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The Price Elasticity of Marijuana Demand

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Abstract

This paper uses crowd-sourced transaction data from a cross-section of the US to examine demand for marijuana. State and regional variations in consumption, price and quality are explored. Price elasticity of demand estimates range between -0.3 and -0.6. Noticeable price differences are found between high, medium, and low quality marijuana, with high quality marijuana, at $13.57 per gram, 144% greater than low quality marijuana, at $5.55 a gram. Significant variation is also found by medical marijuana status and census region, although this variation depends critically on the quality of the marijuana.

Introduction

Over forty years have passed since Nisbet and Vakil (1972) surveyed UCLA students in an attempt to estimate the own-price elasticity of demand for marijuana. Their precedential study paved the way for a topic that has grown exponentially in importance as states recently have decriminalized possession, passed medical marijuana laws, and, in Colorado and Washington, passed legislation legalizing possession for personal use.[1] The motivation for such policies, particularly those in Colorado and Washington, has been to legalize possession in order to use police resources against more serious property and violent crimes, regulate the industry and remove illegal drug dealers from its provision, tax sales in order to raise revenue, and treat addiction as a public health, as opposed to criminal, issue. The impact of these laws, including the response from the Federal Government which still considers marijuana possession illegal, remains to be seen. The changes in demand and supply that result as well as the tax revenue generation potential of marijuana sales have also yet to be determined. Clearly, however, these impacts will depend, in part, on the elasticity of demand. The drastic changes that have occurred with marijuana legislation since Nisbet and Vakil (1972) estimated the price elasticity, and the fact that very few studies have estimated the price elasticity since, is the motivation for this study.

According to the Substance Abuse and Mental Health Services Administration of the Department of Human Health and Human Services (2012), marijuana is the most commonly used illicit drug with 18.1 million past month users. Between 2007 and 2011 the rate of use has increased an estimated 5.8% to 7.0% (Substance Abuse and Mental

[1] Colorado voters passed Amendment 64, Use and Regulation of Marijuana. Washington voters passed Initiative 502.

Health Services Administration, 2012). Marijuana use has been a hot policy topic in the United States for many years. The debate generally centers on the contention that legalization of marijuana would result in sky rocketing consumption versus the futility of the "war on drugs" with claims that legalization and taxation is the rational solution.

This paper does not seek to enter this debate. Rather, the purpose of this paper is straightforward: to provide an estimate of the own price elasticity of demand. Clearly this will be of interest to many as changes in the price of marijuana, perhaps due to changes in its legal status, will impact its consumption.

The next section of this paper reviews the extant literature on marijuana demand. Surprisingly few studies estimate the elasticity of demand, primarily due to the lack of available data. The third section describes the crowd-sourced data used in this study. This is followed by our empirical methodology and results. The last section concludes the paper.

Literature Review

Estimating the elasticity of demand for an illicit good, such as marijuana, is problematic since rarely is information about purchases systematically recorded. The first publication investigating the marijuana price elasticity was conducted by Nisbet and Vakil (1972). Their data were gathered from an anonymous mail questionnaire of 926 UCLA students. Students reported quantities of marijuana purchased at current prices and also quantities they would purchase in the future after hypothetical price changes. Nisbet and Vakil (1972) employed Ordinary Least Squares (OLS) to estimate the effect of price and monthly expenditures on the quantity demanded. Both the double log and linear functional forms were estimated. The researchers concluded that the price elasticities were between -0.40 and -1.51 depending on the data and the functional form.

Due to the lack of reliable transactions data, particularly price data, subsequent marijuana demand studies focused on other demand determinants. While a review of these studies is beyond the scope of the current analysis, these determinants include decriminalization (e.g., Model, 1993; Saffer and Chaloupka, 1999) and price changes in related goods, including alcohol (e.g., Thies and Register, 1993; Pacula, 1998), tobacco (Zhao and Harris, 2004), and other illicit drugs, such as cocaine (e.g., Saffer and Chaloupka, 1999; Desimone and Farrelly, 2003). Some of these studies include marijuana price data, yet none provide marijuana price elasticity estimates. One source for marijuana price data is the System to Retrieve Information from Drug Evidence (STRIDE), maintained by the Drug Enforcement Administration (DEA) of the U.S. Department of Justice. As noted by Pacula et al. (2001), however, these data do not contain information on quality or distinguish between wholesale and retail prices and are therefore of limited use for marijuana studies. Another source of marijuana price data is the Illegal Drug Price/Purity Report (IDPPR), also maintained by the DEA. While containing information on drug purity and distinguishing between wholesale and retail prices, this data source only contains price for nineteen cities in sixteen states.

Since the publication of Nesbit and Vakil (1972), the only other study to estimate the price elasticity of demand in the United States is Pacula et al. (2001). Using both national and repeated cross-section data sets from Monitor the Future (MTF) and marijuana price data from the IDPPR, Pacula et al. (2001) estimate the price elasticity of marijuana demand for youth. Their estimates range from a low of -0.002 to -0.69. The range of estimates depends on the inclusion of potency and time trends as independent variables. Given concerns over the potential endogeneity of other independent variables, including the perception of harm, Pacula et al. (2001) conclude that a conservative lower bound estimate of the price elasticity of demand for youth is -0.30.

More recently, Clements et al., (2010) using survey data on marijuana consumption and marijuana price data from the Australian Bureau of Criminal Intelligence, estimate price elasticities for marijuana, alcohol, and tobacco, with marijuana elasticities ranging from -0.586 to -0.66.

The above three studies are, to date and to our knowledge, the only published studies estimating the price elasticity of marijuana demand. As noted, most other demand studies have focused on cross-price elasticities of marijuana with cigarettes, alcohol, and other illicit drugs or the response of marijuana demand to variation in arrest enforcement and decriminalization. The current study does not attempt to add to the literature on cross price elasticities or response to varying criminal sanctions, in part because our data, described more below, do not allow such analysis. Rather, the objective of this study is to provide an estimate of the price elasticity of demand.

Data and Empirical Methodology

The current study builds on and contributes to the existing literature in in several key ways. First, to our knowledge, this is the first study to empirically estimate marijuana demand using actual transaction histories reported directly from a large number of consumers. While similar to Nisbet and Vakil (1972) in that the data are self-reported, our sample size, at over 23,000 transactions, is notably larger. It also contains transaction data from every state in the United States. Moreover, the data reflect private transactions from individual consumers rather than prices paid by drug enforcement officers, as in the STRIDE and IDPPR data sets. While it is generally agreed that undercover agents pay a realistic price so as not to reveal their identity to the illegal drug dealer, the data used in this study reflects a broader cross section of purchasers from all over the United States. The current data set also allows us to control for variations in quality. Finally, we confirm the robustness of our results using instrumental variables estimation to account for the endogeneity of price in the demand equation.

The data set used in this study is a series of transaction data obtained from the creator of website called “The PriceOfWeed.com”. This website was designed to answer one simple question: "What is marijuana really worth?”. The creators set out to “crowd-source” the street value of marijuana from the most accurate source possible, the consumer. Site visitors anonymously input the following about their most recent marijuana transactions: amount purchased; price of the purchase; and quality, choosing from low, medium or high. Data on the city, state, and country where the transaction took place are also collected. Data from over 31,000 transactions were obtained between September 2, 2010 and August 29, 2011. After dropping observations for transactions that took place outside of the United States, observations lacking complete information, and transactions from Alaska and Hawaii, we are left with 23,611 usable observations.[2] Summary statistics are provided in Table 1.

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[2] Dropping Alaska and Hawaii made no difference in our elasticity estimates, but their inclusion cast doubt on the validity of the instruments chosen in our instrumental variables estimation.

The quantity of marijuana is measured in grams. Marijuana is typically packaged in specific amounts: Eighths (3.5 grams), Quarters (7 grams), Half Ounces (14 grams) and Ounces (28 grams). Observations include amounts between 3.5 grams and 28 grams, with the average purchase equaling just less than 14 grams. The median purchase is 7 grams. Price is dollars per gram, with an average price per gram of $11.52

While these data are unique and rich in certain aspects, several caveats should be noted at this point. Most obviously, these data are self-reported and not a random sample. While having data on the quality of the marijuana purchased is unique, this too is self-reported and clearly subjective. Due to the anonymous nature of the web site, no individual level data are available. Therefore, we do not have any demographic or economic information about the individuals involved in these transactions. Moreover, we do not know whether each transaction represents a unique individual or involves multiple transactions by the same individual.

Given the lack of individual level socioeconomic data, the remaining variables used in this analysis are measured at the state level. For income we use average per capita income, measure in dollars, and gathered from the Bureau of Economic Analysis, for the state in which the transaction took place.

The beer tax is intended to capture the price of another good. There has been much debate as to whether alcohol is a substitute or a complementary good with respect to marijuana. It is measured by the state excise tax placed on beer in the state where the transaction took place. All excise taxes are measured in dollars per gallon and were obtained from the Tax Foundation.

Decriminalization is a dummy variable that identifies whether or not the transaction took place in a state in which penalties associated with marijuana are decriminalized. Thirty nine percent of transactions took place in a decriminalized state. It should be noted, however, that these eleven states, identified in Pacula et al. (2003), have varying penalties association with possession and some non-criminalized states have also reduced penalties associated with possession. In fact, Pacula et al. (2003) note that decriminalized states cannot be uniquely identified. We describe how we account for this in more detail below.

The medicinal marijuana variable is also a dummy variable that represents whether or not the state in which the transaction took place has legalized medicinal marijuana prior to or during 2010. This information was obtained from the Office of National Drug Control Policy's Marijuana Resource Center.[3] Approximately thirty-four percent of transactions took place in medical marijuana states.

Quality is measured by dummy variables that capture if the marijuana in the transaction was reported as high, medium or low quality. In our sample, 60% of transactions involved marijuana reported as high quality, 33% medium quality, and 7% low quality marijuana.

Finally, electricity price is the average per capita electricity price ($/kilowatt hour or kWh) for the state in which the transaction took place. This information was provided by the U.S. Energy and Information Administration through the "Monthly Electric Sales and Revenue Report with State Distributions Report". As discussed more below, this

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[3] Available at http://www.whitehouse.gov/ondcp/state-laws-related-to-marijuana.

variable is a supply of marijuana determinant that is used in our instrumental variables estimation.

To estimate the price elasticity of demand, the following model is estimated:

$$lnQ_i = \beta_0 + \beta_1 lnP_i + \beta_2 lnI_s + \beta_3 lnB_s + \beta_4 H_i + \beta_5 M_i + \beta_6 D_s + \varepsilon_i \quad (1)$$

Where Q_i represents the quantity of grams purchased in transaction i, P_i represents the price paid for that quantity, measured as dollars per gram, I_s is per capita income in the state where the transaction occurred, and B_s is the beer tax, dollars per gallon, in the state where the transaction occurred. Quantity, price, income, and the beer tax are logged so as to obtain elasticity estimates. H_i is a dummy variable equal to one if the marijuana purchases was reported as high quality, M_i is a dummy variable equal to one if the marijuana purchased in transaction i was reported as medium quality. Low quality is the omitted category. D_s is a dummy variable equal to one if marijuana in state s is decriminalized. This model is estimated using both OLS and Instrumental Variables techniques to account for the endogeneity of price.

Empirical Results

OLS estimates

Table 2 shows OLS results from estimating the demand model given by equation (1). The coefficient of the price variable indicates that the demand for marijuana is inelastic and equal to -0.655. This estimate is very much in line with the most recent estimate of Clements et al., (2010), and not that far from Pacula et al., (2001) which range from -0.002 to -0.69, with -0.30 being a conservative lower bound.

The other control variables, perhaps with the exception of *Decriminalized*, are of the expected sign and all are statistically significant. The coefficient on income suggests that marijuana is a normal good but that demand is income inelastic, as states with a 1% higher level of income have average marijuana transactions that are approximately 0.2% larger.

The beer tax variable is significant at the 10% level and positive indicating that beer may in fact be a substitute for marijuana, although the coefficient is small, suggesting a 1% increase in the beer tax increasing the grams of marijuana purchased by .01%. This is contrary to Pacula (1998) who finds that increases in the beer tax decrease both the probability of using marijuana and the amount consumed. Yet other studies have also found marijuana and alcohol to be substitutes. For example, Cameron and Williams (2001) find a 10% increase in alcohol prices increases the probability of marijuana use by 4.17% and DiNardo and Lemieux (2001) find an increase in the drinking age increased marijuana consumption.

Both quality variables are statistically significant and suggest a greater demand for higher quality marijuana than low quality but a lesser demand for medium quality compared to low quality. While the quality measure is subjective, it suggests that purchasers place a greater value of marijuana that is perceived as high quality and that marijuana of perceived lower quality may be more substitutable.

The indicator variable for whether or not the transaction took place in a decriminalized state is also significant at the 1% level but unexpectedly negative. Deterrence theory would certainly suggest that decreased criminal penalties associated with marijuana use would increase demand. However, many studies that examine the impact of decriminalization on consumption find little or no significant impact, (e.g., Thies and Register, 1993; DiNardo and Lemieux, 2001; Williams et al., 2004). There are several reasons to read little into this unexpected result. First, decriminalization as defined here is only capturing state-to-state variation and may be capturing other factors unique to these states. Second, decriminalization may increase demand by increasing the frequency of use, the probability of use, or the number of users, individual-specific factors that this demand specification is unable to detect. Third, and perhaps most importantly, the variable is measured with noise. Indeed, Pacula et al. (2003) note that decriminalized states are not uniquely identifiable since several non-decriminalized states have reduced the criminal status of marijuana possession offenses either through changing the statutory offense or through conditional discharge and expungement of records for first time offenders.

Nevertheless, as a robustness check, we estimate equation (1) excluding the decriminalized variable. These results are presented in column 2 and are very similar to those reported when including *Decriminalized*. As a further robustness check, we also used a definition of decriminalized from the National Organization for the Reform of Marijuana Laws (NORML). NORML defines decriminalization as "no jail time or criminal record for first-time possession of a small amount for personal consumption" and at the time of our sample included the eleven original decriminalized states plus Massachusetts and Nevada. These results, not separately reported, were also nearly identical to those reported in columns (1) and (2). As a final robustness check we also estimate the model including state fixed effects, which should capture any differences in punishment and enforcement of marijuana laws and have been shown to be an important consideration when estimating the demand for illicit drugs (Desimone and Farrelly, 2003). Income and the beer tax variables are dropped since they are state averages for a single year and consequently are collinear with the state fixed effects. Our estimate of the price elasticity when including state fixed effects remains consistent at -0.656.

Instrumental Variable Estimates

To account for the endogeneity of price in our demand equation we use electricity price and medical marijuana designation as instruments. Both of these variables are supply factors that should ensure we are uniquely identifying the demand function in our estimates.

Electricity is arguably the largest factor cost in US production of marijuana. Domestic marijuana production typically takes two forms: indoor or outdoor growth. Because not many climates in the US are suitable for marijuana growth, and for security reasons, most domestic production of marijuana takes place indoors. Without the power of the sun, marijuana plants require High-Intensity Discharge (HID) lighting to grow. HID lights require large amounts of electricity and typically need to be on for 12-24 hours a day in order to simulate the normal cycles of the sun. Electricity is also required for many of the other production processes such as: dehumidification, space heating, and generation of CO^2. Mills (2012) estimates that national electricity use attributable to indoor marijuana growth is somewhere around 20 TWh/year. This is equivalent to the electricity consumption of 2 million average US homes, or 1% of national electricity consumption.

Our other instrument to identify the demand function is the policy variable indicating whether or not marijuana has been legalized for medicinal purposes in the transaction state. It is true that this policy variable is probably correlated with a consumer's willingness to purchase marijuana in that it may be associated with reduced risk of use and increased social acceptance and will therefore likely influence demand. However, whereas the decriminalization variable decreases risk for possession of small amounts, medical marijuana legislation is much more relevant for the producer. A medicinal marijuana prescription not only allows patients to possess and consume marijuana but allows for home cultivation (Pacula et al., 2010). In California alone, over 400,000 individuals are legally authorized to grow marijuana for medical use (Mills, 2012). Nevertheless, because the medical marijuana policy theoretically may impact both demand and supply we estimate our model excluding this instrument as a robustness check.

Instrumental variable estimates of equation (1) are provided in columns (4) and (5) of Table 2, with the latter excluding *Decriminalized* for consistency with the OLS estimates. The point estimates for the elasticity of price are very similar to those obtained when using OLS. Not surprisingly, the standard errors are noticeably larger, giving a 95% confidence interval for our elasticity estimates that range from approximately -0.40 to -0.80. Remaining coefficient estimates are also generally consistent with their OLS counterpoints, although the quality variables drop in statistical significance. Given that our main instrument, electricity price, is a state-level average we are unable to perform IV estimation with state dummies.

The Sargan-Hansen statistic in both IV specifications (3.31 and 0.13 for columns (4) and (5), respectively) fails to reject the null that our instruments, the natural log of electricity price and medical marijuana, are valid. The Cragg-Donald Wald F statistics (111.36 and 221.38 for columns (4) and (5), respectively) suggest that the instruments are also strong. Nevertheless, given that the medical marijuana instrument is theoretically weak for uniquely identifying supply, column (6) reports estimates using only the log of electricity price as an instrument. The price elasticity decreases, with a point estimate of -0.33, similar to the lower bound estimate of Pacula et al. (2001). The coefficients on income, high quality, and decriminalized also lose their significance.

Variation in Price

While the main purpose of this paper is to estimate the price elasticity of demand, given the wide geographic coverage of these data and the information on quality, this section briefly explores variation in the price of marijuana by quality, region, and medical marijuana status. Particular attention is paid to any quality premium that may exist and how medical marijuana laws, which may increase both the demand and supply of marijuana, impact price. Finally, regional differences are also explored.

Table 3 provides descriptive statistics and tests for significant differences in price by quality, medical marijuana, and census region. In terms of quality, high quality marijuana sells for an average price of $13.57 per gram, approximately $4.50 above medium quality and $8 above low quality, suggesting a substantial quality premium. The

Kruskall-Wallis test, a nonparametric test where the null is that the three samples are drawn from the same population, is firmly rejected.

States with medical marijuana laws have different prices per gram than states without these laws, yet the difference depends on quality. For high quality marijuana, medical marijuana states pay a lower price per gram, whereas for medium and low quality marijuana the price is higher. While speculative without further analysis, this suggests that any increases in demand for marijuana may have been offset by greater increases in supply for high quality marijuana, a plausible outcome if marijuana provided for medical purposes is higher quality. In contrast, the increased demand for medium and lower quality marijuana is not offset by corresponding increases in supply, resulting in higher prices and consistent with Pacula et al, (2010).

There is also evidence of significant price variation by region, with notably lower prices for high quality marijuana in the Mountain ($11.44 per gram) and Pacific ($10.73 per gram) states relative to others, where prices range from $14.44 per gram in the West-North-Central states to $15.12 in the West-South-Central. Differences in prices between regions are statistically significant, even when excluding the Mountain and Pacific states.[4]

The prices differences for high quality marijuana by region also exist for medium and low quality marijuana, but the most and least expensive regions change. For medium quality marijuana the East-South-Central states are the least expensive with the Mid-

[4] States corresponding with each Census region are as follows: New England (ME, NH, VT, MA, CT, RI); Mid Atlantic (NY, PA, NJ); South Atlantic (WV, MD, DE, VA, NC, SC, GA, FL); East-South-Central (MS, AL, TN, KY); East-North-Central (WI, MI, IL, IN, OH); West-North-Central (ND,SD, NE, KS, MO, IA, MN); West-South-Central (OK, AR, LA, TX); Mountain (MT, ID, WY, UT, CO, AZ, NM, NV); Pacific (WA, OR, CA).

Atlantic States being the most expensive. For low quality marijuana the West-South-Central states are the least expensive whereas the Pacific states, which have the lowest price for high quality, are the most expensive for low quality. However, the standard deviation for the Pacific states is quite large, due in part to the low number of transactions, 85, for low quality marijuana. Moreover, because quality is self-reported and subjective, quality is not uniformly measured, so any price differences should be gauged with caution.

These results suggest that there is noticeable price variation by region. Reasons for this variation are not clear and it is not the purpose of this paper to explain regional variation. However, Caulkins (1995) found that marijuana prices increased as one went from the Midwest to the East, supporting his hypothesis that greater distance from cultivation centers (the Midwest and Appalachia in his study) resulted in higher prices. A similar pattern arises here, with prices in New England and the Mid-Atlantic states generally higher than other regions. Similarly, the lower prices for medium and low quality marijuana in the West-South-Central states may reflect their proximity to Mexico. The lower prices for high quality marijuana in the Pacific and Mountain states may reflect their proximity to Northern California. At this point, the correlation to between cultivation centers and price is purely speculative and the ability to grow marijuana indoors likely weakens this correlation. Nevertheless, there appears to be significant regional price variation, the reason for which is worthy of further study.

Conclusions

Policies toward marijuana legalization are changing, evidenced most recently in Colorado and Washington where voters approved marijuana legalization. Such policies are likely to significantly impact both the demand for and supply of marijuana. To understand the likely impact these changes will have on consumption, prices, and tax revenue, estimates of elasticity are needed.

This study used a unique data set that contained information on price, quantity, quality, and geographic location. All fifty states were represented in the sample, although for this analysis we excluded Alaska and Hawaii. The advantages of this data set include the large sample of marijuana transactions made by actual users rather than drug enforcement agents, information on quality, and wide geographic representation. However, these advantages must be caveated with the recognition that the data are self-reported, resulting in quality differences that are subjective, and no socioeconomic or frequency of purchase information is available at the individual level. Moreover, the data are a cross section, thereby prohibiting any temporal analysis. Thus, like all marijuana data, this data set is clearly imperfect.

The estimates for the price elasticity of demand in this study are generally consistent with the few other extant studies. Our estimates place the elasticity of demand between -0.3 and -0.6, the former matching the conservative lower bound estimate of Pacula et al. (2001) and the latter consistent with Clements et al. (2010). These estimates are at the lower end of those reported by Nisbet and Vakil (1972) over forty years ago, but indeed the age of their study is justification for new estimates. Thus, the demand for marijuana appears relatively insensitive to price changes. To the extent that, for example, medical marijuana or decriminalization laws increase supply and reduce price, consumption may be less responsive, *ceteris paribus*. Of course, such policies may also significantly increase demand, necessitating further studies of the supply of marijuana, such as Pacula et al. (2010). Indeed, this analysis found evidence of differential prices in marijuana between medical marijuana and non-medical marijuana states, with this differential depending on the quality reported, suggesting that changes in supply and demand may not be uniform across different types of marijuana. Prices also varied significantly by quality and region. Data sets such as the one used here, while imperfect, will hopefully contribute to a better understanding of the market for marijuana.

Table 1: Descriptive Statistics[a]

Variable	Mean	Standard Deviation	Minimum	Maximum
Price ($ per gram)	11.518	5.972	0.101	100
Quantity (grams)	13.920	11.066	3.5	28
Quality High	0.600	0.489	0	1
Quality Medium	0.332	0.471	0	1
Quality Low	0.0678	0.251	0	1
Medical Marijuana State	0.333	0.471	0	1
Decriminalized State	0.364	0.481	0	1
Income (dollars)	40365.19	5542.03	30426	68013
Beer Tax ($ per gallon)	0.247	0.225	0.019	1.05
Electricity Price ($ per kilowatt hour)	12.569	3.035	7.95	19.33

[a]Excludes Alaska and Hawaii and observations where price is zero.

Table 2
OLS and IV Estimates of Marijuana Demand
Dependent Variable: Log of Grams of Marijuana Purchased

VARIABLES	OLS (1)	OLS (2)	OLS (3)	IV	IV	IV[a]
Ln(Price)	-0.6549***	-0.6530***	-0.6566***	-0.6236***	-0.6264***	-0.333**
	(0.0088)	(0.0088)	(0.0089)	(0.0954)	(0.0916)	(0.1672)
Ln(Income)	0.1947***	0.1817***		0.1737**	0.1644**	-0.0211
	(0.0427)	(0.0425)		(0.0768)	(0.0732)	(0.1205)
Ln(Beer Tax)	0.0147*	0.0151*		0.0148*	0.0153*	0.0159*
	(0.0082)	(0.0082)		(0.0082)	(0.0082)	(0.0084)
Quality High	0.2392***	0.2336***	0.2476***	0.2062**	0.2055**	-0.1010
	(0.0234)	(0.0234)	(0.0236)	(0.1034)	(0.0989)	(0.1786)
Quality Medium	-0.0522***	-0.0561***	-0.0455**	-0.0681	-0.0695	-0.2159**
	(0.0227)	(0.0227)	(0.0228)	(0.0535)	(0.0514)	(0.0883)
Decriminalized	-0.0418***			-0.0397***		-0.0198
	(0.0110)			(0.0128)		(0.0162)
Constant	-1.756***	-1.632***	0.2799***	-1.579**	-1.487**	0.0509
	(0.4463)	(0.4453)	(0.0657)	(0.6586)	(0.6685)	(1.049)
State Dummies	No	No	Yes	No	No	No
R^2	0.201	0.201	0.207			
N	23,611	23,611	23,611	23,611	23,611	23,611

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
[a]IV estimates with only the natural log of electricity price as an instrument.

Table 3
Variation in Price by Quality, Decriminalization, and Region[a]

	Quality			
	High	**Medium**	**Low**	***Kruskall-Wallis Test[b]***
Price per Gram	13.57	9.03	5.55	5197.69***
	(4.91)	(6.01)	(5.58)	
	n=14,272	n=7,887	n=1,606	

	Medical Marijuana Law		
Price per Gram (High Quality)	**Yes**	**No**	***t-test***
	11.84	14.57	33.21***
	(4.51)	(4.85)	
	n=5,212	n=9,060	
Price per Gram (Medium Quality)	9.39	8.86	3.58***
	(5.08)	(6.39)	
	n=2,493	n=5,394	
Price per Gram (Low Quality)	6.67	5.25	4.16***
	(6.48)	(5.28)	
	n=335	n=1,271	

Region

New Eng.	**Mid Atl**	**S. Atl**	**ES Cent**	**EN Cent**	**WS Cent**	**WN Cent**	**Mount**	**Pac**	***Kruskall-Wallis Test[c]***
Price per Gram (High Quality)									
14.62	14.96	14.46	14.54	14.06	15.12	14.44	11.44	10.73	2289.95***
(4.32)	(4.91)	(5.01)	(5.72)	(4.69)	(4.76)	(4.29)	(3.86)	(4.29)	
n=1,108	n=2,078	n=2,484	n=434	n=2,057	n=1,070	n=1,071	n=1,162	n=2,708	
Price per Gram (Medium Quality)									
11.26	10.66	7.89	6.59	8.38	7.31	9.37	9.32	9.20	525.93***
(6.53)	(6.20)	(6.00)	(4.62)	(6.25)	(6.73)	(6.26)	(5.18)	(4.39)	
n=650	n=1,294	n=1,479	n=335	n=1,311	n=541	n=517	n=437	n=1,272	
Price per Gram (Low Quality)									
6.65	6.68	5.67	5.21	5.86	3.45	4.59	4.34	9.08	382.72***
(5.31)	(5.47)	(5.56)	(5.14)	(5.28)	(5.29)	(4.12)	(4.06)	(8.59)	
n=138	n=216	n=306	n=80	n=269	n=261	n=167	n=81	n=85	

[a] Mean price by characteristic. Standard deviations in parentheses.
[b] χ^2 with 2 degrees of freedom. Null hypothesis is that three samples are drawn from same population.
[c] χ^2 with 8 degrees of freedom. Null hypothesis is that 9 census region samples are drawn from same population.

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