrey, "The Budgetary Implications of Marijuana Prohibition," June 2005, p 14.

²⁴ Miron, Jeffrey A. and Jeffrey Zweibel, "Alcohol Consumption During Prohibition," *NBER*, April 1991.

Collusion among sellers in the marijuana industry, which leads to the formation of cartels, allows sellers to reap virtual monopoly profits from consumers by charging prices which far exceed both the sellers' costs of production and the prices which would be charged in a competitive environment. The drug cartels are aided by the fact that the demand is inelastic, and so quantity consumed does not decrease proportionately in response to higher prices. Further, the fewer competitive sellers, the easier it is for drug cartels to charge monopoly prices, since consumers lack options to purchase from different sources at lower prices.

In a perfectly competitive market, sellers do not make any economic profits, as the price is set at their cost plus a competitive rate of return on assets. In this case, as seen in Figure 4, both total revenue and total cost are P_1 times Q_1 ; thus, economic profits for the suppliers are equal to zero. However, when cartels are able to monopolize supply, they can set price higher, in the case presented in Figure 4 below, P_M .²⁵ While in inelastic markets, consumption falls slightly to Q_M , the increase in price far outweighs this slight fall in consumption. Assuming costs to the cartel stay the same, the cartel is able to reap significant monopoly profit. The enforcement of prohibition even aids in limiting the number of sellers in the market, making collusion easier.

Figure 4: Generation of Monopoly Profits



²⁵ Typically it is said that P_M is set by the monopolist at a quantity such that the marginal revenue of that additional quantity is equal to its marginal cost. See, for example, Michael L. Katz and Harvey S. Rosen, *Microeconomics* (Boston: Irwin McGraw-Hill, 1998), 413-19.

III. Evaluation of Analyses on the Effects of the Legalization of Marijuana

The prohibition of marijuana is in many ways similar to that of alcohol. In both cases, consumption remained high, and production shifted from public, commercial entities²⁶ which could be regulated, to black markets and organized crime. This raises the question of whether the repeal of marijuana prohibition will have the same outcome as the repeal of the Eighteenth Amendment, namely abatement of crime and introduction of competition that benefited consumers without significantly impacting consumption. Several attempts have been made to quantify what the effects of legalization, regulation and taxation might be on either the national marijuana market or on California specifically. However, each of these analyses is heavily dependent on often unsubstantiated assumptions. Below, we lay out the basics of their analyses, and later introduce some alternative ways to predict post-legalization behavior and its implications on public and tax policy. Table 1 below summarizes the studies.

a. Robert Ingenito²⁷

On October 28 2009, Robert Ingenito, Chief of the Research and Statistics Section of the California Board of Equalization (BOE), spoke before the California Assembly Committee on Public Safety to analyze the fiscal impact of legalizing and taxing marijuana in the state of California. Assuming a \$50 per ounce excise tax, Mr. Ingenito calculates that the excise tax would generate \$990 million and that other tax revenues would generate an additional \$392 million, for a total of about \$1.4 billion.

Mr. Ingenito's analysis does not consider the disparate effects of a \$50 per ounce tax on the different segments in the marijuana market. Marijuana comes in a variety of different qualities and prices, and each variety appeals to a different segment of the market. Whereas some marijuana sells for less than \$40 per ounce, other marijuana sells for well over \$500.²⁸ The differences in price arise from a variety of factors. Cheap marijuana is generally grown outdoors in Mexico, and compressed for transport to the United States. The most expensive marijuana on the other hand is grown in carefully controlled indoor environments with specific lighting, humidity, and air composition requirements. There are virtually limitless grades of marijuana in between, selling on a variety of different factors such as potency and residual effects.²⁹

The imposition of a flat \$50 per ounce tax on marijuana would have drastically different effects in each market segment. In the lower grade market, \$50 per ounce could represent a tax of perhaps more than 100 percent of the post-legalization purchase price. Said differently, if, as Mr. Ingenito assumes, the price of \$40 per ounce marijuana were to fall 50% to \$20 per ounce,

²⁶ "New Billion-Dollar Crop," *Popular Mechanics*, February 1938.

²⁷ "Prepared Testimony of Robert Ingenito" *Board of Equalization*, October 28 2009.

²⁸ Conversations with individuals familiar with the marijuana market. For more sources which confirmed the content of our discussions, please see Stevens, Lindy, "How is the street value of marijuana determined?" *The Michigan Daily*, March 6 2008 <<http://www.michigandaily.com/content/how-street-value-marijuana-determined>>; Gettman, John, "Lost Taxes and Other Costs of Marijuana Laws," September 5 2007, p 22-23. Samuels, David, "Dr. Kush: How medical marijuana is transforming the pot industry," *The New Yorker*, July 28 2008 <http://www.newyorker.com/reporting/2008/07/28/080728fa_fact_samuels?currentPage=all>.

²⁹ Discussions with individuals familiar with the marijuana market.

then a \$50 per ounce tax would increase the net sales price to \$70 per ounce, an increase of 75% over today's price. This onerous tax would certainly allow black markets to continue to flourish.

In contrast, the effects of a \$50 per ounce tax in the higher grade market would be minimal, such that the price of marijuana gross of the tax would be far lower than current levels. If the price of high grade marijuana were to fall 50% to \$250, then the post-tax price of \$300 per ounce would represent a fall in price of 40% below today's price. Consumption of higher grades of marijuana could then be expected to skyrocket. Thus, we recommend that one must consider the market segmentation of the marijuana market in designing an effective tax policy.

b. Jeffrey Miron³⁰

In 2005, Dr. Jeffrey Miron, visiting Professor of Economics at Harvard University, analyzed the budgetary implications of marijuana prohibition. Dr. Miron calculates budgetary savings on both reduced expenses of marijuana enforcement as well as tax revenues. We focus solely on the tax portion of his analysis. Dr. Miron calculated tax revenue on a national basis under two different scenarios, both with the underlying assumption that the national marijuana market size is \$10.5 billion. In the first scenario, he determined that a tax of 30% would lead to tax revenue of \$2.4 billion. In the second case, he added a "sin tax" of 50% to the original 30% tax, yielding revenue of \$6.2 billion.

Although Dr. Miron recognized in his paper that a sin tax could lead to the formation of a black market, he does not fully analyze whether his proposed taxes would lead to the formation of such a market, writing off the possibility because Europeans are taxed more than 75 percent on cigarettes. Again, this analysis fails to take into account the stratification of marijuana customers, as well as each customer segment's likely reaction to price changes.

c. John Gettman³¹

In 2007, John Gettman, senior fellow at George Mason University, analyzed the potential tax revenue that could be generated by legal marijuana sales. Dr. Gettman estimated the value of the national marijuana market at \$113 billion through various measures of supply and price. By applying various federal and state tax rates to the total revenue number, Dr. Gettman concluded that total tax revenues lost nationally is approximately \$31 billion.

The purpose of Dr. Gettman's paper was not to fully analyze the effects of taxation and legalization of marijuana. Dr. Gettman provided no elasticity analysis to show how legalization and tax would impact market size or price. Though the contents of the paper are helpful, the analysis is incomplete for application to a full economic analysis.

³⁰ Miron, Jeffrey, "The Budgetary Implications of Marijuana Prohibition," June 2005.

³¹ Gettman, John, "Lost Taxes and Other Costs of Marijuana Laws," September 5 2007.

Table 1: Summary of Selected Existing Marijuana Market and Tax Estimates

<i>All \$ in billions</i>	Ingenito	Miron	Miron	Gettman
National Market Size	121m oz. ^b	\$10.5	\$10.5	\$113 (498m oz.)
California Market Size	16m oz.	\$1.4 ^b	\$1.4 ^b	\$14.9 ^b
Tax Rate	\$50/oz	30%	80%	28.7%
National Tax Revenue	\$7.6 ^b	\$2.4	\$6.2	\$31.0
California Tax Revenue	\$1.0 ^a	\$0.3 ^b	\$0.8 ^b	\$4.1 ^b

Notes:
^a Mr. Ingenito calculates additional CA general revenue from other taxes of \$392 million.
^b Based on the assumption that the CA market equals 13.18 percent of the national marijuana market (see footnote 33).

IV. An Estimate of Market Shifts and Tax Revenue

We maintain that a critical component of any taxation structure for marijuana is that it be a percentage-based function of the price of marijuana, rather than a fixed price per ounce. This would be less likely to drive consumers of low-grade marijuana to the black market, and provide policy makers with a more effective lever to control incentives and behavior. With this in mind, we perform two analyses. The first is to consider a tax policy factoring in the effects of market segmentation in the marijuana market among different grades of marijuana and different consumer classes. The second analysis is to estimate revenue if state governments were to run their own stores to sell marijuana directly to consumers.

a. Segmented Marijuana Market Dynamics

We perform an estimate of the potential tax revenue through legalization and then taxation, assuming that the marijuana market is actually a continuum of grades of marijuana, each operating in its own market segment.³² We have applied national marijuana market figures only to the California market, based on the number of Californians over the age of 18 who have used marijuana in the latest year available, 2007. Thus, we have assumed that California represents 13.18 percent of the national marijuana market.³³ With this assumption, the total size of the California marijuana market is \$4.6 billion³⁴ with an average price of \$200 per ounce,³⁵ total

³² Stevens, Lindy, "How is the street value of marijuana determined?" *The Michigan Daily*, March 6 2008 <<http://www.michigandaily.com/content/how-street-value-marijuana-determined>>. Gettman, John, "Lost Taxes and Other Costs of Marijuana Laws," September 5 2007, pp. 22-23. Samuels, David, "Dr. Kush: How medical marijuana is transforming the pot industry," *The New Yorker*, July 28 2008 <http://www.newyorker.com/reporting/2008/07/28/080728fa_fact_samuels?currentPage=all>.

³³ Based on the 2006-2007 *National Survey on Drug Use and Health* published by the Substance Abuse and Mental Health Services Administration, a division of the U.S. Department of Health and Human Services, 2.9 million Californians over the age of 18 used marijuana in 2007 versus 22 million Americans over the past year. This translates to about 13.18 percent. The latest year for which state-level data was available was 2007. (see <http://www.oas.samhsa.gov/NSDUH/2k7NSDUH/tabs/Sect1peTabs47to92.htm#Tab1.66A>, Table 1.66A and 1.67A and <http://www.oas.samhsa.gov/2k7State/California.htm>).

³⁴ As seen above, estimates of the California market range from \$1.4b to \$14.9b. We chose a recent estimate, which also assimilated the same range of potential estimates, but considered both supply and demand-based estimates to get an overlapping range between the two models of \$4.6-\$5.9 billion. We chose the lower end of this range to give a more conservative estimate of potential tax revenue.

consumption of 23.1 million ounces, and an elasticity of demand of -0.3.³⁶ To simplify our analysis, we divide the marijuana market into two market segments. In the lower-grade market segment, we have assumed that the current price is \$100 per ounce, comprised primarily of low-grade Mexican compressed marijuana.³⁷ In the higher-grade market segment, we have assumed that the current price is \$450 per ounce. At these prices, 16.5 million ounces of the low-grade product is consumed, and 6.6 million ounces of high-grade. Thus, the market size of the lower grade market is \$1.6 billion, and the market size of the higher quality market is \$3.0 billion. We use a functional form of a demand curve which has roughly constant elasticity,³⁸ i.e. $P_D = \frac{K}{(Q_D)^N}$, where P_D is the price on the demand curve, Q_D is the quantity on the demand curve, and K and N are chosen to fit the admittedly limited data.

The functional form of the linear supply curve is $P_S = Z \times Q_S + P_0$, where P_S is the price on the supply curve, Q_S is the quantity on the supply curve, and Z and P_0 are chosen to fit the data which we have on the marijuana market. We re-estimate the supply function for each market segment independently. The estimated variables in the demand and supply curve estimates are chosen to match the dynamics of the market as described in literature we reviewed as well as through various formal and informal discussions with individuals knowledgeable on the market.

In the first step of our analysis, we analyze the effects of legalization on the marijuana market,³⁹ and assume that price would fall by 50 percent.⁴⁰ For the lower grade market, we assume that

See Nelson, Ariel, "How Big is the Marijuana Market," April 20 2010, <http://www.cnbc.com/id/36179677/How_Big_Is_The_Marijuana_Market>.

³⁵ This figure is a rounded estimate based on the research compiled in Gettman, John, "Lost Taxes and Other Costs of Marijuana Laws," September 5 2007.

³⁶ Cohen, Evan, "Survey of Marijuana Use at Cornell University," *The Michigan Journal of Economics*, Vol 13, No 1, 1997, pp. 72-79.

³⁷ Note that these prices have been chosen to be representative of two different market segments based on research. However, we are not in any way implying that they are the only two prices at which the market operates. Prices exist which are far below or above each of the prices used in this example, as described above in Section III. See Gettman, John, "Lost Taxes and Other Costs of Marijuana Laws," September 5 2007, pp. 22-24.

³⁸ See Appendix for the derivation and proof of constant elasticity.

³⁹ While an outward shift of the demand curve is certainly possible, the benefits to be gained of adding this complexity into this analysis did not outweigh the costs. There is considerable uncertainty to the magnitude and symmetry of any shift. The researchers we detailed above in Section III also assumed no demand curve shift. As Dr. Miron stated, "The assumption of no change in demand is plausible, and it likely biases the estimated tax revenue downward." (Miron (2005), p. 12). Regardless, the main action upon legalization of marijuana will happen on the supply side, and that is the focus of this analysis. The effects of slight outward movements of the demand curve on the conclusions of this paper are minimal.

⁴⁰ A 50% post-legalization fall in price is a reasonable estimate, and is supported by various sources, such as Samuels, David, "Dr. Kush: How medical marijuana is transforming the pot industry," *The New Yorker*, July 28 2008 <http://www.newyorker.com/reporting/2008/07/28/080728fa_fact_samuels?currentPage=all>. See also "Prepared Testimony of Robert Ingenito" *Board of Equalization*, October 28 2009, p 2. Miron, Jeffrey, "The Budgetary Implications of Marijuana Prohibition," June 2005, p 13-14. Montgomery, Michael, "Pot prices plummet in state, putting growers in a bind," *California Watch*, May 15 2010, <<http://californiawatch.org/watchblog/pot-growers-worry-over-falling-prices>>. Dr. Miron compared U.S. marijuana prices to those in the Netherlands, where marijuana is quasi-legal, and found that

the supply curve post-legalization would be a horizontal, perfectly elastic supply curve. This determination was made because California's entire current lower grade marijuana market could be grown on less than five thousand acres of land.⁴¹ Even at the lower end of yield per acre assumptions, marijuana production would utilize just two hundredths of a percent of California's 25 million acres of farmland. Increases in marijuana farming would not significantly alter the demand for arable land, fertilizer or water. Marijuana also grows in a multitude of climates and land types, and the yield per acre is so significant, that were farmers to notice profits being generated by growers, it would be quick and simple for them to transform crop land to marijuana in an amount sufficient to rapidly saturate the market. Thus, for the lower grade market, which is made up of low quality outdoor product, the price at which marijuana could be produced should not be affected by how much is being produced.

For the higher quality market, we expect the supply curve to continue to have a positive slope, which reflects the fact that growing high quality marijuana is more labor-intensive and requires specialized skills, equipment, and understanding as described above. Thus, the cost to produce high quality marijuana will increase as quantity produced increases, as will the price at which suppliers are willing to sell marijuana.

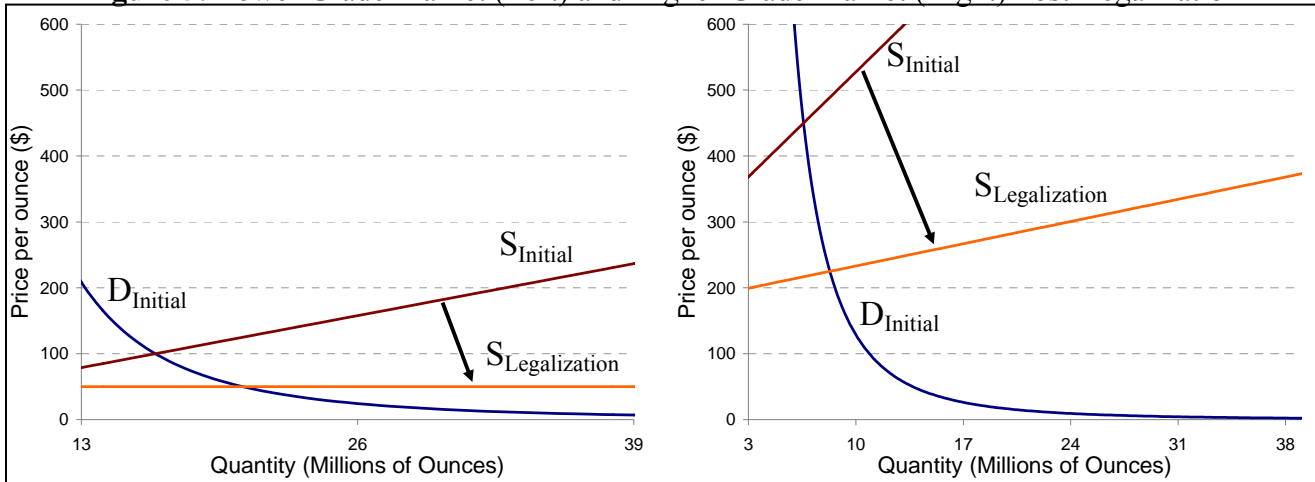
Below, we show the effects of legalization on the marijuana market. The demand curves for the higher and lower grades are assumed such that the market operates at current estimated price and quantity levels, and the elasticity of demand is consistent with results obtained in Cohen (1997). The incremental effect of legalization, given Mr. Ingenito and Dr. Miron's assumption and various other supporting data that price falls by 50%,⁴² is different in each market segment, as shown in Figure 5. In the lower quality market, price falls to \$50 per ounce and quantity increases to 20.6 million ounces, implying a new market size of \$1.0 billion. In the higher grade market, price falls to \$225 per ounce and quantity increases to 8.3 million ounces, implying a new market size of \$1.9 billion. The effects of legalization on the combined market were to decrease it from \$4.6 billion to \$2.9 billion, but to increase consumption more than 25% from 23 to 29 million ounces.

marijuana prices were roughly 50%-100% of U.S. prices; he used a maximum price drop of 50% for his analysis (Miron (2005), p. 13).

⁴¹ This was derived using a variety of estimates of pounds of dried marijuana produced per acre. See Stockberger, W. W. "Drug Plants Under Cultivation," *United States Department of Agriculture, Farmers' Bulletin #662*, June 5 1915, which claims 500 to 600 pounds per acre. Also see "A Perspective in the Profiteering of Marijuana," *California Police Chiefs Association*, which claims 12,250 pounds per acre. Also see Abdel-Monem, "Tamper Free Production of Marijuana for Medicinal Uses," *Washington State University*, February 5 1997, which assumes 750 kilograms, or 1,650 pounds per acre.

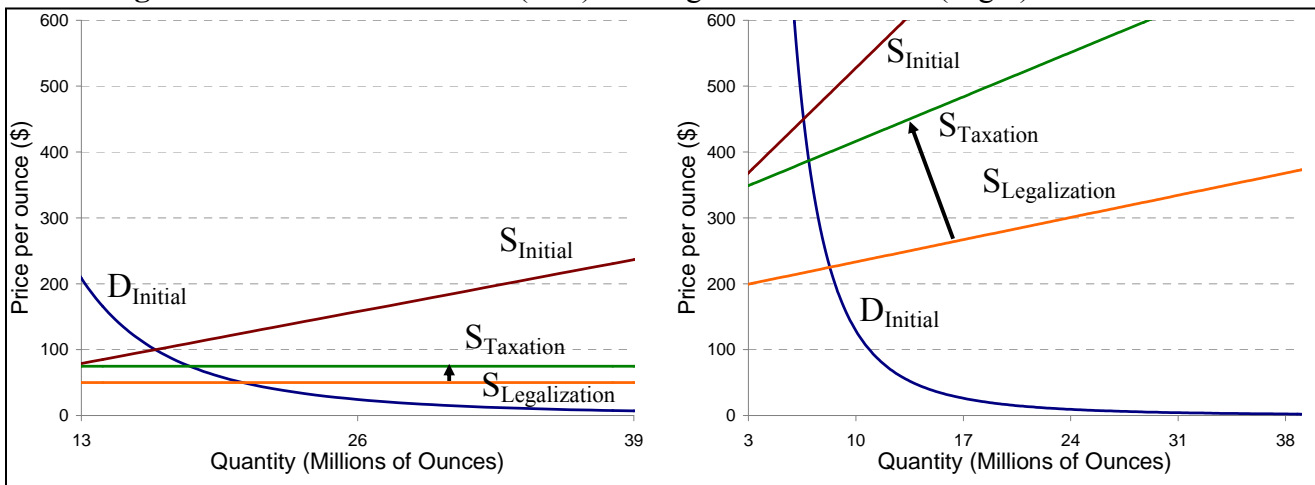
⁴² See footnote 40.

Figure 5: Lower Grade Market (Left) and Higher Grade Market (Right) Post-Legalization



We further suggest a tax of 50% on the pre-tax price of marijuana up to \$100 per ounce or ounce equivalent,⁴³ and a tax rate of 100% thereafter for every dollar above \$100 per ounce or ounce equivalent.⁴⁴ We arrived at this tax proposal as an approximate optimal balance among three factors: minimizing post-taxation consumption, maximizing tax revenues for any given market size, and attempting to minimize the continuance of any significant black market for marijuana. Using this tax policy as well as the other supply, demand and elasticity assumptions as described above, we can predict the prices and quantities which would prevail in each market. As seen in Figure 6, for the lower grade market, the equilibrium price of marijuana would be \$75 per ounce and quantity consumed would be 18.1 million ounces. For the higher grade market, price would be \$387 per ounce, and consumption would be 6.9 million ounces.⁴⁴

Figure 6: Lower Grade Market (Left) and Higher Grade Market (Right) Post-Taxation



⁴³ See footnote 9 for an explanation of ounce equivalent.

⁴⁴ Note that the after-tax price on marijuana which has a post-legalization equilibrium price of \$225 is \$400, but that the actual post-taxation price is \$387. This is because as a result of the taxation, the quantity demanded drops to 6.9 million ounces, and at that point, the pre-tax post-legalization price is \$218. If post-taxation quantity demanded were to remain constant at 8.3 million ounces, then the equilibrium post-taxation price would be \$400.

A comparison of the estimated market sizes for current, post-legalization and post-taxation markets is shown in Table 2 below.

Table 2: Comparison of Marijuana Market Sizes

	Current Market			Post-Legalization Market			Post-Taxation Market		
	Lower	Upper	Total	Lower	Upper	Total	Lower	Upper	Total
Q (million oz)	16.5	6.6	23.1	20.6	8.3	28.9	18.1	6.9	25.0
Total Price (\$/oz)	100	450	200	50	225	100	75	387	161
Market Size (\$b)	1.6	3.0	4.6	1.0	1.9	2.9	1.4	2.7	4.0

b. California Tax Implications

Given the market dynamics above for both the current bifurcated market and the predicted post-taxation markets, what are the implications for California of imposing the suggested tax structure? To summarize, about \$576 million less would be spent on marijuana in the post-taxation environment, consumption would increase by about two million ounces, or 8% over current market level, and tax revenues would equal \$1.6 billion. In addition, beforehand consumers spent \$4.6 billion, all of which went to suppliers, but after taxation, only \$2.4 billion would go to suppliers. Table 3 below summarizes both the low-grade and high-grade post-taxation marijuana markets in California.

Table 3: Summary of National Bifurcated Post-Legalization Taxed Marijuana Market

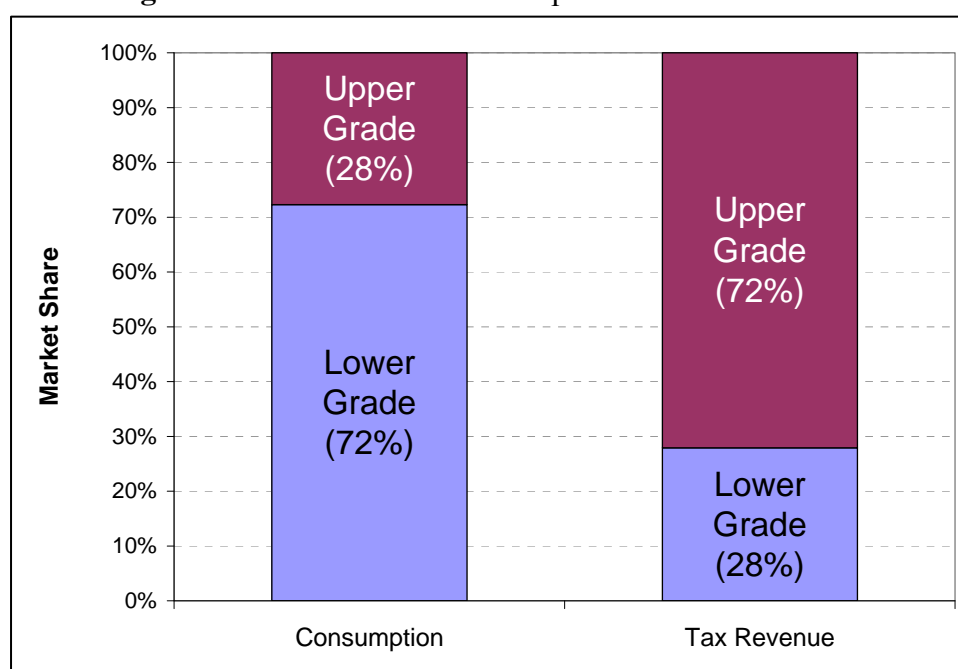
	Market Totals		
	Lower	Higher	Total
Q (million oz)	18.1	6.9	25.0
Base Price (\$/oz)	\$50	\$218	\$97
Tax (\$/oz)	\$25	\$168	\$65
Total Price (\$/oz)	\$75	\$387	\$161
Market Size (\$b)	\$1.4	\$2.7	\$4.0
Tax Revenue (\$b)	\$0.5	\$1.2	\$1.6

There are substantial benefits to this bifurcated view of the marijuana market compared to the simpler single market model described by Mr. Ingenito. Because the lower grade market is taxed at a lower tax rate, the post-legalization, post-taxation price of marijuana is 25% lower than the current market price. The main use of this tax for the lower grade market is to control demand, rather than generate revenue. As shown below in Figure 7, while about 72% of total consumption in a legalized, taxed marijuana market comes from this segment, only about 28% of total tax revenue is generated from lower-grade marijuana. The main consideration in this segment is to balance consumption with minimization of a black market to evade taxes. Allowing a significant black market to operate would be detrimental to government revenues, enforcement expenditures, consumer protection, and academic and medical research. A lower price in a legal environment will make the sustainability of a black market much harder, which is especially relevant considering that the largest supplier of the lower grade market is Mexican drug cartels. To generalize, the lower grade market is likely comprised of lower income-

generating individuals, who would have less to lose in terms of lifetime wages for a marijuana-related criminal charge, and thus are more willing to participate in a black market than a generalized participant in the higher grade market.

In contrast, it is much less likely that the higher grade market would turn to a black market if a legal alternative existed. This is true because the cost of high-grade marijuana is not as significant compared to the incomes of many participants in this market, and the individuals in the higher grade market generally have more to lose in terms of reputation loss and sacrificed lifetime earnings for a marijuana-related criminal charge. Thus, the higher grade market segment could better absorb a higher tax on marijuana. The main goal for policy-makers looking to regulate this segment should be to balance tax revenues with minimizing a black market.

Figure 7: Market Share - Consumption vs. Tax Revenue



However, the calculations above are sensitive to the assumption of a 50% price fall for legalized marijuana. Subsequently, we perform a sensitivity analysis on how much the price of marijuana falls post-legalization. We are most concerned with the evidence that the net fall in price post-legalization may be even greater than 50%; however, we also include estimates of tax revenues in the event that the price decline post-legalization is not as significant as predicted. We utilize the same tax policy described above, and calculate the final prices and market sizes of the lower grade and upper grade markets, as well as total tax revenues. These results, as well as the results from our base case, are summarized in Table 4 below.

Table 4: Sensitivity Analysis on the Post-Legalization Price of Marijuana

% Fall in Price Post Legalization	Lower Grade Post-Taxation Price (\$)	Higher Grade Post-Taxation Price (\$)	Tax Revenue Generated in California (\$ billion)
30%	105	578	2.2
40%	90	482	1.9
50%	75	387	1.6
60%	60	293	1.3
70%	45	202	1.0

As a note, this policy suggestion requires a simplifying assumption about the application of tax and regulatory policy in California. Section 11301 of The Regulate, Control and Tax Cannabis Act of 2010, the initiative to be voted on by Californians in November, gives local governments, not the state, the authority to regulate and tax marijuana.⁴⁵ Under a strict reading of the initiative, the regulation of marijuana could be different in every town in the state. This would include licensing, permitting, fees and taxes. The idea that each town could impose its own tax is difficult to analyze, other than to say that the consequences would likely be chaotic. We could envision scenarios where towns compete with each other to lure business by undercutting neighboring towns' taxes and fees; this type of game theory in maximizing local revenues is beyond this analysis. We have assumed for simplicity that California can adopt a uniform state-wide tax policy.

c. State-Run Marijuana Dispensaries

Our final analysis looks at the revenue and profit which could be generated if California were to open dispensaries for the purpose of selling marijuana in lieu of imposing a tax. This would very much be akin to the 18 alcoholic beverage control states, which exercise a monopoly over the sale of liquor. Eight of those states are also the exclusive retailer of alcohol.⁴⁶ The justification for such stringent regulation dovetails nicely with what the goals of regulation should be:

The purpose of control is to make liquor available to those adults who choose to drink responsibly - but not to promote the sale of liquor. By keeping liquor out of the private marketplace, no economic incentives are created to maximize sales, open more liquor stores or sell to underage persons. Instead, all policy incentives to promote moderation and to enforce existing liquor laws is [sic] enhanced.⁴⁷

It's not just that states could make more money "cutting out the middle man"; it's that the states would have much more control over the proliferation of legal marijuana with a single regulated supplier. In fact, substituting the word marijuana for alcohol or liquor in the paragraph above would make a perfect description for why California might want to take control of the retailing of marijuana after legalization.

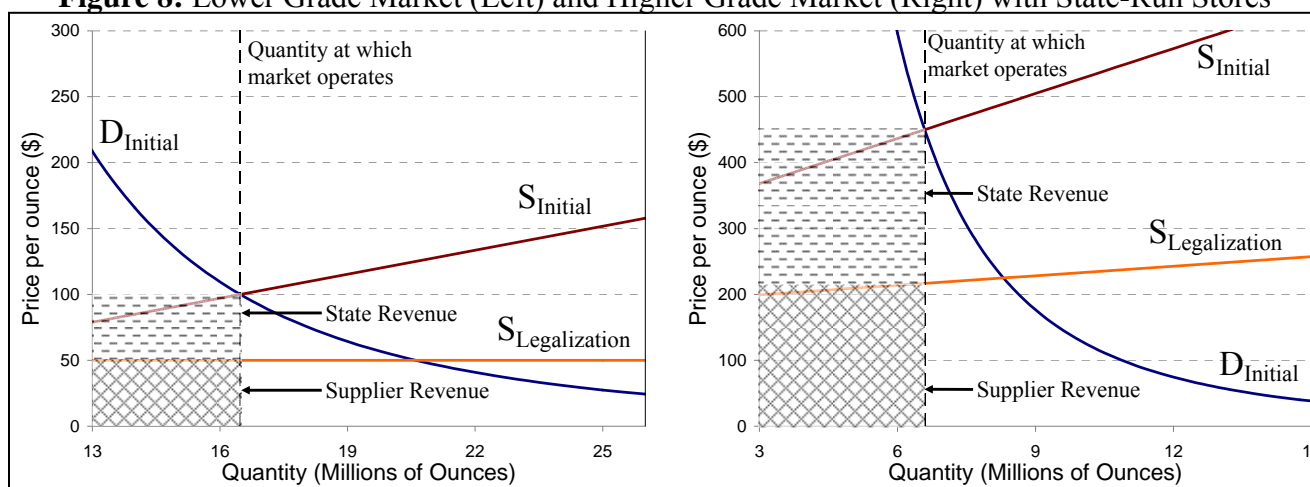
⁴⁵ <<http://www.taxcannabis2010.org/index.php/pages/initiative/>>

⁴⁶ National Alcoholic Beverage Control Association, Control States Data Matrix <http://www.nabca.org/StatisticalData/Files/control_states_matrix.pdf>

⁴⁷ The Origin and Purpose of the Utah Department of Alcoholic Beverage Control, <http://www.abc.utah.gov/Background/origin_purpose.html>

But how would the economics change for California? Using the segmented market analysis described above as a basis, if lawmakers were to sell marijuana at current prices, using the assumption that the demand curve did not shift as a result of legalization, the market would effectively remain the same in terms of quantities consumed and market size. An estimate of the cost of owning and operating these dispensaries (including the acquisition of marijuana) would be roughly equivalent to the post-legalization price of marijuana, as defined by the supply curves estimated in the analysis above. Using the cost estimates from the segmented, taxed market presented above, suppliers reaped \$2.4 billion of the \$4.0 billion market. When the state acts as a monopolist in the sale and distribution of marijuana, suppliers reap approximately \$2.2 billion,⁴⁸ but in a \$4.6 billion market, the state earns the remaining \$2.4 billion in profits.

Figure 8: Lower Grade Market (Left) and Higher Grade Market (Right) with State-Run Stores



This scenario also has benefits relative to a direct government tax. First, California can earn additional profits by selling the marijuana directly rather than taxing it. Second, the state can more carefully regulate the sale of marijuana to ensure that certain restrictions, such as sale to minors, are upheld. Allowing it to be sold in convenience stores or bars leaves enforcement in the hands of owners of these establishments. Third, California can adjust prices dynamically to address potential issues such as the continuance of a black market, a change in consumption habits, or a bumper crop. For example, if the state witnessed the continuance of a black market post-legalization, it could easily lower prices in the stores, eliminating or limiting the growth of the black market. If California were forced to lower prices, state earnings would be less than the \$2.4 billion forecasted above, but the difference would be available for others in the supply chain.

By effectively embedding a different tax into each grade of marijuana, California would have much more control in terms of pricing and quantity in all market segments. Through such dynamic pricing, the state would also have the ability to provide de facto subsidies to farmers, as they could choose to pay higher prices to specific farmers, maybe to encourage growth of particular types of marijuana or to incentivize expansion into certain geographic areas. This

⁴⁸ The revenue to suppliers decreases by \$165 million when the state acts as a monopolist because the higher price above the post-legalization price results in a slightly lower quantity supplied.

pricing mechanism would thus provide much more freedom than a tax, since a tax cannot be too complex and takes time and legislation to change.

Because of the nature of the initiative going to ballot in California in November, the implementation of state-run dispensaries may be the best initial policy decision for California's state legislature. Rather than leaving each individual municipality the task of devising its own regulatory structure, if state law permits it, California's legislature should immediately enact this policy and take control of the sale of marijuana in the event of passage of the initiative.

V. Conclusions

We believe that a tax rate which starts at 50% for the first \$100 per ounce equivalent and increases to 100% for subsequent dollars per ounce will provide California with about \$1.6 billion in tax revenue each year, while minimizing the size of the black market and the total dollar amount spent on marijuana. A preferable solution for various economic reasons would be to sell marijuana through state-run dispensaries, generating \$2.4 billion for the state, and allowing more control in terms of use, subsidies to suppliers, and prevalence of the black market.

Our analysis implements a simplified model of the marijuana market, a necessary consequence of the current lack of data on the supply and demand dynamics of the marijuana market itself. We feel that as a first-pass, one of the tax policies described above will serve the purposes of controlling marijuana use, generating tax revenue, and limiting the size of the black market. However, post-legalization and regulation, as more data can be gathered, policy makers should consider certain aspects of the marijuana market in closer detail. For example, the heterogeneity in the marijuana market should be further understood. There is a substantial difference on so many levels between marijuana that sells for \$50 per ounce, and marijuana that sells for \$500 per ounce, and there are many products in between. The products being sold are quite different, and appeal to completely different consumer bases. Thus each market segment could respond to the tax differently, even if the tax is a percentage of the price charged.

As stated at the outset, we are not endorsing either side of the marijuana legalization debate, and we're not presuming that the solutions we've presented are the magic bullet. We believe, however, that it is important to think about all the regulatory and tax structure issues now, as there is a real likelihood that California will choose to legalize marijuana this November. We believe that as an initial policy decision, what we've suggested is both sound policy and economics. We hope that the next steps in the debate include further discussion on critical aspects of policy and regulatory design which need to be addressed before the will of the California voters is enforced this November.

VI. Appendix

1. Derivation of the Demand Function

The constant elasticity demand function is $Q = A \cdot P^M$. Proof of its constant elasticity is in Appendix 2. M is a constant and is the elasticity of the function. A is a constant.

We can rewrite this equation, $Q = A \cdot P^M$, in term of P .

$$P^{-M} = \frac{A}{Q}$$

$$(P^{-M})^{\frac{-1}{M}} = \left(\frac{A}{Q}\right)^{\frac{-1}{M}}$$

$$P = \frac{A^{\frac{-1}{M}}}{Q^{\frac{-1}{M}}}$$

Let $N = \frac{-1}{M}$ and $K = A^N$. Then $P = \frac{K}{Q^N}$. The demand function is completely determined by (1) the elasticity of demand and (2) one pair of P and Q , those observed in today's market.

2. Proof the Demand Function has Constant Elasticity

The demand function is $Q = A \cdot P^M$. Let Q be the amount demanded, P be the price at which it is demanded, and let A and M both be constants.

$$\begin{aligned} \text{Elasticity} &= \frac{\frac{dQ}{Q}}{\frac{dP}{P}} = \frac{dQ}{dP} \cdot \frac{P}{Q} \\ &= M \cdot A \cdot P^{M-1} \cdot \frac{P}{Q} \\ &= M \cdot A \cdot \frac{P^M}{P} \cdot \frac{P}{Q} \\ &= M \cdot \frac{A \cdot P^M}{Q} \\ &= M \cdot \frac{Q}{Q} \\ &= M \end{aligned}$$

The elasticity of the function is M , a constant.