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Examining the Impact of Marijuana Legalization on Harms Associated with Marijuana Use

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Examining the Impact of Marijuana Legalization on Harms Associated with Marijuana Use

By

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Abstract:

This paper provides suggestive, but not definitive, evidence of the potential budgetary effect to the state of California of an increase in marijuana use associated with legalization for marijuana on health care costs. Estimates are focused on scientifically established health harms for which data is readily available, including the number of dependent users, treatment costs, emergency room visits, and hospitalizations. The exercise shows that the rise in health care expenditures associated with scientifically established health harms known to be associated with use are likely to be small relative to the expected revenue and cost-savings associated with reductions in criminal justice savings. However, the human effects, as measured in terms of lost lives (to car fatalities) and dependence are not estimated to be small. Importantly, the potentially most significant health care costs for California taxpayers would come out of areas where the science has not reached a consensus, namely the causal effects of marijuana on psychoses, schizophrenia, and drugged driving. As the scientific literature regarding these health harms in particular develops further and reaches a consensus regarding the causal impact of marijuana use on the development, progression, and treatment of specific problems, our knowledge of the actual health care expenditure associated with marijuana use will be more precise and a better cost-benefit calculation may be made.

Significant debate has emerged over the year related to a series of legislation and ballot initiatives that would legalize marijuana in California. Advocates for the policy change emphasize the significant tax revenue that can be generated for a cash-strapped state that has been forced to dramatically cut public services, including health care, education and public safety. With over a thousand medical marijuana shops in existence already across the state, many Californians wonder why the product is not already getting taxed and see this as a logical next step. Not everyone is convinced that the net effect of legalization of marijuana will be positive let alone a net fiscal gain, however. The public health community in particular is concerned that legalization would lead to a large increase in use, and with that use, a rise in the harms associated with use including higher treatment episodes, hospitalizations, and drugged driving accidents. As marijuana is already the primary drug of abuse in California, with one-fifth of all treatment admission in the state due to marijuana and the vast majority of these costs are paid for by the taxpayer, the potential for harm caused by a further increase in use is not unrealistic.

An unanswered question for the California voter is whether the harms associated with a rise in marijuana use are large enough to offset any fiscal gains in terms of tax revenue. In this paper we explore this question by looking at the potential effect of an increase in use on the number of well-documented marijuana health harms: the number of dependent users, treatment episodes, emergency room visits, hospitalizations, and drugged driving fatalities. While this does not represent a comprehensive list, it does represent those areas where the science is clear that a health harm is clearly caused by the use and/or abuse of marijuana. However the analysis is significantly limited by the nascent science in two particular ways: (1) for many health harms, such as psychosis, schizophrenia and respiratory illnesses, the scientific literature is still advancing and so it is possible that omitted from this analysis are potentially significant and costly health harms; and (2) the literature identifying how the effect of a policy change (lower price, lower legal risk, or change in social norms) could change the amount of marijuana that gets consumed by existing users or daily users is completely inadequately to understand whether there are dose-response relationships between use and particular harms, as theory might suggest. Thus in most instances, the analysis is stuck projecting changes in harms off of presumed changes in prevalence rates that we know are correlated with average levels of use among users but not accurately predictive of that.

With these very important limitations in mind, a few key insights emerge from this analysis. First, it is unlikely that a rise in the known health harms would lead to a large enough cost to taxpayers to off-set the revenue gains from legalizing and taxing, assuming that taxes are actually paid and not evaded. Second, there are a few areas of potential health harms where causal inference remains unclear, and if some of these areas are subsequently found to be causally related to drug use, then the costs could be sufficiently high that they become potentially more important to consider with respect to a policy change. Third, while the harms considered suggest relatively modest budgetary effects from a taxpayer perspective based on the assumptions made, there are very significant non-budgetary effects associated with the rise in marijuana use that are likely to be important to California voters. In particular, we predict a large rise in the number

of dependent users as well as a near doubling of fatalities associated with drugged driving.

The rest of this paper is organized as follows. In the next section we begin with a discussion of the probable impact of a decline in prices on use and the number of dependent users. We then move in the second section to a discussion of discuss the probable impact on treatment episodes. In the third and fourth section, we consider the impact of a rise in consumption on emergency room visits and hospitalizations, respectively. We then in the fifth section consider the impact of a rise in use on drugged driving. Sensitivity analyses are conducted throughout and the potential effect on California taxpayers are considered.

I. Number of Dependent Users

A major concern regarding a change in policy has to do with a rise in dependence that could occur with a rise in consumption. There is now a convincing scientific literature showing the marijuana is addictive and people do in fact experience real dependence syndromes (see Hall and Pacula, 2003, for a review). Epidemiological evidence from a variety of studies employing similar methods in the US, Australia, Canada and New Zealand during the 1990s show that about 4% of the population in each of these countries met DSM-III criteria for abuse or dependence on marijuana at some point in their lives (Hall et al., 1999; Russell, Newman and Bland, 1994; Hwu and Compton, 1994; Wells et al., 1992; Anthony et al., 1994; Robins and Reiger, 1991). This translates into approximately 1 in 10 lifetime users who have enough symptoms to be qualified for the label of experiencing abuse or dependence.

Table 1 shows the number of people in the U.S. household population who meet DSM-IV criteria for abuse or dependence in the past calendar year from 2002-2008, the most recent survey year (SAMHSA, 2009). As can be seen here, the number of dependent users has been relatively stable over the period, hovering just over 4 million (the average for the 7 year period is actually 4.2 million). Trend analysis related to the prevalence of past year users has also been relatively stable over this same period, as shown in the second column of Table 1.¹ If we divide the number of dependent users by the number of past year users, say for 2008 (35.53 million), we find that the ratio of dependent users to past year users in the U.S. is amazingly close to the 1 in 10 number observed in previous decades pertaining to lifetime users. Today, 11.8% of *past year users* meet DSM-IV criteria for abuse or dependence.

¹ Major design changes in the NSDUH survey occurred during the middle of this period which make led to changes in the populations projected by prevalence rates in a given year. Prevalence rates, however, remained stable and are probably remained far more stable, at least in terms of reports of past year use.

Table 1: Dependent Users of Marijuana in the Past Year 2002-2008

Year	Number of People Meeting DSM-IV Criteria for Abuse or Dependence (In Millions)	Percent of Household Population Reporting Use of Marijuana in the past year
2002	4.3	11.0
2003	4.2	10.6
2004	4.5	10.6
2005	4.1	10.4
2006	4.2	10.3
2007	3.9	10.1
2008	4.2	10.3

If we assume the number of dependent users is evenly distributed across the U.S. in a manner consistent with the U.S. population, then the fact that California contains 1/8th of the population in the United States suggests that it holds at (.125*4.2 million=) 525,000 dependent users prior to the policy change.²

How would this number change with a change in the policy? We begin with some very basic assumptions regarding the hypothesized change in price associated with legalization, a thirty-day participation price elasticity and the non-price effect of legalization on prevalence. In a previous chapter, we use information on the cost of production and change in consumption to estimate the impact of legalization on the legal price of marijuana (Caulkins, 2010a). Based on findings in that model, our best guess is that price will fall by 75%. Assuming a participation price elasticity of -0.3 (Pacula, 2010), and a non-price effect of +0.35 (MacCoun, 2010), the anticipated total change in thirty day prevalence associated with legalization is expected to be nearly sixty percent ($-0.75 \times -0.3 + 0.35 = 0.58$). In light of the previous findings that the number of dependent users is a constant proportion of the number of past year users, we can assume that the number of dependent users also rise 58%. Under these baseline assumptions, we predict a rise in the number of dependent users by over 300,000 (actual estimate is 304,500).

Of course, there is tremendous uncertainty underlying all of the parameters used to generate this estimate. Thus in Table 2 we show how sensitive this estimated rise in the number of dependent users is to alternative assumptions regarding the size of the fall in price, the demand response (in terms of elasticity of demand), and the non-price effect on consumption. As can be seen in this table, the hypothesized effect on number of new dependents is indeed quite sensitive to the assumptions made for each of the

² Alternatively, we have calculated the number of dependent users based off of estimates of California's population, the NSDUH state prevalence rate for past year users (11.24%) and the implied relationship of dependence to past year user and gotten a very similar estimate = 354,000. As the proportion of population estimate is slightly smaller, we will use it for our baseline estimate.

Table 2: Sensitivity Analyses of Alternative Parameter Estimates on Number of New Dependents

Change in Single Model Parameter	Net Increase in Number of Dependent Users
Hypothesized change in price	
-50%	262,500
-75%	304,500
-90%	325,500
Assumptions regarding price elasticity	
-0.20	262,500
-0.30	304,500
-0.50	380,625
Assumptions regarding non-price effect	
0.05	144,375
0.35	304,500
0.50	380,625

parameters, leading to very broad ranges on the number of dependents. The minimum and maximum number of new dependents under the various alternatives differ by a factor of 3, with the assumption regarding the non-price effect having the largest impact.

There are currently no estimates in the literature of the social cost of a dependent user, thus it is not possible to quantify a budgetary impact of this rise in dependence on California taxpayers. Not all dependent marijuana users enter into or receive drug treatment, and those that go on living with dependence may experience reductions in their productivity, increases in their health care costs, and difficulties with their family responsibilities. To the extent that dependence does impose costs to individuals in any of these forms, a rise in the number dependent represents a real loss to the citizens of California, albeit one that is not measured through budgetary impacts.

II. Impact of Legalization on Marijuana Treatment Episodes

Marijuana is now the primary drug of abuse in one-fifth of California treatment admissions; and the majority of treatment costs are borne by the taxpayers. If legalization leads to increased marijuana use and dependence, one might expect an increase in marijuana treatment to partially offset some of legalization's beneficial effects on California budgets. The question we try to address here is whether that is a large or relatively minor consideration.

The answer is complicated by the role of criminal justice system (CJS) referrals to marijuana treatment. After legalization, the only CJS referrals of those 21 and older would be of marijuana-dependent individuals charged with another offense (e.g., burglary). Some of those who would no longer be referred directly might still find their way into treatment later on by some other route, but we found no data to quantify that effect. Hence, as a first pass we divide the marijuana treatment population into four primary groups based on age (over or under 21) and source of referral (criminal justice

system or other). Table 3 shows what would happen to marijuana treatments if the 21 and over criminal justice referrals disappeared, and the other three groups' numbers increased by 50% or by 75%, two numbers that are plausible given the expected increase in marijuana use.

Table 3: Plausible Rough Estimates of Legalization's Effect on Marijuana Treatment

	Today	After Legalization with Dependence Increasing by	
		50%	75%
21 and older CJ referrals	9,164	0	0
21+ other referrals	5,305	7,958	9,284
<21 CJ referrals	7,749	11,624	13,561
<21 other referrals	12,343	18,515	21,600
Total	34,561	38,098	44,446
Increase in Treatment		3,537	9,885
% Increase		10%	29%

Even at these relatively large assumptions regarding the proportional increase in treatment admissions, the total increase in the numbers treated rise by relatively small amounts (only 39% when all non-CJS treatment admissions are presumed to rise by 75%). At an average cost of \$575 per treatment episode, this suggests an increase in treatment expenditures on the order of from \$2.0 - \$5.6 million. With government being responsible for about 60% of these expenditures, it suggests a budgetary impact on the order of only a \$1.2 to \$3.4 million, only a few million dollars annually. Such sums, while not unimportant in an absolute sense, are small compared to the uncertainties in the hundreds of millions of dollars concerning tax revenues.

The remainder of this section gives a more detailed and careful derivation of the simplified results summarized in Table 3 as well as an explanation where some of the assumptions underlying the calculations come from. What is shown is that even with more careful construction of the effects on treatment and varying assumptions regarding plausible parameter changes, the net result in terms of taxpayer costs is not all that significant relative to other factors being considered (criminal justice savings, emergency room episodes, and so on).

II.A. Who is in Treatment for Marijuana in California Before a Policy Change

We begin with an examination of the number of primary marijuana treatment admissions in California over the past 15 years. Table 4 shows the number of treatment episodes by year and for specific age groups from 1995-2009 both in total and for which marijuana was the primary drug of abuse. There are other episodes for which marijuana was mentioned as a secondary or tertiary contributing substance, but the custom in the literature is to attribute the episode to the primary substance.

Table 4: Marijuana Treatment Admissions for California 1995-2009

	MJ-primary	Total ADM	%MJ	%12-17	%18-20	%21-25	%26-30
1995	11,275	183,488	6.1	45.9	10.7	11.9	10.1
1996	11,971	172,277	6.9	48.1	10.3	10.9	9.9
1997	12,266	163,606	7.5	44.1	11.5	11.9	10.7
1998	13,762	157,755	8.7	46.0	11.4	11.5	9.3
1999	17,092	181,549	9.4	45.8	11.9	12.2	9.0
2000	18,848	183,566	10.3	46.8	11.7	13.5	8.7
2001	21,729	178,876	12.1	48.9	12.1	12.8	7.8
2002	28,250	213,570	13.2	44.9	12.3	14.8	8.0
2003	27,499	203,344	13.5	43.1	12.0	15.9	8.5
2004	24,858	183,704	13.5	42.3	11.3	16.6	9.5
2005	26,718	183,200	14.6	43.4	11.3	15.4	9.5
2006	29,308	197,617	14.8	44.6	11.0	14.9	10.1
2007	32,659	201,649	16.2	44.5	11.5	14.2	10.1
2008	35,461	201,027	17.6	46.4	11.6	13.6	10.0
2009	32,616	172,280	18.9	50.0	11.5	12.5	9.2

Source: Treatment Episode Survey Data, State data. <http://www.dasis.samhsa.gov/webt/NewMapv1.htm>

There are several things to note from this:

- Marijuana as a fraction of total treatment admissions is growing within the state, representing only 6% of total admissions in 1995 and accounting for 19% in 2009. This is consistent with patterns in the Netherlands, Australia and other parts of Europe.
- The bulk of these marijuana treatment admissions (89% for the period 2005-2008) are handled in outpatient settings, most of which are non-intensive. However a surprising fraction (8.5% between 2005-2008) are handled in long term residential treatment. A third of these cases treated in residential settings involve youth between the ages of 12-20.
- A large share of the marijuana treatment admissions in California facilities over time (45 to 50%) involve youth between the ages of 12 and 17, while another 10-12 percent are individuals between the ages of 18 and 20. These age groups (youth and young adults less than 21) have been consistently represented in treatment admissions even with the advent of Prop 36 and drug courts. Importantly, more of the treatment admissions experienced by youth are paid for by government payers (65.7%), suggesting that the overrepresentation of youth in California treatment settings may mean a larger share paid for by the taxpayer today. This is explained in greater detail below.

A perennial debate concerning marijuana treatment admissions is whether they are “real” in the sense of truly being medically indicated or are merely an artifact of criminal justice referrals, e.g., because the courts are using treatment referrals as a form of prison diversion. The latter motivation would disappear if marijuana were legalized (at least for adults over 21). Table 5 shows the fraction of episodes that are due to criminal justice referrals has grown since 1995 and now hovers around 50%, after a peak in 2002 of nearly 60%, but that does not speak directly to whether the criminal justice system was

intervening usefully with people who truly needed treatment or was exploiting treatment as a convenient escape valve in the face of prison and jail over-crowding.

Table 5: California Marijuana Treatment Episodes Involving Criminal Justice Referrals

	MJ-primary	%MJ that are CJ referrals	Non-CJ MJ - primary
1995	11,275	41.6	6,585
1996	11,971	47.4	6,297
1997	12,266	48.6	6,305
1998	13,762	49.5	6,950
1999	17,092	53.1	8,016
2000	18,848	56.4	8,218
2001	21,729	56.5	9,452
2002	28,250	59.6	11,413
2003	27,499	58.3	11,467
2004	24,858	56.3	10,863
2005	26,718	50.8	13,145
2006	29,308	50.6	14,478
2007	32,659	49.6	16,460
2008	35,461	48.9	18,121
2009	32,616	51.9	15,688

Source: Treatment Episode Survey Data, State data. <http://www.dasis.samhsa.gov/webt/NewMapv1.htm>

But while nearly half of all treatment admissions come through the criminal justice system, it is important to differentiate youth from adults, as use by youth (individuals < 21 years of age) will still be illegal under the change in law and subject to probable diversion into treatment. Table 6 shows the breakdown of source of referral for youths versus adults in the 2008 California treatment data (can't get individual level information for 2009). Key insights are that:

- While half of all marijuana treatment admissions are CJ referrals in California, this is largely driven by referrals for adults and young adults between the ages of 18-20. For youth, who represent nearly half of all admissions to treatment in 2008, only one-third come from criminal justice referrals.
- Assuming use and possession remains illegal for individuals < 21, Table 6 demonstrates we will avert 63.3% of adult cases (age 21 and older) – and the adult cases represent < 45% of all cases. In 2008, we avert 9,164 treatment admissions for marijuana, or 25.8% of the treatment admissions.

Table 6: Primary Source of Referral for California Treatment Admissions in 2008

Source of Referral	Age(12-17)	%(12-17)	Age(18-20)	%(18-20)	Age (21+)	%(21 +)
Individual	3031	18.9	820	20.4	2443	16.9
ADP service provider	816	5.1	175	4.4	543	3.8
Other health care provider	824	5.1	79	2	300	2.1
School	2954	18.4	139	3.5	24	0.2
Employer/EAP	12	0.1	9	0.2	89	0.6
Community	2937	18.3	547	13.6	1906	13.2
Court/criminal justice system	5497	34.2	2252	56	9164	63.3
Total MJ Admissions	16,071	100%	4,021	100%	14,469	100%

Author's own analysis of on-line TEDS data available at :
<http://www.icpsr.umich.edu/cocoon/SAMHDA/DAS3/00056.xml>

II.B. Who Pays for Marijuana Treatment and How Much Does it Cost?

Why should California taxpayers care about the number of people in drug treatment? As stated above, unlike most medical services the vast majority of drug treatment is paid for by the government either through government insurance (Medicaid, Medicare, SSDI) or other government payments (block grant funds to pay for free care, prison drug treatment, etc). Individuals and private insurance currently pay for less than 20% of all drug treatment services provided. This is particularly true for treatment received by youth, who in California make up the majority of treatment episodes. Table 7 shows the breakdown of expected source of payment for youth (ages 12-20) in treatment in California for 2008.³ Two-thirds of all admissions were paid for by government insurance or payments, and another 7 percent of free care was made possible due to government block grants made specifically to local areas. Less than 20% of treatment admissions for youth were expected to be paid by individuals or private insurance. So, ultimately, the California taxpayer is paying for 80% of youth treatment episodes.

Table 7: Expected/actual source of payment for treatment of youth (ages 12-20), 2008.

Expected/actual source of payment for treatment	N	%
Self-pay	6030	10.9
Blue Cross/Blue Shield or other private insurance	5146	9.3
Medicare, worker's comp	131	0.2
Medicaid/Medi-cal	16,936	30.6
Other govt payments	19,351	34.9
Free / charity	3971	7.2
Other	3819	6.9

Author's own analysis of on-line TEDS data available at :
<http://www.icpsr.umich.edu/cocoon/SAMHDA/DAS3/00056.xml>

What does it cost California taxpayers? Using average cost estimates derived as part of the California Treatment Outcome Project (Ettner et al., 2006) and using information on the median length of stay in treatment, we estimate that the total cost of marijuana

³ Information regarding source of payment was not available for the most recent 2009 data at the time of this writing.

treatment in California in 2009 was \$25.6 million.⁴ If we consider just the taxpayer's burden for treating youth (those < 21), it is basically half of this amount, or \$12.6 million in 2009.⁵ If we add in the fraction of adult episodes paid for directly by the government (Medicaid, Medicare, worker's compensation, and other government payers), which represents 53.5% of adult cases, then the California taxpayer paid for a total of \$17.9 million in marijuana drug treatment in 2009 (or 69.9% of the total cost of marijuana treatment). Of course, this only represents costs for those cases in which marijuana is the *primary* drug of abuse. There are another 380,000 cases where marijuana is also mentioned as a drug of abuse, just not as the primary drug. As it is difficult to understand which of these treatment episodes were driven by the marijuana use in conjunction with the other substance, it is unclear how we should treat these cases. For the purposes here, we simply note that all of the estimates focused on treatment costs here ignore those cases and only consider instances where marijuana is the primary reason for the treatment episode.

II.C. Predicting the Effect of a Policy Change on Marijuana Treatment Episodes and Cost

We are unaware of any studies that have examined how dependence, particularly among youth, changes in response to a change in prices or legalization. Thus it is difficult to know with certainty how treatment costs will change, and in particular those born by the California taxpayer, in response to California's proposed change in policy. Nonetheless, there are a few pieces of information that could be used to try to generate an estimate of what could happen given a change in policy under some very simple (but refutable) assumptions: (1) non-criminal justice referrals for adults will occur in the same proportion to total consumption as they do today; (2) there will not be an increase or decrease in the rate of enforcement against youth, so CJ referrals of youths will grow proportionately with an increase in youth use; (3) marijuana abuse/dependence, and by extension the fraction of people seeking treatment for abuse/dependence, is constant as a proportion of the number of regular users. This last assumption is perhaps the most contentious as it may be that concentrating more dollars on prevention may generate a reduction in the number of individuals who abuse or become dependent on marijuana. Alternatively, it may be that the decline in price associated with legalization leads to even more abuse/dependence among regular users than when price is significantly high. Of course, there are numerous reasons why one might speculate that this assumption overestimates or underestimates what will truly happen to the number of people seeking

⁴ Data on length of stay is heavily skewed to the right, so the median length of stay in treatment is significantly shorter than average lengths of stay (SAMHSA, 2008). To make sure we error on the conservative side, we use as our cost per episode the median length of stay, generating a cost per residential treatment of \$2,439.00 (rather than \$4,4146 for the mean length of stay) and \$630.04 (rather than \$920.19) for outpatient treatment. In California in 2009, there were 2,772 (8.5%) inpatient episodes for marijuana and the rest (29,844) were outpatient visits (based on author's calculation of TEDS on-line state data, see footnote to Table 1).

⁵ We know that 61.5% of all treatment admissions in 2009 were for individuals < 21 (from Table 1), and per calculations in the previous paragraph, the taxpayer is paying for at least 80% of these youth cases. Even if marijuana is legalized for adults, criminal justice referrals for youth will remain so it is appropriate to keep them in this baseline calculation. Thus to calculate the cost for just youth you multiply: \$25.6 million x 0.0615 x 0.80 = \$12.6 million

treatment, but given the lack of data available to empirically test these alternative assumptions we are left picking a somewhat neutral and plausible starting point.

To be consistent with methods applied to other health harms (described later in this chapter), we will assume that the number of people entering drug treatment with marijuana as the primary drug of abuse rises in proportion to the number of past month users. We focus on past month users because they are the ones that are more likely to use regularly and experience problems of abuse or dependence. Table 8 shows the calculations needed to estimate the effect of legalization on marijuana treatment under the assumption that drug treatment increases in proportion to the increase in the number of users. As youths are treated differently under the law than adults and because such a large fraction of current treatment admissions are youth, we estimate these numbers separately for youth and adults.⁶

Table 8: Generating an Estimate of the Fraction of Past Month Users Who End up in Treatment

Population of Users, NSDUH and CA Dept of Finance	
2009 Population of 12-17 year olds	3,497,305
2009 Population of 18 year olds and older	28,071,669
Thirty-day prevalence of MJ Use, 12-17 yr olds	0.068
Thirty-day prevalence of MJ Use, 18 and up	0.065
Total number of youth past month users	238,866
Total number of adult (18+) past month users	1,830,273
Treatment Admissions, 2009 California TEDS	
All treatment admissions 2009, including alcohol	172,280
MJ primary drug of admission, 2009	32,616
Youth (12-17)& MJ admission	16,308
Adult (18+) MJ admissions	16,308
% Adult MJ tx non-CJ referral	37%
Youth MJ tx to 30 day user	0.068
Adult MJ tx to 30 day user	0.009
Adult MJ tx to 30 day user- No CJ referral	0.003

As illustrated in Table 8, thirty day prevalence rates between youth and adults are approximately equal in California according to data from 2006-2007 NSDUH. This is due in large part because of individuals between 18-25 being grouped with adults, thus bringing up the average for the adult group. And as was already pointed out in Table 3,

⁶ The state-level NSDUH data are not reported in a manner that allow us to know the prevalence rate among 18-20 year olds separately. Instead, data are reported for 12-17, 18-25 and 26 and older. In light of this significant limitation, and combined with the fact that more 18-20 year olds are diverted to treatment from the criminal justice system (like adults) than youth, in this section we group 18-20 year olds with adults rather than youth.

approximately half of all marijuana treatment admissions in 2009 were for youth (12-17), which is why in Table 8 the total treatment admissions are evenly split between youth and adults. However, a very large fraction (63%) of the adult marijuana admissions are the result of criminal justice referrals. These cases would not result if marijuana were legalized, unless some of these people were in fact convicted of other offenses or eventually decide to self-refer. Taking a conservative approach of assuming that none of these adult criminal justice referrals are due to a real need for treatment, we will base our projection of the proportion of adult users who end up in treatment on all non-criminal treatment episodes. At the bottom of Table 8, this assumption means that less than one half percent (0.3%) of all adult past month users end up in treatment in a given year. In the case of youth, a policy change could still result in referrals to treatment from the criminal justice system as it will remain illegal for youth to use marijuana. Thus the fraction of youth marijuana treatment episodes to thirty day users for 2009, 6.8%, retains these individuals in the total number of treatment admissions and generates an estimate of the fraction of past month users who end up in treatment.⁷

Based off of these historical estimates of the fraction of regular users in California who enter treatment⁸, we develop an estimate of the increase in annual treatment episodes under specific assumptions regarding what that change in policy will do to the price of marijuana. Table 9 demonstrates what the implied increase in thirty-day prevalence rates among youth and adults users means in terms of additional treatment episodes. With the assumptions specified above, the increase in thirty day prevalence would generate an extra 9,377 new youth treatment admissions, and an increase of 3,441 new episodes among adults, for a total of 12,818 new admissions each year. However, there would also be a reduction in treatment admissions associated with criminal justice referral, which according to the 2009 data was approximately 63% of adult cases (n=10,274). So, on net the impact of the policy change could net a relatively minor net increase of treatment episodes of 2,544, which at a weighted average price of marijuana treatment of \$576.49 (obtained by taking the weighted average of inpatient and outpatient cost per episode) results in nearly a \$1.5 million dollar increase in total spending on treatment, of which \$1.025 million would fall upon the taxpayer.⁹

⁷ Recall, this assumes that enforcement against minors remains constant, which is clearly uncertain.

⁸ Another implicit assumption in this calculation is that every treatment admission represents a unique individual, which we know is not the case. However, very few people re-enter treatment for marijuana abuse. The average number of treatments for marijuana abuse/dependence reflected in available data is just over 1 episode, unlike findings for other drugs. Thus, we will maintain this assumption without fear of grossly misrepresenting the problem.

⁹ The net increase in treatment projected using this method is smaller than that shown in Table 3 because it presumes that additional adults identified through the CJS would not be referred to treatment (10,274).

Table 9: Calculation of the Possible Effects of Legalization on Treatment Costs for California Taxpayers

Hypothesized Effect of Legalization on Thirty-Day Prevalence	
Hypothesized change in price	-75%
Thirty day participation price elasticity	-0.3
Non-price effect of legalization on prevalence	0.35
Percent change in youth & adult prevalence rate	57.5%
Thirty-day prevalence of MJ Use, 12-17 yr olds	0.068
Thirty-day prevalence of MJ Use, 18 and up	0.065
Implied increase in youth prevalence rate	3.9%
Implied increase in number of youth users	137,348
Increase in youth treatment admissions	9,377
Implied increase in adult prevalence rate	3.7%
Implied increase in adult users	1,052,407
Increase in adult treatment admissions (non-CJ)	3,441
Increase in treatment admissions due to new users	12,818
Reduction in treatment admissions due to no CJ referrals	10,274
Net effect on treatment admissions	2,544
Weighted average cost of marijuana treatment (\$2009)	\$576.49
Additional cost of net treatment episodes	\$1,466,845
CA taxpayer's burden of additional cases	\$1,025,324

How sensitive are these results to the assumptions underlying the model? We show in Table 10 just a few sensitivity analyses. What is readily apparent is that the increase in the cost of treatment does not seem to be a particularly important factor for rejecting a policy change, in large part because of the savings that emerge by reducing the enormous number of referrals to treatment from the criminal justice setting. If we were to make alternative assumptions regarding the cost savings associated with reductions in criminal justice referrals to treatment, the cost to taxpayers could go up. However, as illustrated in Table 10, the magnitude of costs is relatively small (a few million dollars) vis-à-vis the revenue that might be obtained by taxing and legalizing marijuana.

Table 10: Testing the sensitivity of findings to alternative key assumptions

	Net effect on admissions	Net effect on taxpayers (In Millions)
<i>Sensitivity to assumptions regarding adult treatment cases</i>		
Base case: None of adult CJ referrals remain in tx	2,544	\$1.03
Twenty-five percent of adult CJ referrals still end up in tx	4,049	\$1.63
Fifty percent of adult CJ referrals still end up in treatment	5,526	\$2.23
Seventy-five percent of adult CJ referrals still end up in treatment	7,900	\$2.82
<i>Sensitivity to assumptions regarding hypothesized price change</i>		
Base case: 75% drop	2,544	\$1.03
Assume a 50% drop in price	872	\$0.50
Assume a 90% drop in price	3,548	\$1.43

II. Impact of legalization on Marijuana-Involved Emergency Room Visits

The chemical properties and method of administration for marijuana make it unlikely to cause acute health problems when used in moderation.¹⁰ However, as an empirical matter, apparently marijuana use does cause negative health outcomes that lead the user to seek immediate medical attention. In particular, in a not trivial number of emergency room episodes recorded by the Drug Abuse Warning Network (DAWN), marijuana is the only substance involved. Marijuana co-occurs with other substances in a far greater number of episodes, but the custom in the literature is to presume that in those cases it is the other substance which causes the user to seek medical attention.

The objective in this section is to estimate the financial burden of these episodes today and how much that might increase with legalization. Similar to what was observed for treatment, the overall cost of marijuana-involved emergency room episodes under a range of alternative assumptions generates cost estimates in the tens of millions, suggesting a relatively small cost offset to the projected revenues possible under a change of policies, unless tax evasion is highly prevalent. Currently the cost per emergency episode is a little over \$600, and the number of episodes involving marijuana is about 75 per 100,000 people, which in a state of 38 million works out to be \$17.5 million. Over the five years 2004 – 2008, in Los Angeles and San Francisco 30% of DAWN episodes involving marijuana involved no other drug, so presumably at least $0.3 * \$17.5M = \$5.2M$ of these costs can be attributed to marijuana.

The literature suggests that the number of DAWN mentions may be slightly more responsive to price changes than is consumption overall (price elasticity estimates of -0.265 to -1.188, Grossman (2004)). Assuming legalization brings a 75% price decline and a 35% bump up in use due to non-price factors, that suggests that DAWN marijuana

¹⁰ It is possible that legalization will lead to more marijuana being consumed “bundled” with other products (in beer, brownies, etc.), so mode of administration might shift somewhat toward modes that make it more difficult for users to titrate their dose.

mentions might increase by between 50% - 120%.¹¹ So the additional emergency department cost might be on the order of \$2.6M - \$6.2M from episodes involving only marijuana and some unknown additional cost from episodes that involve marijuana and other substances (unknown, but upper bounded by \$9.4M - \$21.9M, the figures that would pertain if all DAWN marijuana episodes were causally attributable to marijuana use).

In round terms, the additional cost because of hospital emergency department visits might be comparable to that for additional marijuana treatment. As is demonstrated in the rest of this section, these back of the envelope calculations based on national numbers are incredibly close to estimates generated from alternative methods focused on California data alone. The rest of this section refines these calculations to be a bit more precise to the California situation, but the simple message conveyed from the back of the envelope calculation just conducted remains.

III.A. Marijuana Involved Emergency Department Visits in California

For smoked marijuana the risk of a fatal overdose of the sort seen with opioids is extremely low because the ratio of the usual lethal dose to the standard effective dose for nonmedical purposes (the so-called “safety ratio”) is on the order of 1,000 (Room, 2005). However, there is some risk of overdose when marijuana is consumed orally because of the lag between dosing and effect and because there can be synergistic effects with other substances (notably marijuana’s anti-emetic properties increasing the risk of overdose from other substances). Unexpected adverse reactions (“panic attacks”) can occur when consuming amounts well below lethal doses. Further, even moderate doses of marijuana use have been shown to impair complex motor skills and distort perception, thus interfering with an individual’s ability to operate heavy machinery, drive motor vehicles and perform other significant tasks (US DOT, 1999; Robbe and O’Hanlon 1999). If the individual undertakes these types of activities while under the influence, he or she is at greater risk of an accident (Polen et al., 1993).

That something is possible does not mean it is common, so a critical question to ask is: how frequently do such negative health events occur because of marijuana? Common perception is that they are rare. An indicator frequently used to demonstrate the health harms associated with many illegal substances are trends in emergency room episodes involving those substances. Visits to emergency departments are a particularly costly form of health care and would presumably only be used if there were a real perceived need for immediate medical attention. Thus, these incidents should reflect at least some dimensions of acute health problems attributable to drug use. Furthermore, drug-involvement is determined through laboratory testing and clinical assessment not just self-reports and is deemed relevant enough to include as part of the medical record.

Table 11 shows the frequency of marijuana involved emergency episodes for two DAWN cities from California, San Diego and San Francisco. Things to notice:

- Marijuana is involved in a nontrivial number of emergency department episodes for both cities, representing 6 to 7% of all ED episodes in both cities.

¹¹ Here we treat Grossman’s numbers as arc elasticity and assume it is additive with the non-price effect.

Table 11: Marijuana Involved Emergency Room Episodes for Two California DAWN Sites

SAN FRANCISCO									
	Total ED	Total MJ ED	Alcohol ED	MJ Rate per 100,000	ONLY MJ (one drug)	ONLY Alc & MJ	MJ + other drug (two drugs)	MJ w/ Alcohol	% treated & released
2004	16,071	1,166	3,689	68.2	301	184	426	502	0.695
2005	33,829	2,179	6,310	127.0	720	553	901	978	0.841
2006	24,414	1,566	4,786	90.6	462	294	592	656	0.793
2007	23,690	1,549	5,280	88.6	595	334	558	627	0.769
2008	22,403	1,629	4,430	92.0	543	346	569	702	0.768

SAN DIEGO									
	Total ED	Total MJ ED	Alcohol ED	Rate per 100,000	ONLY MJ (one drug)	ONLY Alc & MJ	Two drugs	MJ w/ Alcohol	% treated & released
2004	10,231	837	2,082	28.6	156	111	386	293	0.689
2005	18,450	1,644	3,444	56.1	390	239	716	548	0.744
2006	20,727	1,660	3,642	56.5	471	283	686	552	0.711
2007	19,829	1,622	3,580	54.8	454	262	659	539	0.709
2008	31,539	2,067	4,757	68.9	632	429	786	816	0.742

- Marijuana is more often found in combination with other substances, particularly alcohol, rather than by itself. However, approximately 10-30% of the ED episodes involving marijuana over the 5 year time period have marijuana as the only drug.
- For both cities, the vast majority (around 75%) of ED episodes involving marijuana are treated in the emergency room and released. A much smaller fraction is admitted into the hospital.

III.B The Relationship Between Marijuana Use and ED visits

The standard concern about using emergency room data, specifically the Drug Abuse Warning Network (DAWN) data, to explore the health-effects of marijuana use is that most ED episodes involving marijuana also mention some other substance, and the health consequences could have been caused by that other substance, not by marijuana. A growing number of studies support the notion that regular, habitual or recent marijuana use is associated with increased risk of accidents (Blows et al., 2005; Hall and Pacula, 2003; Polen et al., 1993). Two studies in particular are relevant for the current analysis in that they consider how changes in the availability of marijuana influence hospital admissions.

The first study examined city-level emergency room data 1975 to 1978 to assess whether state decriminalization policies are positively associated with marijuana-related emergency room episodes (Model, 1993). Model (1993) found that states that decriminalized marijuana experienced significantly higher rates of marijuana-related emergency room episodes, suggesting that decriminalization led to increased marijuana use as well as harms. However, the study was unable to account for independent variation in price and other factors that might have also been correlated with use. In a second study, Grossman (2004) examines time series data to see whether changes in marijuana prices predict changes in marijuana involved emergency room episodes. He finds a negative and statistically significant effect, generating price elasticities ranging from -0.265 to -1.188 depending on how the time trend was specified.

As legalization can result in changes beyond just the legal risk of using marijuana, we use the findings from the Grossman study to try to assess what the possible effect of legalization would be on marijuana-involved emergency room admissions in California. As marijuana prices should not be correlated with emergency room use except through their impact on consumption, use of these price elasticities should provide us with an accurate measure of how marijuana-induced ER visits are affected (identifying causal relationships).

In Table 12 we provide a simple framework for thinking about the potential impact of legalization on marijuana-involved ED visits. We begin with the price estimates provided by Grossman (2004) and maintain our base assumption of a 75% decline in the price of marijuana. In light of this percent change in price and the elasticity range given by Grossman (2004), this would suggest an increase in the number of marijuana-involved ED episodes of 19.9 – 89.1%. However, this percentage increase represents only the

change in ED visits that would occur given a change in consumption due to the price decline. It is also possible, as discussed previously, that consumption would rise due to a reduction in the non-price components of demand. We do not know how ED-visits would respond to a rise in consumption associated with these non-price effects, but if we presume that demand responds similarly (i.e. we use the same elasticity derived by Grossman), then the total effect on ED-visits in light of a change in legalization would be more on the order of 29% - 131%.

To predict the new level of marijuana ED episodes, we must start with a baseline rate assumption. Data from the two cities in California participating in DAWN (San Diego and San Francisco, respectively) provide us with a lower and upper bound rate of ED episodes per 100,000. The problem in simply using this base rate is that it presumes that all the marijuana-involved episodes included in the baseline were actually caused by the marijuana use. This may not be the case, but we have no basis for knowing what the appropriate fraction is so we test the sensitivity of the results as a function of that unknown parameter. For the time being, we begin with an assumption that 20% of all marijuana-only involved ED episodes were actually caused by marijuana use itself.

Table 12: Potential impact of legalization on marijuana-involved ED visits

	Low	High
Grossman price elasticities	-0.27	-1.19
Presumed percent change in price	-0.75	-0.75
Calculated % change in MJ involved ED episodes	19.9%	89.1%
Non-price effect on consumption	0.35	0.35
Total change in MJ involved ED episodes	29.2%	130.7%
Baseline rate MJ episodes per 100,000 (2008)	68.9	92
Assumed fraction of baseline rate that is caused by MJ use	0.2	0.2
Increase in rate of MJ induced episodes per 100,000	4.0	24.0
CA state population (2009)	38,064,002	
Number of MJ induced hospital episodes	5,245	7,004
Average cost per ED visit	\$614	
Total cost of MJ-involved hospital visits	\$3,220,565	\$4,300,319
Fraction paid for by taxpayer	60%	
Total cost of MJ involved hospital visits to taxpayer	\$1,932,339	\$2,580,191

As can be seen near the bottom of Table 12, under the assumptions discussed above, the number of marijuana-induced emergency department episodes associated with this policy would fall somewhere between 5200 and 7000. At an average cost per emergency room

visit of \$614,¹² this generates a total health care cost between \$3.2 and \$4.3 million. However, the taxpayer is not necessarily responsible for all of that cost, as some of these visits are paid through private insurance (and hence hit the taxpayer through rises in their own premiums). Based on national data of the fraction of emergency room visits paid for by the government either directly through insurance or by providing free care, we estimate that approximately 60% of this total bill would be paid for by the taxpayer. This suggests that the burden of marijuana-involved hospital visits would add an additional \$1.9 - \$2.6 million dollars annually to California's budget.

Of course, the total burden borne by taxpayers is highly dependent on assumptions regarding the causal attribution of marijuana to the baseline number of marijuana visits. While we can be reasonably comfortable that the change in emergency room visits can be attributed to actual consumption, these changes are evaluated from a specific base. In Table 13 we show how sensitive the results are to alternative assumptions regarding the baseline rate. What this shows is that the cost to taxpayers associated with increased emergency room visits caused by greater marijuana use associated with legalization could be on the order of tens of millions depending on what we learn regarding the extent to which marijuana use is the cause of these ED visits versus just present in these cases.

Table 13: Taxpayer burden of increased marijuana-involved ED episodes under alternative assumptions about regarding baseline

Sensitivity Analysis to Assumption of Baseline Share Caused by MJ	Low	High
10% of baseline MJ episodes due to MJ use	\$966,169	\$1,290,096
20% of baseline MJ episodes due to MJ use	\$1,932,339	\$2,580,191
30% of baseline MJ episodes due to MJ use	\$2,898,508	\$3,870,287
40% of baseline MJ episodes due to MJ use	\$3,864,678	\$5,160,382
50% of baseline MJ episodes due to MJ use	\$4,830,847	\$6,450,478

IV. Hospital Admissions

There are at least two types of marijuana hospitalizations that can occur in response to a rise in marijuana consumption: those where marijuana is the direct cause of the hospitalization and those where marijuana contributes to another condition, aggravating it, and leading to either the need for hospitalization or an increase in the length of stay. The literature identifying circumstances where marijuana use directly causes a hospitalization is thin, in large part because individuals who use marijuana generally use other substances and it is difficult to ascertain the extent to which marijuana is the direct cause of an accident or problem leading to hospitalization. Of course, when marijuana is identified as the primary diagnosis, then causality is not in question.

IV.A. Hospitalizations for Marijuana as the Primary Diagnosis

The California Office of Statewide Planning and Development (OSHPD) maintains state-level information on the number of admissions to hospitals located throughout California.

¹² We were unable to identify an average cost of an emergency room visit for California EDs, so instead we use the reported average cost for Western hospitals of individuals participating in the Medical Expenditure Panel Survey (MEPS), as reported by the Agency for Healthcare Research and Quality (Machlin, 2006).

There were 181 admissions to hospitals for marijuana abuse or dependence in 2008, the most recent for which data is available.¹³ Medical cases involving abuse and dependence of marijuana are more likely to occur among individuals who use marijuana on a regular basis than casual or occasional users or those who are actually dependent. So to try to evaluate the impact of marijuana legalization on hospitalization where marijuana is the primary diagnosis, we rely on the assumptions used previously in this chapter, i.e. that abuse/dependence is proportional to thirty day use and will rise in proportion with use. If hospitalizations for abuse and dependence rise proportionally with the rise in abuse and dependence, then we can again use the change in thirty-day prevalence as a guestimate for how hospitalizations could change, assuming the proportion remains constant post legalization.

If visits increase proportionally with dependence at the same rate post legalization as pre legalization, then we can use our baseline assumptions regarding a change in thirty-day prevalence (58% increase) to calculate a rise in marijuana hospitalizations using the baseline number of episodes of 181. Using this method, generates an anticipated rise in marijuana primary hospital admissions of 104 cases. At an average charge per episode of \$22,179 (calculated from the California OSHPD data for the 181 cases), the total cost of these additional episodes would be about \$2.3 million.

Of course, the findings regarding the increase in hospital costs are highly uncertain given the large number of assumptions that had to go into constructing them. In Table 14, we demonstrate the sensitivity of these findings to alternative assumptions that could have been used in formulating the estimates. What it shows is that the total cost estimate is not very sensitive to different assumptions regarding the price drop, price elasticity and non-price effect on legalization (which is a theme that will be seen throughout). Variation in these assumptions leads to changes in the order of a \$1 million or less. The factor that has a bigger influence on the cost of these cases is assumptions regarding whether hospitalizations will rise proportionally with the rise in consumption. If for some reason the proportion observed in 2008 is not representative of how things would be post legalization, then such a change could lead to larger implied costs of hospitalization, but the effects are still on the order of a few million.

¹³ There are an additional 25,000 cases where marijuana is listed as a second, third or fourth diagnosis. Given that the number of episodes suggested from the ED visits is so much larger than that observed for primary admissions in the inpatient data, one must presume that the coding of diagnoses in the inpatient data will not necessarily be the same as the coding of cases when they come into the emergency department.

Table 14: Sensitivity Analyses Related to Primary Marijuana Hospital Admissions

	Additional hospitalizations	Total Cost (In Millions)
Fraction of hospitalizations for MJ		
50% of consumption	52	\$1.154
Proportional to Consumption	104	\$2.308
150% of consumption	156	\$3.462
200% of consumption	208	\$4.617
Hypothesized change in price		
-50%	91	\$2.007
-75%	104	\$2.308
-90%	112	\$2.489
Assumptions regarding price elasticity		
-0.20	91	\$2.007
-0.30	104	\$2.308
-0.50	131	\$2.910
Assumptions regarding non-price effect on legalization		
0.05	50	\$1.104
0.35	104	\$2.308
0.50	131	\$2.910

Hospitalizations should matter to taxpayers for two reasons. First, taxpayers pay for those medical occasions where the individual is publicly insured (Medicare, Medicaid, Indigent care) or receiving temporary state assistance (e.g. worker’s compensation). Thus, some of these cases are paid for directly by the taxpayer. Second, even if the medical costs are paid through other private insurers, individuals who are part of these risk pools will experience rises in premiums due to higher health care costs of other members of these risk pools. Thus, even if these cases are not paid for directly through taxes, the taxpayers in California who buy private insurance will incur some share of the costs.

IV.B Marijuana Comorbidity on Hospital Costs

While it is easier to attribute cases of abuse and dependence directly to marijuana, research shows that marijuana abuse and dependence is related to other health problems, particularly psychoses and schizophrenia (McGrath et al., 2010; Moore et al., 2007; Hall and Pacula, 2003). While there is growing evidence that marijuana can trigger early onset of these problems for those that are pre-disposed or initiate marijuana use particularly early, the evidence regarding the extent to which marijuana causes these problems is still debated in the scientific literature. Thus, it is not possible to project the extent to which rises in marijuana prevalence rates could generate increases in these health problems. We simply mention here that the potential burden could be substantial. Our analysis of the 2008 California OSHPD hospital discharge data show that 7.5% of the hospital admissions for schizophrenia (n=3941) include marijuana as an additional co-morbidity. The average charge for the nearly 4000 marijuana-involved schizophrenia cases was just over \$20,300, suggesting that the burden of these cases in terms of health care costs could be on the order of \$80 million. There were also 2,367 marijuana-involved psychoses in 2008, representing 6.3% of all primary psychoses admitted to the

hospital. The average charge for these marijuana-involved visits was \$12,680, for a total of over \$30 million in treating these cases. Without knowing the extent to which marijuana use led to the need for hospitalization, the development of the problem, or increases in the cost of treating these conditions, it is impossible to speculate how a change in consumption might influence the costs born by taxpayers for these particular problems. But even if marijuana's involvement is fairly small (e.g. 10%), it could translate into tens of millions of dollars to California taxpayers. Given the tremendous uncertainty regarding the role of marijuana in causally contributing to these health problems, these speculative guesses are left out of the overall analysis and merely raised to demonstrate the potential magnitude of the problem should science determine definitively that marijuana causes such episodes.

V. Drugged Driving

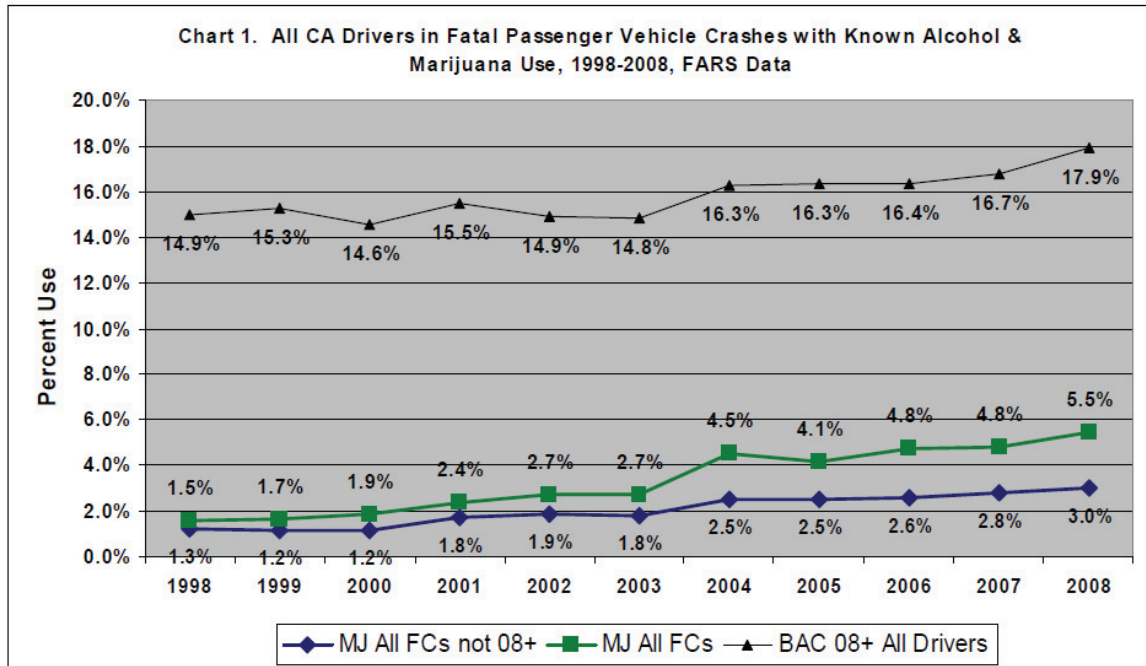
While it is common knowledge that driving while impaired is risky and potentially dangerous, a question remains whether cannabis use impairs individuals sufficiently to impact driving. While there is significant experimental literature suggesting a diminished effect on response rates and performance under very strictly controlled conditions, evidence from epidemiological studies has been less conclusive (See Ramaekers, et al., 2004, or Blows et al., 2005, for reviews). The notable exception of course are cases where alcohol is used in conjunction with marijuana, in which case the evidence is clear that the combined effect of these two drugs impairs driving significantly more than alcohol alone (Bramness, Khiabani and Morland, 2010; Jones et al., 2003; Dussault et al., 2002). Given the uncertainty of the science in determining the role of marijuana use in accidents, it is impossible to ascertain the extent to which increases in marijuana use alone would translate into more accidents, or worse fatal accidents. Thus it is not something that we explicitly consider in our main calculations.

But, suppose that the raw correlations observed in national highway traffic statistics turned out to reflect real causal effects. A reasonable question might ask, how bad would it be? We decided to consider this question to provide the reader with a sense of how important knowledge in this area is in terms of swaying decisions related to the costs and benefits of a change in policy. Our analyses suggest that answering this question is very important.

According to Crancer and Crancer's (2010) analysis of California's Fatality Analysis Reporting System (FARS), 5.5% of passenger vehicle fatal crashes in California in 2008 were cases where one or both drivers were established as having used marijuana. Determination of marijuana use can be made either through urine tests or blood tests, but the authors rely on information only from blood tests which increases the reliability of identifying actual use near the time of the accident.¹⁴ This rate has been steadily

¹⁴ Information from the NORML website indicate that blood tests are a better gauge of current impairment because they detect the actual presence of THC within a shorter window and more proximal to when an individual is impacted by a high associated with use, i.e. within a few hours after ingestion. According to one expert panel funded by the Marijuana Policy Project, the blood concentration of THC correlates with impairment of driving skills for only a period of 1 to 4 hours after consuming, unlike testing for metabolites

increasing since 1998 even if you omit cases including alcohol (see Crancer and Crancer, 2010). Importantly, the study shows large differences across counties within California, with the top 5 counties having marijuana involvement rates in fatal crashes above 20% and 8 counties with rates of 16.0% or higher (Craner and Crancer, 2010: Table 13).¹⁵ The authors note that fatal crash rates involving marijuana in these top counties approach those for alcohol where the blood alcohol content was .08 or higher.



Source: Crancer and Crancer (2010).

While the Crancer and Crancer (2010) study attempts to project the impact of the California ballot initiative on drugged driving in California, it does so assuming that rates in all counties could rise to that of rates of the top counties. An alternative and more conservative method for projecting the possible increase in marijuana-involved fatal accidents that is more consistent with projections developed in the previous health areas is to assume that fatal accidents will rise in proportion to the increase in prevalence rates. This generates a very conservative estimate because it ignores the impact that the policy might have on average levels of use among existing users and assumes that all the change in drugged driving rises just proportionately to the number of new users. Levels of use, however, are also quite important for thinking about impairment. However, we have inadequate data on which to base a projection on how the quantities of marijuana consumed change in response to prices and risks, other than that they increase when these both fall. Thus, the numbers provided here should be considered a lower bound.

which can stay in the system considerably longer, well after intoxication (Grotenhermen et al, 2005). The level of THC in whole blood the expert panel identifies as indicating impairment is within the range of 3.5-5 ng/ml.

¹⁵ Top 8 counties in terms of drivers using marijuana in fatal crashes in 2008 are: Modoc (50%), Del Norte (22.2%), Yuba (21.4%), Mendocino (20.7%), San Luis Obispo (20%), Inyo (18.2%), Placer (17.4%), and Humboldt (16%).

As done in the other areas, we can construct an estimate of the rise in marijuana-involved fatal accident reports based on the same baseline assumptions used throughout this chapter with respect to changes in price, elasticity of consumption, and non-price effects. According to the Crancer and Crancer (2010) study, there were 126 marijuana-involved single vehicle fatal crashes in 2008. Of those, 75% were cases where alcohol levels, if present, were below the .08 threshold, so the bulk of these cases were cases not being driven by alcohol impairment. However, given the scientific evidence demonstrating that marijuana in combination with alcohol impairs driving skills more than alcohol alone, we retain all of these mainly marijuana cases. Assuming the same 58% increase in thirty-day prevalence rates caused by a change in policy and assuming that fatal accidents rise in proportion to prevalence rates, this approach suggests that post legalization there would be $126 * 1.58 = 199$ marijuana-involved fatal accidents of which 73 could be attributed to the policy.

Of course, there again is considerable uncertainty surrounding this estimate and projections could be made under alternative assumptions regarding the price change and ultimate effect on thirty-day prevalence rates. In the first column of Table 15 we show how the magnitude of this estimate changes under alternative assumptions. Again, we see the biggest factor to influence these estimates is the presumed number of fatalities causally attributed to marijuana use. Under alternative assumptions regarding the fraction of cases that can be causally attributed to marijuana, you can get some very wide ranges in terms of the number of deaths.

Table 15: Sensitivity Analysis of Cost of Drugged Driving

	Additional Fatalities	Social cost (in Millions)
Presumed Change in Baseline Number of MJ Induced Crashes		
50% of baseline	37	\$183
Baseline = 126	73	\$365
150% of baseline	110	\$548
Hypothesized change in price		
-50%	63	\$315
-75%	73	\$365
-90%	78	\$391
Assumptions regarding price elasticity		
-0.20	63	\$315
-0.30	73	\$365
-0.50	91	\$457
Assumptions regarding non-price effect on legalization		
0.05	35	\$173
0.35	73	\$365
0.50	91	\$457

Note that our projection, based off of a presumed relationship between marijuana use and fatal accidents, is substantially lower than that obtained by Crancer and Crancer (2010), who develop a projection off of evidence of the percentage of all fatalities involving

marijuana in the top 8 marijuana-involved FARS counties. Based on their alternative assumptions, they project a much larger rise in marijuana-involved fatalities, with a range between 669 and 826 persons killed. What is a bit misleading in their approach is that the counties experiencing very high shares of marijuana-involved fatalities are counties that are fairly rural and do not have very many auto-related fatalities in the first place. Thus two deaths related to marijuana use in a rural county results in a much higher share than two deaths in an urban area. Inflating these ratios for rural counties to the total number of fatalities for all areas is likely to overstate the potential effect of the policy. Our estimates, on the other hand, will likely underestimate the effect.

Placing a monetary value on these lives is a difficult and controversial thing. There are three primary methods for estimating the value of a human life: the human capital approach, the contingent valuation approach, and the revealed preference approach and each has its strength and weaknesses. Economists tend to prefer the revealed preference approach because it considers the consumption value people place on their life, not just the value of things that can be purchased. For this study, we base our estimate of the value of a statistical life on findings from a review conducted by Viscusi and Aldy (2003). They reviewed the economics literature examining the value of a statistical life based off of revealed preference decisions and conclude that current estimates of the value of life fall within the range of \$4 million and \$9 million per statistical life in 2000 dollars. In an effort to take a more conservative approach, we adopt the lower bound estimate of \$4 million but then inflate this value to 2009 dollars, generating an estimate of \$4.98 million, which we round to \$5 million. Assuming a statistical value of life of \$5 million, the social cost of just these 72 new accidents caused by a change in policy is over \$362 million. The social cost associated with other assumptions is shown in the second column of Table 15.

When one considers the magnitude of the costs shown in Table 15 to those shown in previous tables it becomes clear that the value of the lost life associated with drugged driving is likely to be the largest cost anticipated for California by a change in marijuana policy. Unlike the other health care costs considered above, however, this is not a cost that will be reflected in state budgets, although a portion of it might be quantified in terms of foregone future income tax revenue. However, even though these costs are not reflected in the revenues and payments addressed by the state budget, they represent very real losses to the citizens of California.

VI. Summary and Conclusions

The exercise conducted herein was done to provide suggestive, but certainly not definitive, evidence of the potential impact of a rise in consumption on health harms and to demonstrate whether and how uncertainty with respect to the potential rise in consumption and the dose-response relationships between consumption and harms impacts the calculation regarding whether legalization is a net revenue gain for the state of California. What the exercise shows is that the health care expenditures associated with marijuana use are likely to be small relative to the expected revenue and cost-

savings associated with reductions in criminal justice savings. Of course, this is due in part to our conservative approach which was biased downward in two important ways. First, all our calculations were based on increases in the prevalence of consumption ignoring additional impacts that might emerge due to additional increases in the average quantities consumed among users. Second, assumptions regarding causal relationships between marijuana prevalence and health harms were consistently kept conservative. By taking a conservative approach, we were able to see what the minimal health harm is likely to be and how that might influence the calculation.

While the health expenditure is estimated to be fairly small relative to the other factors that would change with legalization, the human effects, as measured in terms of lost lives (to car fatalities) and dependence are not estimated to be small. Importantly, the potentially most significant health care costs for California taxpayers would come out of areas where the science has not reached a consensus, namely the causal effects of marijuana on psychoses, schizophrenia, and drugged driving. And losses associated with these health harms would not be fully reflected in budgetary estimates, just as the losses to individual freedoms associated with criminalization are not fully reflected in criminal justice estimates.

As the scientific literature regarding these health harms in particular develops further and reaches a consensus regarding the causal impact of marijuana use on the development, progression, and treatment of specific problems, our knowledge of the actual health care expenditure associated with marijuana use will be more precise and a better cost-benefit calculation may be made. Until then, this analysis suggests that the health care expenditure associated with *scientifically established* health harms appears to be relatively small vis-à-vis the other factors being considered in this debate. However, as the science continues to develop it is possible that findings from it will suggest that the health costs associated with use could be on the order of tens to hundreds of millions of dollars, which could at that point sway the benefit-cost calculation in light of the uncertainty regarding revenues.

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