

Design considerations for legalizing cannabis: lessons inspired by analysis of California's Proposition 19

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ABSTRACT

Aims No modern jurisdiction has ever legalized commercial production, distribution and possession of cannabis for recreational purposes. This paper presents insights about the effect of legalization on production costs and consumption and highlights important design choices. **Methods** Insights were uncovered through our analysis of recent legalization proposals in California. The effect on the cost of producing cannabis is largely based on existing estimates of current wholesale prices, current costs of producing cannabis and other legal agricultural goods, and the type(s) of production that will be permitted. The effect on consumption is based on production costs, regulatory regime, tax rate, price elasticity of demand, shape of the demand curve and non-price effects (e.g. change in stigma). **Results** Removing prohibitions on producing and distributing cannabis will dramatically reduce wholesale prices. The effect on consumption and tax revenues will depend on many design choices, including: the tax level, whether there is an incentive for a continued black market, whether to tax and/or regulate cannabinoid levels, whether there are allowances for home cultivation, whether advertising is restricted, and how the regulatory system is designed and adjusted. **Conclusions** The legal production costs of cannabis will be dramatically below current wholesale prices, enough so that taxes and regulation will be insufficient to raise retail price to prohibition levels. We expect legalization will increase consumption substantially, but the size of the increase is uncertain since it depends on design choices and the unknown shape of the cannabis demand curve.

Keywords Cannabis, drug policy, legalization markets, prices, regulation.

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INTRODUCTION

The wisdom or folly of legalizing cannabis has been debated at length (e.g. [1,2]), usually at a high level of abstraction. However, unless one insists on strict libertarian principles, the merits of legalization will depend importantly on the design of the associated regulatory regime. This paper provides insight concerning some key design choices and associated trade-offs. The insights were uncovered through analysis of two recent California legalization proposals [3,4], but the choices are ones that will be confronted by any jurisdiction.

We take no position on whether legalization is a good idea, whether it is possible to design an effective

regulatory regime, or whether such a model design would actually prevail in the political process. Rather, we simply flag these choices as ones that should be addressed.

We use the term 'design' to stress that there are consequential choices to be made. However, public policies are rarely designed in the sense of having a single architect or a clearly articulated objective. Rather, they emerge from a stakeholder-driven political process that is often adversarial and never pretty.

Indeed, any design emerging from this process will balance a variety of competing goals, and the process will be complicated by great uncertainty about relevant parameters. The drug reform literature implicitly recognizes the difficulties; it is long on criticisms of the current

prohibition but generally vague about details of alternatives, with a few exceptions (e.g. [5]).

Our focus is legalization of wholesale production, distribution and sale to recreational users, rather than partial reforms such as decriminalization, depenalization, medical cannabis, allowing personal home cultivation or the 'Dutch model'.

GOALS OF CANNABIS LEGALIZATION

There are multiple motivations for creating a legal cannabis market, including:

- 1 Raising tax revenues. Arguably, this was the key argument that brought legalization into mainstream debate in California.
- 2 Eliminating arrests. This aims at reducing both the costs to government and the costs to the individual arrestees, including not only the punishment itself but also stigma, disruption to life and non-criminal sanctions.
- 3 Undercutting black markets and associated harms from corruption and violence.
- 4 Allowing criminal justice resources to be redirected toward other priorities.
- 5 Assuring product quality.
- 6 Increasing choices for those seeking intoxication. Prohibition makes it illegal to consume a substance many believe to be less harmful than some legal intoxicants [1,6].
- 7 Limiting youth access. Some legalization proponents argue that it would be easier to control youth access to cannabis in a regulated market (e.g. [7]).

One could expand this list, but two points are salient. First, any given design will serve some goals better than others. Secondly, subjective benefits derived from intoxication (pleasure) are difficult to quantify and hence not usually considered in explicit cost–benefit calculations; like most other analysts, we will also ignore them.

THE NOVELTY OF THE CALIFORNIA PROPOSALS

Many countries have significantly reduced criminal penalties for cannabis possession. For example, the Argentinean Constitutional court, in ruling that possession of any psychoactive drug for personal use could not be prohibited, said the government should not intrude into private life [8]. Portugal shifted to civil penalties for all drug possession offenses in 2001 because the government believed criminal penalties ineffective and intrusive [9]. Most countries that have made reforms reduced the penalties for all psychoactive drugs; only a few countries singled out cannabis (Belgium, the Netherlands and some jurisdictions in Australia and the United States).

Some jurisdictions (e.g. Spain and Alaska in the past) allow limited growing for self-supply, but only the Netherlands tolerates retail sales, waiving arrest and prosecution for small quantities. Indeed, in no country is it completely legal to produce, sell and use cannabis for non-medical use [10].

What was debated in California would go well beyond the Dutch *de facto* legalization of small quantity transactions. The California debate in 2010 concerned two different paths to cannabis legalization: a statutory law before the California legislature (AB 2254) and a proposition on the November ballot (the Regulate, Control, and Tax Cannabis Act, also known as Proposition 19). Both would have fully legalized cannabis with respect to California state law. The federal prohibition would have remained enforceable, so in theory federal agents could have taken over low-level enforcement. In practice, federal prosecutors typically only accept cases involving larger quantities (e.g. more than 500 pounds), so we judge it likely—although not certain—that the federal government would not have massively stepped up its enforcement against users, domestic distributors or discrete producers (e.g. those operating grow houses that were indistinguishable from other residential houses).

AB 2254, often referred to as the Ammiano Bill, would have legalized cannabis possession for those aged 21 and older and tasked the Department of Alcoholic Beverage Control (ABC) with regulating possession, sale and cultivation. The bill would also have initially imposed a \$50 per ounce (28 g) excise tax to be paid at the point of retail (in addition to sales tax), and it specified narrow use of these funds. The Ammiano Bill died before reaching a floor vote in the State Assembly.

California voters narrowly rejected Proposition 19 (53.5% voting no) which, in addition to legalizing cannabis possession for those 21 and older and permitting adults to cultivate 5' × 5' plots in their homes, would have allowed local jurisdictions to enable, regulate and tax commercial production and distribution. Unlike AB 2254, the proposition did not specify any tax rate. Although Proposition 19 was defeated, the support was so strong that a redesigned initiative is likely to be on the 2012 ballot in California, and possibly other states.

TWO KEY INSIGHTS ABOUT LEGALIZATION

Our analysis of California's legalization proposals uncovered a range of insights. Here we discuss just two, because they have implications for any jurisdiction: legalization will dramatically reduce wholesale prices, and there is irreducible uncertainty concerning the amount by which legalization will increase consumption.

The decline in wholesale prices will be dramatic

The literature recognizes that legalization will lower prices, but may underestimate the potential magnitude of the decline. Current wholesale prices in the United States are \$500–1500 per pound for commercial grade, increasing with distance from Mexico, and \$2000–4500 per pound for sinsemilla [4]. Legalizing cannabis would reduce these prices because there would be a decrease in risk [11], increased automation and economies of scale [12].

Indeed, if cannabis could be farmed outdoors like other crops, we calculate that production costs would be less than \$20 per pound. This is consistent with the National Organization for the Reform of Marijuana Laws' claim that if cannabis production was unregulated, '[T]he price of marijuana would presumably drop as low as that of other legal herbs such as tea or tobacco—on the order of a few dollars per ounce . . . or a few cents per joint' [13]. At that point, production costs become negligible compared to distribution, branding and marketing costs. The analogy would be to bottled water.

Even if production were confined to grow houses, a small, low-tech business could produce sinsemilla for about \$400–450 per pound [12]. Costs would be driven by, in decreasing order: (i) materials, (ii) rent, (iii) producer's overhead and profit (iv) electricity and (v) agricultural labor (assuming federal enforcement is sufficiently lax that semi-skilled production workers would be compensated as for typical agricultural workers). Factoring in a healthy mark-up for distribution and retailing, we anticipate untaxed retail prices of about \$40 per ounce of unbranded, unbundled sinsemilla [12]. Compared to current prices of \$250–400 per ounce, this represents an 80–90% reduction.

Legal cannabis production may not be a large industry. It would only take about 8000 grow houses to meet current US consumption on a 9- Δ -tetrahydrocannabinol (THC)-adjusted basis [3,12]. Given modest economies of scale and mechanization of the sort that could remain hidden within the house, each grow house might require no more than one full-time agricultural labourer, with perhaps one other employee [master growers, heating, ventilation and air conditioning (HVAC) technicians, drivers, bookkeepers, entrepreneurs, etc.] per agricultural worker. Sixteen thousand jobs is miniscule against a national labor force of 140 million; it is even small compared to current (illegal) employment in production and smuggling. Given the high value per unit weight ratios and limited number of houses required, production could locate anywhere, presumably migrating to jurisdictions offering the friendliest taxes and regulations and/or lowest labor, housing and electricity costs. Plausibly, the greater economic opportunities could come from

distribution and bundling with other services and products (e.g. cannabis cafes, cannabis-infused foods and drinks [3]).

Legalization will increase consumption, but it is unclear by how much

Legalization's non-price effects on consumption, such as from reduced stigma and increased advertising, are hard to estimate as no jurisdiction has ever fully legalized cannabis. The Netherlands comes closest to having legalized from the user's perspective. Looking at the Netherlands and a range of other analogies, MacCoun suggests that non-price effects might stimulate consumption increases of 5–50% [14]. These non-price effects will also differ depending on the pre-legalization cannabis culture (e.g. does the jurisdiction already have a heavily promoted medicinal market?).

The uncertainty concerning price effects is even greater, and stems from two distinct sources: (i) uncertainty about how responsive consumption is to changes in price within the ranges that have been observed and (ii) uncertainty about how to extrapolate that experience to prices well below those that have ever obtained in a developed country in the modern era.

One limitation of current elasticity estimates is that the best evidence concerns how price affects annual or 30-day prevalence of use among broad populations, such as students or those in the household population. These populations frequently include large numbers of light users or new initiates. Typical price elasticities of participation range between -0.002 and -0.7 , depending on the population studied, with a narrower range of -0.3 to -0.5 for youth [15] that is the same as the corresponding range estimated for cigarette participation elasticities [16]. However, consumption is heavily concentrated among a minority of the heaviest users [17]; their response—in terms not only of prevalence but also intensity of use conditional on participation—dominates how a price change will affect the overall quantity of cannabis consumed. For tobacco and alcohol the elasticity of the total quantity consumed is 1.5–2.0 times greater than the general population participation elasticity, but there is almost no literature on total price elasticity of cannabis. Based upon what evidence is available, Pacula judged that the total elasticity of demand for price changes around the current price might be between -0.4 and -1.2 [15].

Beyond this 'parametric uncertainty', there is also 'structural uncertainty' concerning how linear or convex the demand curve is as one moves to much lower prices. That is not a question that can be answered empirically, because there simply are no data on cannabis consumption at such low prices. We considered two classic

textbook forms for demand curves (linear and constant elasticity) to demonstrate that the projected increase in consumption will depend dramatically on implicit assumptions embedded in the choice of functional form. For example, under one scenario the linear demand curve suggests price-driven consumption increases would probably be in the neighborhood of 75–100%, whereas the corresponding range with constant elasticity demand was 150–200% [3, see Fig. 4.1]. Thus, we conclude that legalization will increase consumption substantially, possibly dramatically, but it is important to recognize that back in the late 1970s consumption was substantially higher than it is today, so it not certain consumption would rise beyond the historical peak.

FIVE IMPORTANT LEGALIZATION DESIGN CHOICES

We highlight five choices those creating legalization regimes will have to confront, implicitly if not explicitly. Some play out differently when the action is taken by a nation as opposed to a single state (or city) still subject to federal prohibition, and those distinctions are noted.

How high a tax

Presumably, jurisdictions will want to collect taxes and licensing fees on cannabis to generate revenue and offset the costs of regulation. These taxes could also partially offset the price drop. Because legal production costs are far below current prices, it would take a concerted effort and a well-designed scheme to prevent retail prices from falling dramatically (and such a scheme would incentivize black market suppliers to remain in the market-place). Thus, dismissing the price drop with reference to simply using excise taxes or price regulations to maintain more or less current prices is unconvincing, even though it is a staple of economists' writings on the subject (e.g. [18]).

Untaxed retail prices of \$40 per ounce of sinsemilla imply that preventing a price decline would require taxes \$210–360 per ounce, or \$7–13 per gram. By comparison, a \$3 excise tax on a 20-g pack of cigarettes is only \$0.15 per gram, and even such relatively small tobacco taxes generate considerable tax avoidance and gray market sales [19–23]. Taxes of \$7–13 per gram generate a strong incentive for evasion, literally 10 times stronger per unit weight than the price differential that induces smugglers to bring cannabis into the United States from Mexico [3]. Therefore, deciding to use excise taxes to avoid a price collapse probably implies subordinating other goals to the objective of making tax evasion

difficult, e.g. by collecting taxes from producers and tightly constraining the number of producers as well as the quantities produced.

For those whose principal motivation is a new source of tax revenues, the goal is to find the tax rate that will yield the highest revenues. Given the sensitivity of legitimate sales to the extent of tax evasion, as well as the elasticity of demand, that may not be a very high tax. Hence, there is probably no one tax rate that simultaneously achieves both maximum government revenues and a small increase in consumption.

Taxing and/or regulating cannabinoid levels

The potency of herbal cannabis, as reflected in THC content, varies by a full order of magnitude, from 2–3% for low-end commercial grade to 20–30% for nederwiet (a common Dutch name for a 'skunk' variation of marijuana bred in the Netherlands for its high potency with THC levels); even higher potencies could be created by extracting THC from plant material, concentrating it, and adding it back ('fortified' cannabis); so if a tax is assessed per unit weight, this creates a powerful incentive to sell higher potency versions.

The range in potencies is analogous to alcohol, with beer typically being 4–6% alcohol by weight and distilled spirits being much higher, typically from 20% to 80% alcohol. Alcohol taxes in the United States vary by type of beverage. Something analogous might be useful for cannabis taxes [24], although compliance with that increased complexity might be easier to achieve if there were a modest number of larger, licensed producers rather than with a cottage industry or cooperative model of production.

As an additional wrinkle, there is growing suspicion that both sought-for psychopharmacological effects and unwanted side effects are influenced not only by THC content but also by the ratio of THC to other cannabinoids (e.g. cannabidiol (CBD) [6]). To the extent that is true, a public health-driven regulatory regime might consider still more complicated taxing structures that reward 'good' ratios of THC to other cannabinoids.

Requiring suppliers to test for cannabinoids and contaminants (e.g. pesticides, bacteria and mold) would impose costs. For the testing facility that serves the largest medical marijuana dispensary in California, these costs can be as much as \$520 per test [assuming no quantity discount; \$120 for THC/CBD/cannabinol (CBN) levels; \$100 for a microbiological screen; \$300 for pesticide screen].¹ The main question is how many samples would need to be tested from each harvest. Suppose a grow

¹Based on prices from Steephill Laboratories in Oakland, California which are higher than some of the other quotes we found on-line. For example, PureAnalytics of California reports that testing one sample for potency, pesticides, molds, and fungi would be \$240. If more than 20 samples were tested, the discounted rate would be \$186 per sample.

house yielded 137 pounds per harvest, packaged in 1-pound increments, and tested samples from 10% of the packages (i.e. 14 samples). That would cost about \$0.12 per gram [$\$7280/(137*16*28.35)$]; even testing 50% of packages would cost only \$0.59 per gram; so it seems unlikely that potency and contaminant testing will be a major driver of retail prices.

Allowing home cultivation

There are many arguments for allowing home cultivation, notably taking market share away from businesses whose profit-interest is in having many dependent users (as the minority of users who are dependent account for the bulk of sales volume). One might similarly want to allow sharing and gifts, and perhaps even supply by non-profit cooperatives [25].

The market share of user- or non-profit grown cannabis will interact with taxes and regulations of the purely commercial production sector. If commercial production is sufficiently regulated that a price collapse is averted, then it is plausible that an important share of consumption could be provided by non-profit growing. In contrast, if prices collapse, then the user-growing might be confined to aficionados and people who enjoy gardening.

However, it would be harder to regulate commercial production and prevent diversion if user growing were allowed. If the only legal production were that which occurred in a handful of tightly regulated facilities, then one could require stamped packaging or quantity limits; e.g. no cannabis could leave the approved production facility packaged in quantities larger than an ounce (28 g). Possession of more than an ounce that is not sealed in a stamped container could be *prima facie* evidence of illegal production. However, if user growing is allowed, such tight regulation would be enormously more difficult, because someone caught in possession of contraband could claim that it had been grown legally at home. This creates a potential Catch-22; allowing home cultivation might undermine the very regulations needed to prevent prices from falling so far that home cultivation would not be worth the effort, except for those who enjoyed growing as a hobby.

Restricting advertising

If one desideratum is minimizing use among youth, then tight restrictions on advertising through print, point-of-sale, internet, radio and television are essential, as are similar restrictions on other promotions, such as free samples or discount days [26].

In nations where corporations' speech rights are not viewed as constitutionally protected, such restrictions may be feasible. Certainly the Dutch governments

(national and municipal) have substantially limited promotional activities by coffeeshops, which are not permitted to advertise in mass media.

However, in the United States the Supreme Court has been protective of corporations' rights to free speech, and have even struck down state restrictions on alcohol advertising. As a consequence, it may be very hard in the United States to allow a commercial market without also permitting promotion. The United States could allow growing only by individuals for non-commercial purposes; those individuals would have the right to advertise, but no incentive to do so. However, that scheme falls short of the topic of this paper, which is legalizing commercial production.

In principle, one can finesse this problem by establishing a government monopoly on retail sales, as has been carried out for alcohol in various Scandinavian nations and some US states. In practice, this would require change at the federal level that seems unlikely in the near or medium term. A US state cannot participate actively in cannabis distribution in the face of a continued national prohibition, and government stores would be opposed by both social conservatives and libertarians. Even elsewhere, active participation of the government in supplying recreational cannabis is a more flagrant abrogation of international treaty obligations than is merely allowing a free market.

Government monopolies also raise concerns about inefficiency and political corruption, and the experience with liquor monopolies suggests there may still be more complicating factors [27–30]. Promotion in the liquor industry is mainly the business of producers, who are privately owned. If the state monopoly for cannabis sold generic cannabis, without specific labels, or if it were responsible for production as well as distribution, the problem would be elided.

Who designs the regulatory system and how is it adjusted over time

The above discussion makes clear that there are meaningful choices to be made even after one has committed to legalizing cannabis, and to some extent the Devil is in the details. No modern affluent nation has ever legalized commercial production and distribution, so the chance that a proposed regulatory system picks the ideal approach from the outset is very small. There will probably be surprises, large and small, and it would only be through a process of trial and error and incremental adjustment that jurisdictions could determine the 'best' way to regulate this new industry according to any particular definition of best.

Voter-passed propositions are difficult to amend and nearly impossible to scale back in several of the US

states, infamously so in California. Hence, propositions might be an unwise way to implement marijuana legalization there. A parallel but more general observation for jurisdictions elsewhere is that neither California legalization proposal looked at all like what a public-health minded planner would have designed. This is a reminder that regulatory capture by industry and special interests is a recurring theme even in well-functioning democracies. Therefore, while ongoing review and adjustment towards better policy promoting public welfare would be desirable, it is not necessarily what would happen in practice.

CONCLUSIONS

In *The Candidate*, an early Robert Redford film, after learning that he has won a bitterly fought election, Redford calls his aide into a private room and asks: 'So now what do we do?'. There is some of that feel to the current struggle to create a legalized cannabis market. Even if the public agreed that such a market should exist, there are decisions that could substantially affect how much cannabis is consumed, in what form and potency and how much revenue the state earns. The political and legal contexts clearly matter; for example, restricting promotion is probably much more difficult in the United States than in western Europe.

Further, there is enough uncertainty about the demand curve for cannabis in the new context and how much tax evasion will occur, that predictions of the consequences of any specific regime will have large error bands. The first version of some, if not most, regime design choices may well be flawed, and there is a need to build in an ability to make corrections.

Declarations of interest

None.

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Commentaries on Caulkins *et al.* (2012)

THE LONG AND WINDING ROAD TO CANNABIS LEGALIZATION

Although some countries have quasi-legalized cannabis use (the Netherlands), made cannabis available for medical purposes (California currently has more than 1000 medical marijuana shops) or allowed the growing of a small number of cannabis plants for personal use (Australia), in most countries (the Netherlands included) cannabis supply, distribution and use is prohibited [1]. Nevertheless, cannabis is the most popular illicit drug. In 2009, between 2.8% and 4.5% of the world population aged 15–64 years, corresponding to between 125 and 203 million people, had used cannabis at least once in the past year [2]. Clearly, prohibition does not work and the debate on legalization of cannabis gains momentum. This debate is often emotional, with strong views of both proponents and opponents. Those who are in favour of legalization tend to ignore the negative health effects of cannabis use. Those who are against legalization ignore the fact that legal substances such as alcohol and tobacco also have bad health effects [3].

Caulkins *et al.* [4] provide an interesting contribution to the legalization debate. Rather than discussing the pros and cons of legalization they discuss legalization design choices: the level of taxes and whether taxes should depend on cannabinoid levels, rules on home cultivation, advertising restrictions and design adjustments over time.

The use of cannabis is widespread, but many individuals use for only a short period. Others use it on a regular basis, but are still recreational users for whom cannabis use is comparable to drinking a beer every now and then. It is difficult to predict what will happen if such an unprecedented policy change as legalization of cannabis is introduced. Legalization will affect cannabis use mainly—although not exclusively—through the change in price, which in itself will depend upon one of the legalization design choices, the level of taxes. When considering price effects, the dynamics of cannabis use are important. Usually, some youngsters start using cannabis between ages 15 and 25 years. If they have not done so before age 25 they are very unlikely to do this later in life. From an Amsterdam study it appears that about half of youngsters start using cannabis, but about 20% of them use cannabis for less than 1 year. Median duration of use is about 10 years, while about 30% of users persist [5].

There is hardly any study on the relationship between cannabis price and dynamics in use. A study based on

Australian data shows that a lower price lowers the age of initiation but has no effect on the duration of cannabis use [6]. It is also not immediately clear how the intensity of cannabis use will change. It could be that a price drop affects only the extensive margin, i.e. attracts casual users without increasing frequent use. It could also be that a price reduction does not affect overall use but does affect frequent use. The effects of a cannabis price drop are likely to be strongest for youngsters. For the purpose of illustration, Fig. 1 shows the association between cannabis price and cannabis use of American youngsters.

In the period 1991–1997 in the United States there was a drop in real cannabis prices of almost 60%, while between 1997 and 2007 cannabis price increased by 150%. These price fluctuations were accompanied by changes in ever use between 30 and 45% and changes in last 30 days use between 15 and 25%. Although the plots in Fig. 1 cannot be interpreted as causal, they suggest

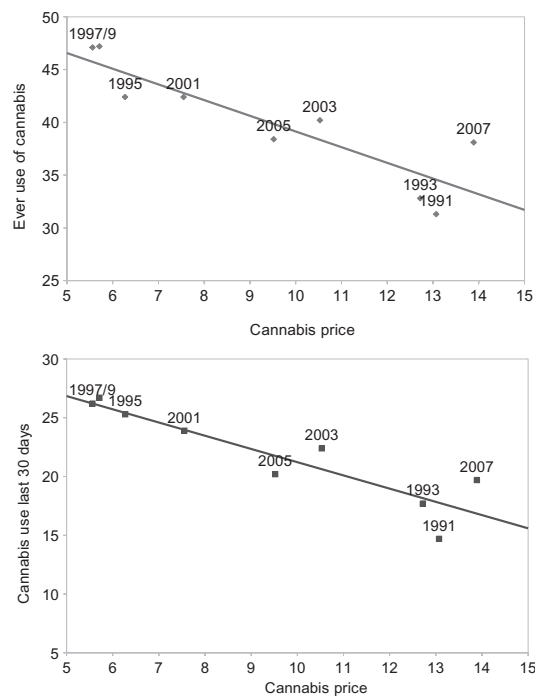


Figure 1 The association between cannabis prices and cannabis use of youngsters; United States 1991–2007. (a) Ever cannabis use (%); (b) cannabis use last 30 days (%). Source: Cannabis use among 9th to 12th graders: Youth Risk Behavior Survey; median cannabis price in constant 2007 dollars per gram for small quantities (less than 10 g) [14]

that both intensive and extensive margins of cannabis use will be affected by legalization. Legalization might cause a drop in cannabis price of 75% [7]. Although this is substantial, it is within the range of actual price changes in the United States in past decades. The price drop caused by legalization would mean no more than a return to mid-1990s prices.

There is a large epidemiological literature on adverse health effects [8] and recent evidence suggests that there is a negative causal effect of cannabis use on health [9,10], but in the grand scheme of risky health behaviours cannabis use has a modest contribution [11]. All the linkages to assess the health effects of legalization have one element in common: uncertainty. Therefore, opinions of individuals who have had personal experience with cannabis use may be helpful. From an analysis of Australian data it appears that past cannabis users are more in favour of legalization than non-users. Apparently, for individuals with personal experience the pros of legalization are more important than the cons [12].

The legalization design choices Caulkins *et al.* [4] discuss are important. It seems to me that taxes should be sufficiently high to discourage cannabis use and sufficiently low to drive out illegal supply. Furthermore, taxes should depend on cannabinoid levels, home cultivation should be allowed under restrictions and advertising should be banned. The nature of the legalization debate can be summarized in one word: ignorance. Therefore, the most important design choice of legalization is the flexibility to adjustment, allowing for learning by doing. There are many relationships about which researchers are uncertain, debating whether they are causal or mere associations. As long as nowhere in the world is cannabis legalized it is difficult to gain any clear idea about the consequences of legalization [13]. Removing the veil of ignorance that surrounds the legalization debate requires a great deal of additional research effort. However, researchers rarely agree, and even if they agree it is doubtful whether that would convince politicians to proceed with cannabis legalization. Conducting further research and hoping that an evidence-based cannabis policy will emerge is wishful thinking. Rather than muddling through for several decades it would be wise to start moving on the long and winding road to cannabis legalization. This would make life more comfortable for cannabis users, remove criminal organizations from the scene, allow for the possibility of quality control, provide governments with tax revenues and make it possible for researchers to collect empirical evidence. In short, it is time for politicians to walk down the legalization road 'to boldly go where no man has gone before'.

Declaration of interests

None.

Keywords Adverse health effects, cannabis use, design choice, illegal supply, legalization, price effects.

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ADDITIONAL CONSIDERATIONS

The authors bring a welcome degree of rigor to this helpful effort to analyze recent cannabis legalization efforts in California [1], especially considering the relative paucity of scientific data.

Public support for making cannabis legal has shifted dramatically in the last two decades, particularly in the

last few years. The gap in support, as measured by Gallup in regular polling, narrowed from 24 points (36 in favor; 60 opposed) in 2005 to a remarkable four points (46 versus 50) in 2010 [2]. The majority of liberals, 18–29-year-olds, voters in western states, Democrats, Independents, moderates and men now support legalizing cannabis.

If this trend persists, which seems likely, a majority of Americans will soon support making cannabis legal. It is therefore incumbent upon public policy experts and public health advocates to think critically about optimal policies for regulating cannabis.

Our organization advised the drafting of California Assemblyman Ammiano's far-reaching bills introduced in 2009 and 2011 to fully legalize cannabis (AB 390 and AB 2254), and we advocated for the passage of both proposals. Although AB 390 never came up for a floor vote, it was the first cannabis legalization bill to win a committee vote in a state legislature.

Conversely, Proposition 19 nearly became law, winning 46.5% of the vote [3]—and its approach to making cannabis legal merits greater scrutiny and clarification.

This voter initiative represented a substantially narrower proposal than the Ammiano bill. Proposition 19 eliminated penalties for possession of up to one ounce by adults 21 and older, permitted cultivation by adults for personal use within a private 25-square-foot parcel and delegated all authority to cities and counties rather than mandating a state-wide system.

Not widely recognized outside of California, this 'local control' provision would have ensured a slow and modest implementation of commercial cannabis sales. Most localities probably would not have permitted sales of recreational cannabis, at least at the outset. It is worth noting that 15 years since Californians legalized medical marijuana by passing Proposition 215, only 60 cities and counties have formally regulated cannabis dispensaries, while 276 have blocked their establishment or banned them outright [4]. Even if Proposition 19 had won, commercial sales would have been far more limited than most people assumed.

Ballot initiatives to legally regulate cannabis will probably appear on the Colorado [5] and Washington [6] ballots in 2012. Both are far more tightly drafted than the California proposals, reflecting public health concerns as well as the desire to reassure ambivalent voters who favor legalization in principle but are wary of how it will work in practice. The Washington initiative, for instance, does not allow for home cultivation of cannabis in any amount.

While we agree with much of what the authors say regarding the potential risks of increased cannabis consumption, we question the authors' choice to disregard

'subjective benefits derived from intoxication (pleasure)' and other potential benefits.

Millions of Americans use cannabis not just 'for fun' but because they find it useful for many of the same reasons that people drink alcohol or take pharmaceutical drugs. There is a growing body of evidence that moderate cannabis use not only poses minimal harms but provides substantial health benefits. These include anti-inflammatory, anti-anxiety and notably anti-cancer properties documented in many government-supported studies [7–9]. The *Lancet*, Britain's leading medical journal, observed in 2003 that 'we are only just beginning to appreciate the huge therapeutic potential of this family of compounds' [10]. Given the science that already exists, implicitly assuming that only harms are associated with increased consumption of cannabis does not seem right.

Any model for legally regulating cannabis production and distribution must be compared not just with an ideal scenario but with the realities of contemporary cannabis prohibition. While the authors correctly identify tremendous uncertainties associated with alternatives to present-day prohibitions, they are insufficiently attentive to the probable consequences of persisting with the *status quo*—mass arrests for low-level possession, staggering race-based imbalances in cannabis law enforcement, out-of-control youth access, unregulated content and the crime, violence and corruption endemic to an underground economy of this size.

The original criminalization of cannabis was grounded not in reasoned analysis but in racial prejudice and politics [11]. We hope that the authors' fine analysis will inform current and future thinking regarding how best to regulate legal cannabis. It would be a shame, however, if the valid concerns they raise undermine momentum for reform by distracting attention from the very real and immediate failures and harms of current policies. Legalizing cannabis may be risky, but its benefits almost certainly outweigh its potential harms.

Declarations of interest

Stephen Gutwillig is California director, Jag Davies is publications manager and Ethan Nadelmann is founder and executive director of the Drug Policy Alliance, a US organization promoting alternatives to the war on drugs.

Keywords Cannabis, drug policy, legalization.

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PRACTICAL EXPERIENCE WITH LEGALIZED CANNABIS

Caulkins *et al.* astutely identify the major policy challenges confronting cannabis legalization, in particular the likelihood of dramatic price declines, the concomitant risk of increased consumption and abuse, and the difficulty of preventing diversion to the black market if significant taxes or other restrictions are imposed [1].

The authors' prediction of dramatic cost reductions is confirmed by current experience in Israel, where medical

cannabis gardens have been established under the supervision of the Health Ministry. The Israeli program produces high-grade medical cannabis outdoors at a cost of \$.79/g (\$22 per ounce), and sells it for up to \$1.58/g (\$44/oz) [Mimi Peleg, personal communication]. This is equivalent to the authors' price estimate for indoor grow houses, and almost an order of magnitude lower than prevailing prices on the gray market in California.

A different perspective is provided by the state-approved medical cannabis system in the Netherlands, where pharmacy-grade cannabis is grown indoors by Bedrocan BV under tightly regulated conditions and distributed through the Dutch Ministry of Health. Bedrocan's cannabis is currently sold at a price of €42.5/5 g (= \$11.60/g, comparable to the price on the illicit market [Tjalling Erkelens, personal communication]). The high price of Bedrocan's product is not due to taxes, but to the highly exacting pharmaceutical-grade production and testing conditions required by the Dutch government. Despite the high price, black market competition is not a problem, because cannabis is readily available at lower prices in coffee houses.

Regulation should therefore be considered alongside taxation as a tool for maintaining prices. In addition to raising the costs of production, regulation raises prices through licensing fees that are passed on to consumers.

An instructive historical example of successful regulation can be seen in the case of India, where cannabis was legally taxed and regulated in many states until recent decades. The Indian system was described in detail by the British Indian Hemp Drugs Commission report of 1893–94, which still stands today as the most thorough and exhaustive examination of cannabis regulation, albeit from a century ago. The commission examined the gamut of state regulatory systems in India with an eye on how to maximize tax revenues. State regimes ranged from complete prohibition to near *laissez-faire*, but typically involved some form of regulation, licensing or taxation.

The Commission singled out Bengal as having the most successful regulatory regime. In Bengal, the state licensed production and sales and imposed both a duty and licensing fees. In 1892–93 the excise tax came to 2.9 rupees per pound, while license fees added 2.5 rupees more, accounting for about half the total retail price [2]. Hemp-drug taxation was an important source of state revenues in Bengal, constituting 21% of excise revenues. The Commission concluded that a 'combination of a fixed duty with license fees for the privilege of vend constitutes the best system of taxation for the hemp drugs' [3].

The Hemp Drugs Commission report provides useful insight into the economics of a legal cannabis market. Depending on the region and quality, the retail price of ganja in India ranged from 3/8 to 20 rupees per pound

in 1893 [4], when a rupee was worth about \$0.30. In today's dollars, this translates to between \$2.75 and \$150 per pound, consistent with the authors' low-ball cost estimates. Modern costs would probably be higher due to more advanced production techniques. The cost of a regular habit was estimated at one to six pice per day, a pice (1/64 rupee) being the smallest coin in circulation [5].

Despite the low cost of hemp drugs, the Commission observed only modest rates of consumption in India. Regular users constituted $\leq 1\%$ of the population in every region except Calcutta, where they numbered 5.4% [6].

It is noteworthy that Bengal and other states prohibited private cultivation and limited possession in order to prevent illicit diversion. Therefore legalization did not eliminate cannabis-related crime: in 1892–93, Bengal reported 407 arrests for ganja offenses [7].

The historical example of India proves the viability of legal cannabis regulation. However, it does not provide final answers to the questions raised by Caulkins *et al.* which must be re-addressed in the context of modern American culture.

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Keywords Cannabis, India, legalization.

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RESPONSE TO COMMENTARIES

We thank the commentators for helping to move forward the discussion of specific policy options rather than broad general concepts. All three discussants offer important insights and perspectives. Specifically, Dale Gieringer suggests there are lessons to learn from the costs of production and prices in 19th-century India and of medical marijuana in Israel and the Netherlands [1]; Jan van Ours points to the importance of cannabis use dynamics, which are still poorly understood [2]; and Ethan Nadelmann and his colleagues observe that legalization comes in many forms and that some initiatives are 'far more tightly drafted' than others [3]. This is precisely the kind of more detailed policy discussion we hoped this paper might stimulate.

Most discussion and even analysis to date has compared the *status quo* with a nebulous and inadequately specified equilibrium post-legalization. However, the initial policy choices matter, transitory effects matter and the long-term equilibrium may not necessarily reflect the starting point due to mid-course changes and market dynamics. For example, prices may not fall to their final levels for some years because it will take time for the legal industry to expand. Similarly, it could take a generation or more to see the full effects on consumption; birth cohorts that are now over the age of 25 may remain primarily alcohol consumers, even if younger cohorts who grow up with legalized marijuana sustain higher rates of cannabis consumption throughout their lives. These are the kinds of dynamics we can only speculate about today. We concur with van Ours when he says: 'the most important design choice of legalization is the flexibility to adjustment, allowing for learning by doing' [2].

There is little to disagree with in these comments. We do, however, take issue with two points. First, van Ours asserts that legalization in the United States would not take prices much below levels seen in the mid-1990s [2]. However, like Gieringer, our conclusion is that production costs post-legalization can drop far below current wholesale prices, unless increased artificially by extremely stringent regulations. Hence, while most people might agree with van Ours in principle that 'taxes should be sufficiently high to discourage cannabis use and sufficiently low to drive out illegal supply' [2], we are

skeptical that such a level can be achieved, at least not without designing the entire legalization regime around that objective.

Secondly, while Nadelmann *et al.* [3] note that we did not discuss the benefits of marijuana use, we also did not address the costs; our essay focused explicitly on design choices for implementing legalization rather than an assessment of the pros and cons of legalization versus prohibition. Our analyses of the latter appear elsewhere [4–6]. While such an assessment might seem, logically, to precede the design task, we think progress on the design front could actually facilitate progress on the assessment front.

Thus, we appreciate Nadelmann *et al.*'s useful discussion of differences between California Assemblyman Ammiano's bills and California's Proposition 19, and similarly the differences between Proposition 19 and the initiatives likely to appear on the ballots in Colorado and Washington in 2012. Because of these differences, we hope partisans on both sides will stop referring to legalization as if it were a well-defined entity—something about which sweeping statements can sensibly be made. Instead, we hope the literature and public debate will make statements along the lines of: 'in our estimation, the benefits of legalization along the lines of Proposition 19 would be . . .' or 'if marijuana was taxed and advertised like tobacco, the effects would be . . .'. This would promote a more productive debate about marijuana policy.

Finally, drug policy analysts could draw profitably on expertise and experience from related fields. The Kettil Bruun Society has been discussing the nuances of alcohol control for 25 years, suggesting just how difficult it is to get this kind of regulation right. Studying gambling and prostitution markets and policies may also yield useful insights [4]. Coming up with a good design for the regulation of a legal marijuana market is a scientific, as well as political, challenge.

Declarations of interest

JC has consulted for a company whose clients include law firms that provide services to tobacco companies.

Keywords Cannabis, legalization, regulation.

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