Real Options for Legalization
(Comments benefit from many collaborations)

Considering Marijuana Legalization
Insights for Vermont and Other Jurisdictions
by Jonathan P. Caulkins, Beau Kilmer, Mark A. R. Kleiman, Robert J. MacCoun, Gregory Midgette, Pat Oglesby, Rosalie Liccardo Pacula, Peter H. Reuter

Design Considerations for Legalizing Cannabis
Lessons Inspired by Analysis of California's Proposition 19
Published in: Addiction, v. 107, no. 5, Commentary, May 2012, p. 865-871
by Jonathan P. Caulkins, Beau Kilmer, Robert J. MacCoun, Rosalie Liccardo Pacula, Peter H. Reuter

dprc.rand.org www.MarijuanaLegalization.info
Legalization Defined

• These things are not legalization
  – Eliminating mandatory minimum sentences
  – Decriminalization (as in many US states since 1970s)
  – Legalizing medical use within the CSA (as with cocaine)
  – Legalizing personal possession and use (as in AK)

• These things are legalization, but are not alike
  – Legalizing own-growing & gifting (as in AK & DC)
  – Legalizing co-ops or cannabis clubs (as in Spain, Belgium)
  – Government monopoly (as with lotteries)
  – Legalizing non-profit or public-benefit corps’ production
  – For-profit industry (What is happening in the U.S.)
VT Report discusses 12 alternatives to status quo supply prohibition.
Quick Tutorial on Real Options Theory

• Financial options
  – Pay now to retain option to do something later.
    • On August 7th, with Apple’s stock trading at $157.82, it cost $19.40 to buy a call option to buy one share of Apple Stock by November 17th with a strike price of $140.
    • If price rose to $180, exercising that option would pay off more than 100%: Profit = $180 - $140 - $19.40 = $20.60.

• “Real” options
  – Similar, but with real, physical activities.
    • When building a factory to meet uncertain demand, pay extra now for a large parcel of land even though initially only build a small factory & upgrading later costs extra
Example

Should you

– Build a small factory on a small parcel of land,
– Build a large factory on a large parcel of land, or
– Build a small factory on a large parcel of land?
## Example with Numbers

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### Example: Punchline

**Keeping options open wins even though:**

- It is more expensive to start small and later expand than to go big from the start.
- Ex post, it is never the best strategy.

**Moral:** Hedge in the face of uncertainty.

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Is There Any Reason Why Commercial Legalization Might Go Badly?

1. Pareto Law
   – Consumption is concentrated among heavy users
2. Effects of acute intoxication on “performance”
   – Vs. “medical” effects (which are small)
3. Sharp price declines
4. Proliferation of novel (un-researched) products
5. Effects on use of other drugs
6. Industry behavior
   – Consolidation/emergence of large corporations
   – Preeminence of marketing over horticulture
7. Dose escalation
1. Illustration of Pareto Effect: What Is the Typical Use Pattern?

• What proportion of the U.S. cannabis market is associated with adults who
  – Use fewer than 10 times per month and
  – Do not suffer from substance abuse or dependence?
The Answer Depends on the Metric

Market Share of Adults Who Report No ABOD Problems & Using < 10 Times per Month

- PY Users: 30%
- PM Users: 20%
- Days of Use: 5%
- Purchases: 5%
- MT Used: 0%
The Relatively Small Number of Daily Users Dominates Use & Use-Related Harm
Today About Half of Use is by People who Struggle with Substance Abuse

- Adult with no ABOD/TX, 46%
- Past or present drug or alcohol ABOD/TX, 46%
- No ABOD/TX, but under age 21, 8%
Most of the Rest is High-Frequency Users

Adult < 10X PM, no ABOD/TX, 2%
Past or present drug or alcohol ABOD/TX, 46%
Adult DND, no ABOD/TX, 35%
Adult 10-20X PM, no ABOD/TX, 8%
No ABOD/TX, but under age 21, 8%
Adult “Light Users” Are a Very Small Part of the Market

- Adult, no SUD, used < 10 days in PM
- Adult, no SUD, used 10-19 days in PM
- Adult, no SUD, used 20+ days in PM
- No SUD, but under 21
- Evidence of SUD
3. The Likely Effects of Legalizing Large-Scale Production on Costs
Price Declines of Marijuana in WA State

Ratio of Sales Value to Weight, WA State Marijuana

Dollars per Gram

May-14  Sep-14  Dec-14  Mar-15  Jul-15  Oct-15  Jan-16  Apr-16

Retail ($/gm)

Wholesale ($/gm)
Legalization Reduces Production Costs

Wholesale Price (2008)
Small Firm (WA, 2013)
Wholesale Price (2013)
Large Firm (Nov '16)
Canadian Medical MJ
Dutch Medical MJ
Growhouse
Industrial Warehouse
Greenhouse
Outdoor Farm

Production Cost/Price per Pound

$0
$500
$1,000
$1,500
$2,000
$2,500
$3,000
$3,500

<--- Prohibition
<--- Quasi-legalization -->
<-- Legalization with onerous regulations-->
<-- Projected cost with light regs and no taxes -->
4. Proliferation of Novel (i.e., under-studied) Product Forms
Market for Extracts if Growing
(Revenue by Product Type, WA)
Substantial Product Innovation

• Will be hard to make money on basic intoxicant
• Think organic vs. generic vegetables
7. Escalation in “Dose” Size – Average Daily THC Consumption
Contrast THC Consumption of Two Types of Users

• 1 joint each weekend night, pre-2000
  – Assuming 0.4 gms/joint, 4% THC
  – \( \frac{2}{7} \times 0.4 \times 4\% = 4.6 \text{ milligrams/day} \)

• Average daily user in WA today
  – Assuming 1.3 gms/day, 20% THC
  – \( 1.3 \times 20\% = 260 \text{ milligrams/day} \)

• That’s ~60 times as much THC
Contrast **Cocaine** Consumption of Two Types of Users

- 1 cup of coca tea per day
  - 1 gm of tea contains 5 milligrams, most of it gets into water. **4.2 milligrams/day**

- Chronic cocaine user in 2005
  - 3.1 million chronic users accounted for ~90% of nation’s 327 (pure) MT of consumption. **260 milligrams/day**

- That’s ~60 times as much cocaine
Contrast **Caffeine** Consumption of Two Types of Users

- One 20-ounce bottle of Diet Coke – 76 milligrams
- To get ~60 times as much caffeine ...

- Drink **Thirty** 16-oz. Starbucks cappuccinos – 30 * 150 mgs = **4,500 milligrams**
  – (some guess lethal dose is 5-10,000 mgs)
Contrast Water Consumption of Two Types of Users

• If I drink a little over half a cup of water
  – Result: Quenched thirst

  – Result: Death by fatal water intoxication
Contrast Blueberry Consumption of Two Types of Users

• One-sixth of a pint of blueberries
  – Result: Happiness

• 10 pints of blueberries
  – Result: Stomach ache
Do We Understand Effects of 260 mg on Health/Behavior/Performance?

Note: Dose was 20 mg

Fig. 4 Effect of smoking a cannabis cigarette containing 20 mg tetrahydrocannabinol (THC) on pilot performance in a flight simulator landing task (Leirer et al, 1991). --- ■ ---, 20 mg THC; ●●, placebo.
From Fabritius et al. (2013):

This graph is for effects on occasional users.

Note: Mean dose was 43 mg
1. Pareto Law
   – Consumption is concentrated among heavy users
2. Effects of acute intoxication on “performance”
   – Vs. “medical” effects (which are small)
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The U.S. Appears Poised to Make an Irreversible Leap
Conclusion for Worriers

It's better to keep your Options Open than your Eyes Closed.

- DreamNofTahiti
Conclusion for Optimists

May the bridges I burn today be for a better tomorrow.

Personally, I am worried.