The Relationship Between Enforcement and the Price of Marijuana

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Abstract
Using a global, internet-based survey of transaction prices, the relationship between enforcement of the prohibition of marijuana and its price is investigated. In places where the prohibition is "strictly enforced" as compared with places where marijuana has been decriminalized, the price is something like 50 percent higher. Implications for decriminalization and legalization are briefly discussed.

I. Introduction

Interest in exploring alternatives to the prohibition of marijuana has recently revived. According to the United Nations Global Commission on Drugs (2011, p.3), "The global war on drugs has failed, with devastating consequences for individuals and societies around the world." The report describes recent experiments with decriminalization and advocates a shift in policy from criminal sanctions to legal regulation. In the United States, Massachusetts, in 2008, by citizen initiative, and Connecticut, in 2011, through the legislative process, decriminalized possession of small amounts of marijuana. These actions bring the number of states decriminalizing marijuana to 13; the other 11 decriminalized during the 1970s. California and Colorado, two of the decriminalization states, have moved to legalize the production, sale, and distribution of small amounts of so-called medical marijuana (in spite of the continued illegality of the same under federal law, as affirmed by the U.S. Supreme Court in *Gonzalez v. Raich* in 2005).

In a number of other democratic countries, a similar interest in relaxing the prohibition of marijuana has recently emerged or revived. In Australia, several states have decriminalized possession of small amounts of marijuana. In Canada, recent court rulings have put criminal sanctions against personal use into flux. The Czech Republic, in 2010, through the legislative process, decriminalized personal use. In Germany, a court ruling concerning a Constitutional prohibition of excessive punishment and police practices in several landers combine to decriminalize personal use.

Among the issues involved in decriminalization is the possibility that reduced enforcement of the marijuana prohibition will lead to increased use of marijuana by youth and, via the gateway drug effect, increased use of hard drugs. Studies of the effects of the decriminalization of marijuana in several states during the 1970s found no such gateway effects. Instead, they found that young people responded to changes in the legal status of alcohol and of marijuana—due to changes in the legal drinking age and the decriminalization of marijuana—in ways that indicate that these are substitutes for each other. That is, changes in the legal status of one or the other substance mostly shifted demand between these substances as opposed to dramatically increasing demand (DiNardi and Lemieux, 2001; Thies and Register, 1993).

Similarly, with respect to the more recent decriminalization of marijuana in Australia, Williams (2004) found no evidence that decriminalization led to significantly greater use by young adults (although she found some evidence of greater use by persons over 25). In something of a follow-up study, Van Ours and Williams (2007) found that a lower price induces more experimentation with marijuana by young adults. Clements (2004) relates the recent fall in the price of marijuana in Australia to the development of hydroponic cultivation and the relaxation of the prohibition.

Saffer and Chaloupka (1999) estimate the demand for several drugs relative to the prices of each, except that they did not incorporate the price of marijuana into their model for lack of data. Desimone and Farrell (2003) (see also Desimone, 2008) use the price of marijuana in 16 metropolitan areas, as tracked by drug enforcement agencies, to infer the price of marijuana throughout the country so as to estimate a complete set of elasticities of demand. Although they find demand to be inversely related to price for young

adults, they do not obtain such a finding for juveniles. However, they always find that arrests reduce demand.

Farrelly et al. (1999) argue that increases in the price of tobacco contributed to the doubling of the rate of marijuana use during the 1990s. Grossman (2004) argues more generally that changes in price explain much of the changes in cigarette smoking, binge alcohol drinking, and marijuana use by high school seniors that have occurred since 1975. In particular, changes in the real price of marijuana explain 70 percent of the reduction in its use from 1975 to 1992, 60 percent of the resurgence in its use to 1997, and almost 60 percent of the decline since that year.

Grossman (2001, p. 3) defines the *full price* of an illegal good to be the purchase price, the cost in time of purchase, the expected value of legal penalties, and the expected value of adverse health effects. Without completely discussing the issues of decriminalization and legalization, he notes (p. 20) that "permanent increases in price due to excise tax increases or permanent reductions in price due to legalization will have substantial effects on the use of addictive substances." Accordingly, this paper now develops a model of the effect of prohibition on the price of marijuana.

II. A Model of Prohibition

This section develops a simple model for identifying the effects of prohibition. Given the supply and demand curves shown in Figure 1, the free market price would be \$30, and quantity would be "b". Consumer surplus would be the area defined by $\alpha + \beta + \gamma$. Producer surplus (or economic profit) would be the area defined by $\delta + \varepsilon + \lambda$.[1]

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[1] Stringham (2001) argues that welfare calculations are impossible. Hummel (2009) argues, contrariwise, that welfare calculations can be useful. Stringham (p. 48) says, "To truly figure out willingness to pay, the government would need to read minds to determine how much every single person would value every possible state of the world." But even Murray Rothbard drew demand curves (to be sure, with lots of tiny discontinuities). In any case, human action, whether by individuals or collectives, is not based on "truly" knowing, especially not during times Ludwig Lachmann described as "kaleidic change," when many things are changing at the same time, like in a kaleidoscope, and when the "other things equal" assumption of equilibrium economics does not hold. While resolving the continuing controversy between the Austrian and neo-classical approaches to utility theory is beyond the scope of this paper (for a masterful contribution to this matter, see McCulloch, 1977), the focus on consumer surplus (defined as the difference between price and willingness to pay as indicated by the demand curve) is respectful of consumer
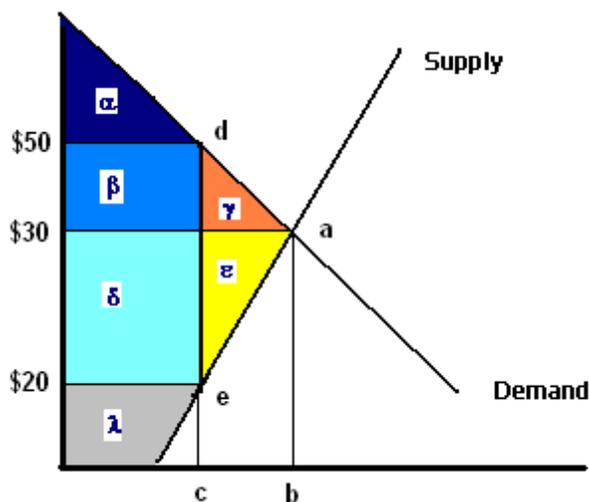
Figure 1. Black markets.

Let's say the government imposes an excise tax of $30. Then, the price to the consumer would be $50 and the price to the producer $20. The tax *drives a wedge* between price to the buyer and price to the seller. Consumer surplus would be (only) the area defined by α. Producer surplus would be (only) the area defined by λ. Both consumer and producer surplus are smaller. Revenue to the government would be the area defined by β + δ. Accordingly, part of the loss of consumer and producer surplus is picked up as revenue to the government. However, the area defined by γ + ε is lost to all. This is the "dead-weight loss" of the tax.

Now let's say that instead of taxing the product, the government makes it illegal. And let's say that a black market develops in which the probability of the seller being convicted times the value of imprisonment is $30. In expected value terms, this looks like a tax, in that a *wedge* is driven between the price to the consumer and the price to the producer. But, in this case, the government is not picking up any revenue. The whole amount β + δ + γ + ε is the dead-weight loss. Notice that prohibitions are generally *inefficient*. The reduction of

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sovereignty and, hence, libertarian. What would be unlibertarian would be to consider the reduction of consumption by others, from b to c, to be a value.

quantity from "b" to "c" comes at a dead-weight loss of only $\gamma + \varepsilon$ with a tax but is $\beta + \delta$ *larger* with prohibition.[2]

Returning to the wedge, the difference between a tax and problematic criminal sanctions is important. Problematic criminal sanctions give rise to huge profits when sellers are not caught and to huge losses when sellers are caught; therefore, they give rise to violent resistance to law enforcement and to corruption.

Caulkins and Reuter (1998) estimate that something like two-thirds of the retail price of marijuana is consumed by the risks of imprisonment, of being killed or suffering some other physical injury, and of seizures of drugs and other assets (with much of the rest of the retail price being consumed by the cost of transporting the product, which is high because it is illegal). The cost of the product in Colombia, they say, is only 1 percent of its retail price in the United States. Caputo and Ostrom (1994) similarly estimate the cost of the product, if legal, at approximately 1 percent of its retail price.

Thus, the way prohibition works is by raising the price of marijuana to buyers (who are mostly held harmless) by making dealing in marijuana a high stakes game in terms of the potential gain or loss to sellers.

III. Enforcement Regimes Around the World

Enforcement of the marijuana prohibition varies tremendously around the world. At one extreme, there is the People's Republic of China, where dealers in illegal drugs and repeat offenders for using illegal drugs are subject to capital punishment and where executions for such offenses are common.[3] At the other extreme, there is Mexico, which in 2009 decriminalized both marijuana and hard drugs to combat drug violence.[4] In between these extremes are enforcement regimes that vary in strictness because of differences in statutory law, judicial interpretation of constitutional rights, and local police practices.

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[2] Some qualifications of this admittedly simple model must be stated. A high enough excise tax will give rise to a black market. Even if the excise tax did not itself induce a black market, age restrictions might. The cost to the taxpayer of law enforcement, to include the imprisonment of offenders, would have to be added to the dead-weight loss shown above.

[3] http://www.freeexistence.org/drugindex.html (accessed 16 June 2011)

[4] According to the aforementioned source, the drug violence of that country is now associated with smuggling into the United States, where drugs are still illegal.

Marijuana is, in the United States, a Schedule 1 substance, meaning that it has "a high potential for abuse, no currently accepted medical use in treatment in the United States, and a lack of accepted safety for use of the drug or other substance under medical supervision."[5] Nevertheless, enforcement of the prohibition varies tremendously within the country from one place to another, reflecting state laws and local practice.

In Europe, nations exercise more control over statutory drug policy, e.g., distinguishing one from another drug. "Most European countries have examined or implemented distinctions between drugs in their legal frameworks." (European Monitoring Centre, 2010, p. 24) Even so, enforcement differs from one place to another mostly because of local practice. For example, in certain places in the Netherlands, which is famous for its "coffee shops," the legal status of marijuana is simultaneously illegal, tolerated, and regulated.

Pacula et al. (2003) have made the point that, within the United States, characterizing enforcement of the prohibition as "all or nothing" is insufficient. Many states, they point out, that have not decriminalized have nevertheless reduced criminal penalties and in other ways relaxed enforcement. Ideally, a *scale* of enforcement would consider differences in statutory law, relevant judicial rulings, and local police practice.

IV. A Global Survey of Marijuana Prices

The standard source of marijuana price data is drug enforcement agencies. As was mentioned above, in the United States, price data are available nationally and for 16 metropolitan areas. In Europe, similar data (from drug enforcement agencies) is available for a large number of countries. But, until recently, the price of marijuana had not been systematically available at the local level.

In September 2010, PriceOfWeed.com began soliciting marijuana transaction prices. During that month, the website was promoted by several established and new media. By June 2011, the site had accumulated more than 25,000 prices. Approximately 80 percent of these prices were from the United States.

Table 1 presents some descriptive statistics from the PriceOfWeed.com survey pertaining to California. Both the mean and median prices for an ounce of marijuana are approximately the

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[5] http://www.justice.gov/dea/concern/marijuana.html (accessed 16 June 2011)

same at $300. The standard deviation, range, and inter-quartile range all indicate very wide dispersion.

Focusing on quality, it can be seen that approximately two-thirds of the transactions involve marijuana described as "high quality" and about one-third as "medium quality." Only a few transactions are described as involving "low-quality" marijuana. Comparing the second with the first row, it can be seen that the distribution of the price of medium quality lies to the left of the distribution of high quality (as would be expected), except that the maximum medium-quality price is higher than the maximum high-quality price. Much the same thing can be said about the distribution of low-quality prices relative to medium-quality prices. The only difference in these comparisons is that the unrepresentative if not incorrect maximum low-quality price distorts the mean low-quality price.

Focusing on the size of the transaction, it can be seen that approximately 80 percent of transactions involve either an ounce (or 25 or 30 grams) or an eighth-ounce (or 5 grams). Approximately 10 percent involve each of a quarter-ounce (or 10 grams) and a half-ounce (or 15 or 20 grams). Ignoring some oddities concerning minimum prices by size, the distributions of price of smaller-size transactions lie to the right of the distributions of price of larger-size transactions.

Table 1. Descriptive Statistics of the Price Marijuana per Ounce, California Transactions, September 2010–June 2011

	Count	Mean	Std. Dev.	Min.	25th %tile	Median	75th %tile	Max.
All transactions	2,417	$297	$191	$1	$200	$300	$400	$5,670
Breakouts by Quality								
High quality	1,576	$319	$142	$1	$240	$320	$400	$2,000
Medium quality	776	$252	$168	$1	$151	$240	$320	$2,835
Low quality	65	$283	$713	$1	$57	$123	$283	$5,670
Breakouts by Size of Transaction								
Ounce	943	$213	$117	$1	$140	$200	$300	$1,000
Half ounce	166	$266	$174	$19	$200	$270	$300	$2,000
Quarter ounce	220	$301	$209	$28	$213	$292	$360	$2,835
Eighth ounce	1,088	$373	$210	$6	$320	$360	$440	$5,670

Examining the distribution of transaction prices from California, several things are clear: Price is a function, presumably among other things, of quality and the size of a transaction. There is a wide dispersion of prices about their central tendency. And the survey includes unrepresentative and possibly incorrect prices.

V. Regression Analysis

For the purpose of performing regression analysis, prices from all places that have at least five transactions were assembled into one global sample. This global sample includes prices from 234 states or other jurisdictions from 49 countries. The sample includes all fifty states of the United States as well as the District of Columbia and Puerto Rico. It includes ten provinces of Canada and eleven landers of Germany. Most of the other countries of Europe are included as well as Australia and New Zealand, seven countries from Latin America, six in Asia, and one in Africa.

Two sources were used to construct an index of enforcement. The first was the PriceOfWeed.com website which, for each location, gives a five-part scale of enforcement. The original scale runs from 1 to 5, where 1 represents loosely enforced and 5 strictly enforced. The second source was FreeExistence.org, which, for each nation and for selected places within federal nations, gives a scale from 0 to 10 by increments of 0.5, where 0 represents very strictly enforced and 10 represents legal. Each of these indices was converted to scales ranging from 0 to 4, where 0 is loosely enforced and 4 strictly enforced, and the average of these two scales is used as this study's index of enforcement.

Two additional variables were added to the observations of the sample: 2007 GDP per capita from the Penn World Tables (Heston et al., 2011) and a latitude variable. The latitude for a place is a representative latitude, usually the latitude of its capital city, whether northern or southern. Based on some experimentation, the latitude variable is defined as (latitude − 35)/15 subject to a maximum of 1.

Table 2 presents some regression estimates. All explanatory variables are of the expected sign and are very significant. Nevertheless, the explanatory power of the model reported in the first column, indicated by R^2, appears low, as might result from the inclusion of unrepresentative and possible incorrect price data. To investigate the extent to which parameter estimates might be affected by the inclusion of bad price data, the second and third columns

Table 2. Regression Analysis of the Logarithm of Price of Marijuana per Ounce, Transactions from 234 "States" of 49 countries, September 2010–June 2011.

	Full sample	Truncated at four prediction errors	Truncated at three prediction errors
Constant	-1.7959	-1.0710	-0.6567
	(0.2071)	(0.1847)	(0.1715)
	[-8.6710]	[-5.7972]	[-3.8299]
Latitude variable	0.1957	0.1891	0.1710
	(0.0158)	(0.0139)	(0.0125)
	[12.3488]	[13.6098]	[13.7210]
Enforcement variable MIN(1.5,X) where X ranges from 0 to 4	0.4541	0.4422	0.4453
	(0.0261)	(0.0139)	(0.0125)
	[17.4076]	[19.3134]	[21.6846]
LN(GDP per capita)	0.6057	0.5467	0.5125
	(0.0192)	(0.0171)	(0.0159)
	[31.4995]	[31.8791]	[32.1605]
Medium quality (relative to High)	-0.5017	-0.5210	-0.5094
	(0.0098)	(0.0098)	(0.0077)
	[-51.1590]	[-60.8242]	[-66.5179]
Low quality (relative to High)	-0.7958	-0.8542	-0.9122
	(0.0188)	(0.0165)	(0.0148)
	[-42.4211]	[-51.8577]	[-61.6064]
Half ounce (relative to Ounce)	0.1600	0.1081	0.0795
	(0.0185)	(0.0161)	(0.0144)
	[8.6711]	[6.7111]	[5.5222]
Quarter ounce (relative to Ounce)	0.4275	0.3617	0.3254
	(0.0142)	(0.0124)	(0.0111)
	[30.0456]	[29.1128]	[29.2977]
Eighth ounce (relative to Ounce)	0.7442	0.6709	0.6225
	(0.0104)	(0.0091)	(0.0081)
	[71.6954]	[73.8694]	[76.6672]
R-square	31.0%	35.4%	39.4%
Number of observations	25,579	25,346	24,991

Standard errors in parentheses; t-statistics in brackets.

present regression results with truncated samples. On one hand, with regard to the parameter of interest (the effect of enforcement on price), the possible effect of bad data is small and of little consequence to any policy implications. On the other hand, the constant and the coefficients of some of the control variables appear to be sensitive to exclusion of outliers.

The regressions indicate that stricter enforcement of the prohibition of marijuana increases price. Comparing strict enforcement (i.e., an enforcement index value of 1.5 or higher) to decriminalization (an enforcement index value of 0), the model reported in the third column indicates that strict enforcement raises price by approximately 50 percent.[6] Other results indicate that marijuana is higher priced in the high northern or high southern latitudes (presumably because of the cost of transporting an illegal substance, shortened growing seasons, and the cost of indoor cultivation) and that local prices reflect local incomes.[7]

VI. Policy Implications

As demonstrated above, a relaxation of the prohibition of marijuana from relatively strict to relatively loose can be expected to lower price and increase the quantity demanded. Past experience with decriminalization indicates that the increase in demand is not very large and mainly comes from a shift of demand from other drugs such as alcohol. Such a consequence may be viewed as acceptable. However, decriminalization is a relatively minor change of policy. With decriminalization, marijuana remains illegal; criminal sanctions still attach to dealers; the price of marijuana, while lower, remains very high; and dealers continue to be involved in a high-stakes game.

Legalization, as opposed to decriminalization, offers the possibility of fundamentally changing the conditions of the marijuana market. In particular, legalization offers the possibility of eliminating

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[6] On the suggestion of a reader, the possibility of a non-linear relationship between the enforcement index and the log-price of marijuana was explored. Experimentation indicated that the entire increase in price occurs in the range 0 to 1.5 on the index. The effect of decriminalization is calculated as $LN(1 + 1.5 \times$ coefficient of the enforcement variable).

[7] Were marijuana to be legalized, it might be expected to be priced like a commodity. Local prices might then be equal to a base price (e.g., price in Colombia) plus a relatively low cost of transportation plus whatever tariff or excise tax is applied locally, and possibly be independent of local income.

the high-stakes game involved in dealing in the substance. But, without an excise tax and other controls on supply, such as the licensing of production, to keep the price of marijuana high, the fall in the price of marijuana might be very substantial, much more than the 50 percent fall that appears to be associated with decriminalization, with the result that the increase in the quantity demanded would be much greater. Relative to reducing quantity demanded via either strict prohibition or decriminalization, legalization in conjunction with taxation and regulation may be able to achieve a superior set of results.

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