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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

[1]Based 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 advertizing

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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