



Supported by  
The Robert Wood Johnson Foundation

## MARIJUANA AND YOUTH

**Rosalie Liccardo Pacula, Ph.D., RAND and NBER**

**Michael Grossman, Ph.D., CUNY and NBER**

**Frank J. Chaloupka, Ph.D., UIC and NBER**

**Patrick M. O'Malley, Ph.D., Univ. of Michigan**

**Lloyd D. Johnston, Ph.D., Univ. of Michigan**

**Matthew C. Farrelly, RTI**

Research for this paper was supported by grants from the Robert Wood Johnson Foundation to the University of Illinois at Chicago and the University of Michigan, under the Bridging the Gap Initiative, and a grant from the National Institute on Drug Abuse to RAND (R01 DA12724-01).

# MARIJUANA AND YOUTH

## Purpose

---

- To describe factors that are significant in predicting trends in marijuana use among youth and evaluate the importance of these factors in contemporaneous demand equations.
- Obtain an estimate of the price elasticity of demand using nationally representative data.

## Motivation

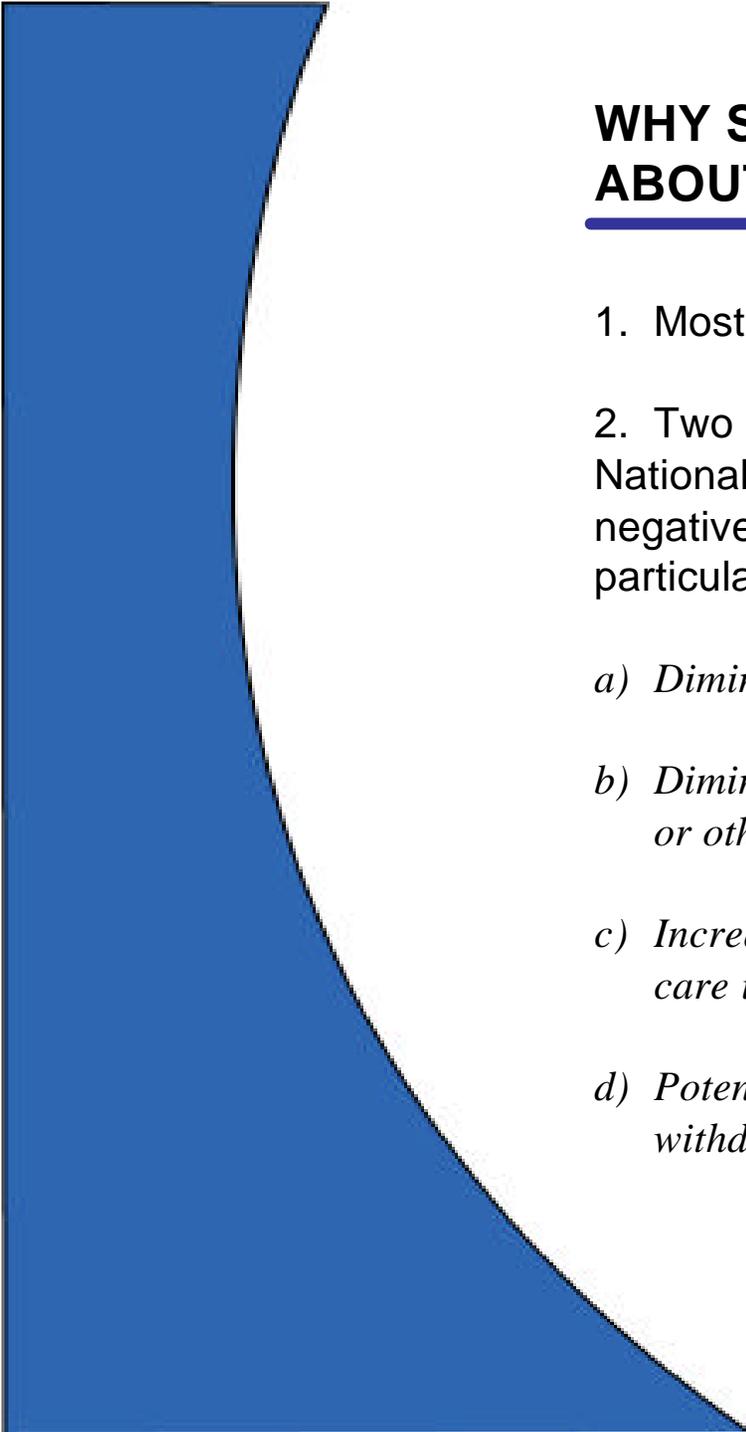
---

- Marijuana use, the most commonly used illicit drug, is on the rise among youth in the United States.

impacTEEN

A Policy Research Partnership  
to Reduce Youth Substance Use

YES!  
Youth,  
Education,  
& Society



## WHY SHOULD WE CARE ABOUT MARIJUANA USE IN PARTICULAR?

---

1. Most widely used illicit substance.
2. Two reports commissioned by the U.S. NIDA and Australian National Task Force on Cannabis suggest that there are some negative consequences attributable to marijuana use in particular.
  - a) *Diminished cognitive functioning → human capital formation.*
  - b) *Diminished psychomotor performance → accidental injury to self or others.*
  - c) *Increased risk of particular types of illnesses → increased health care utilization.*
  - d) *Potential for developing dependence, although physical withdrawal symptoms appear to be minor.*

## BACKGROUND

---

Previous work in the sociology literature suggests that significant predictors of the contemporaneous demand for marijuana cannot account for the trends in marijuana demand over time. Attitudinal variables are by far the most powerful predictors of trends in use.

- Bachman, Johnston, O'Malley, and Humphrey (1988) [1976-1986]
- Bachman, Johnston and O'Malley (1998) [1976-1996]
  
- *Caulkins (1999) challenges this conclusion.*
  - ✎ Calculates simple correlation coefficients between seniors' self-reported marijuana use and national marijuana prices over the period 1981-1997.
  - ✎ Simple correlation coefficients varied between  $-0.79$  and  $-0.95$ .

## WHAT WE DO IN THIS STUDY

- Examine national trends in annual and thirty-day marijuana participation from 1982-1998 using time series analysis.
  - Compare these findings to those obtained from repeated cross-sectional analysis over the period 1985-1996.
- 

## WHY BOTH?

### *Time Series Analysis Enables Us To:*

1. Examine purity on equal footing as the other determinants since this variable is only measured at a national level.
2. Determine whether changes in price and perceived harm account for a significant share of the observed changes in youth marijuana use over time.

But there are only a small number of observations and a considerable amount of inter-correlation among the variables.

### *Repeated Cross-Sectional Analysis Enables Us To:*

1. Incorporate more determinants of demand, particularly cross-price effects for alcohol and tobacco.
2. Obtain an estimate of the price elasticity of demand using variation in prices across cities as well as over time.

But purity of marijuana cannot be adequately controlled for in these models.

## TIME SERIES ANALYSIS

---

### A. DATA

1. USE AND PERCEIVED HARM  
1982-1998 Monitoring the Future (MTF) Survey of High School Seniors
2. PRICE AND POTENCY  
DEA's Office of Intelligence or Intelligence Divisions' publications:
  - The Domestic Cities Report (1982 – 1985 Q(3)).
  - The Illicit Drug Wholesale/Retail Price Report (1985 Q4 - 1990).
  - Illicit Drug Price/Purity Report (IDPPR) (1991- 1998).

✎ Descriptive statistics on these variables are recorded in Table 1.

✎ Trends in data can be seen in Figures 5 & 6.

Figure 5

Annual Prevalence of Marijuana Use, Thirty-Day Prevalence of Marijuana, and the Perceived Risk of Great Harm from Regular Marijuana Use, 1982-1998

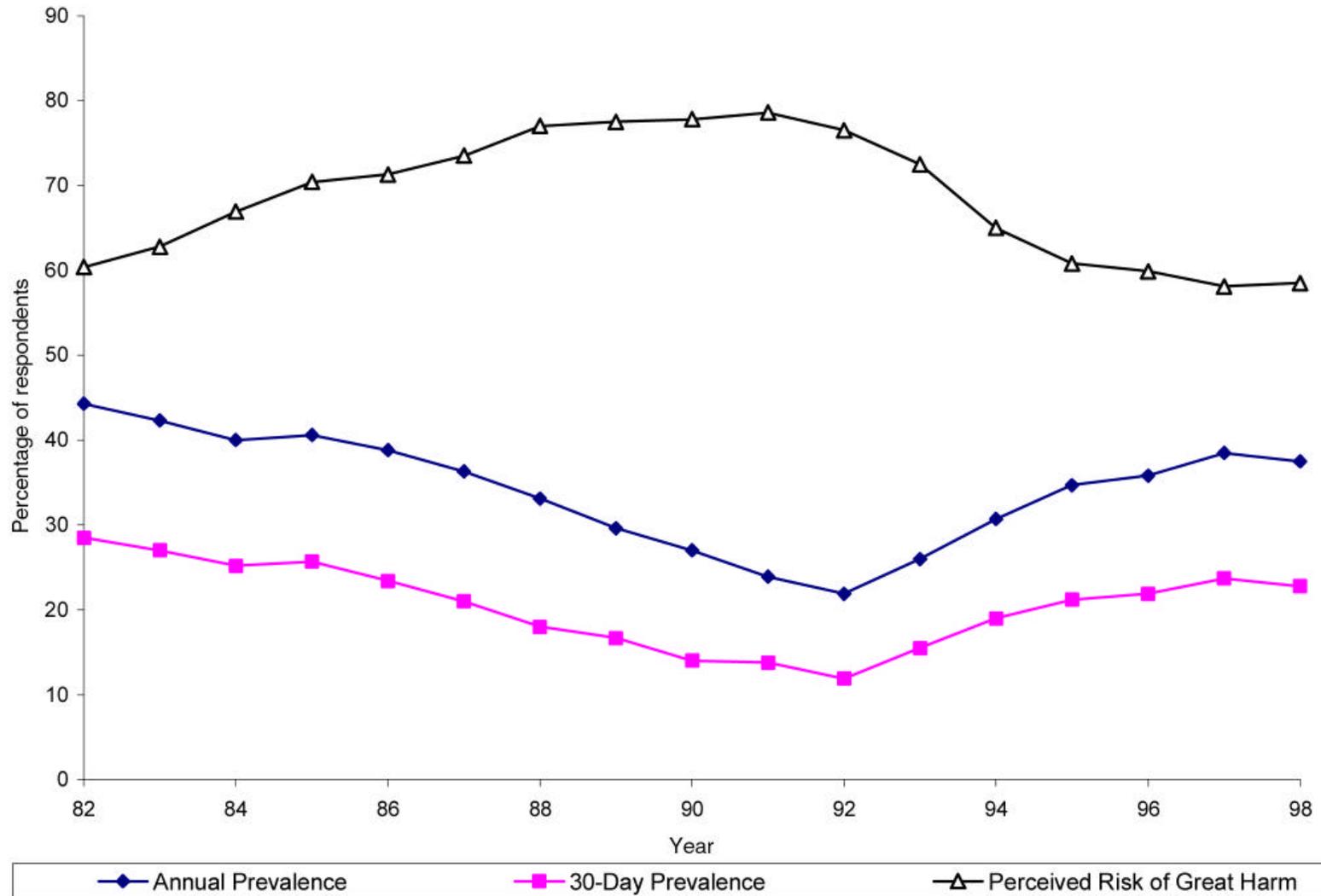
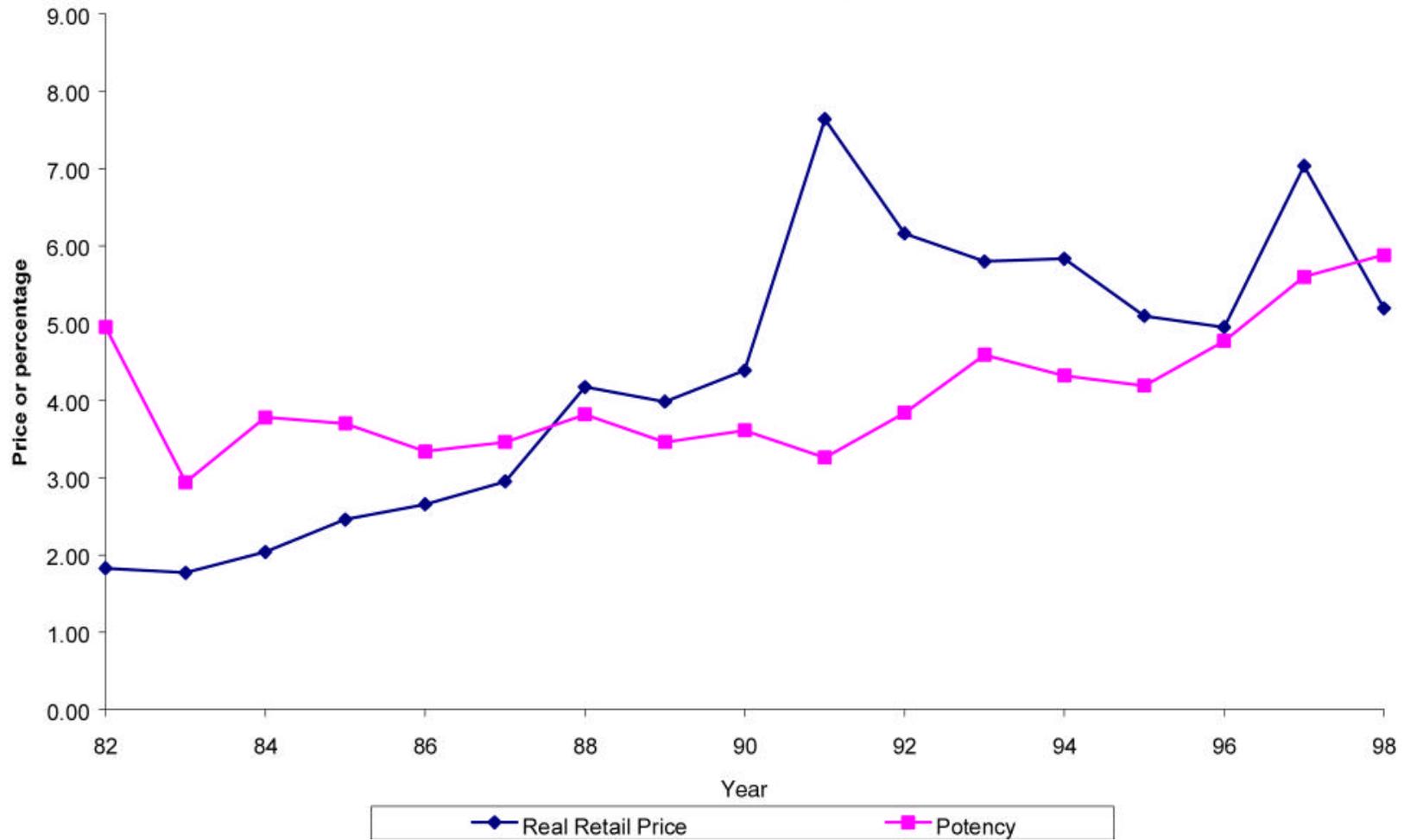


Figure 6

Real Retail Price of Commercial Marijuana and Potency of Commercial Marijuana, 1982-1998



# TIME SERIES ANALYSIS

---

## B. SPECIFICATION OF THE MODEL

$$M_t = \alpha_{0t} + \alpha_{1t} p_t + \alpha_{2t} q_t + \alpha_{3t} h_t + \alpha_{4t} t_t + \alpha_{5t} t_t^2 + \varepsilon_t$$

### ISSUES:

- Incorporating Potency.
- Measurement Error in Price.
- Harm is Potentially Endogenous

Newey-West standard errors are calculated in all specifications to allow for heteroskedasticity and autocorrelation up to a lag of three.

 Results for annual prevalence in Table 2 and thirty-day prevalence in Table

3.

**TABLE 2**  
ANNUAL MARIJUANA PARTICIPATION REGRESSIONS<sup>a</sup>

Panel A: Price and Harm Entered Separately

	(1)	(2)	(3)	(4)	(5)	(6)
Price	-3.205 (-7.83)	3.167 (-3.27)	-2.122 (-2.59)			
Potency	4.074 (4.04)	4.120 (2.59)	-0.406 (-0.37)			
Time		-0.020 (-0.06)	-3.326 (-3.10)		-0.861 (-4.50)	-1.400 (-1.08)
Time Squared			0.192 (3.30)			0.032 (0.41)
Harm				-0.590 (-2.95)	-0.746 (-5.91)	-0.656 (-3.19)
R-squared	0.723	0.723	0.851	0.446	0.839	0.841
F-statistic	93.54	60.70	31.96	8.70	20.27	12.03
Price Elasticity <sup>b</sup>	-0.407	-0.402	-0.269			

<sup>a</sup>Newey-West (1987) t-statistics are in parentheses. Standard errors on which they are based allow for heteroscedasticity and for autocorrelation up to and including a lag of 3. Intercepts are not shown.

<sup>b</sup> Evaluated at sample means.

TABLE 2			
ANNUAL MARIJUANA PARTICIPATION REGRESSIONS <sup>a</sup>			
Panel B: Price and Harm Entered Together			
	(7)	(8)	(9)
Price	-2.408 (-5.81)	-1.595 (-2.08)	-1.626 (-2.01)
Potency	0.263 (0.26)	0.776 (0.76)	0.411 (0.32)
Time		-0.385 (-1.28)	-0.949 (-0.79)
Time Squared			0.036 (0.53)
Harm	-0.517 (-4.47)	-0.567 (-4.20)	-0.485 (-3.55)
R-squared	0.866	0.881	0.882
F-statistic	96.74	45.94	42.38
Price Elasticity <sup>b</sup>	-0.306	-0.203	-0.206

<sup>a</sup> Newey-West (1987) t-statistics are in parentheses. Standard errors on which they are based allow for heteroscedasticity and for autocorrelation up to and including a lag of 3. Intercepts are not shown.

<sup>b</sup> Evaluated at sample means.

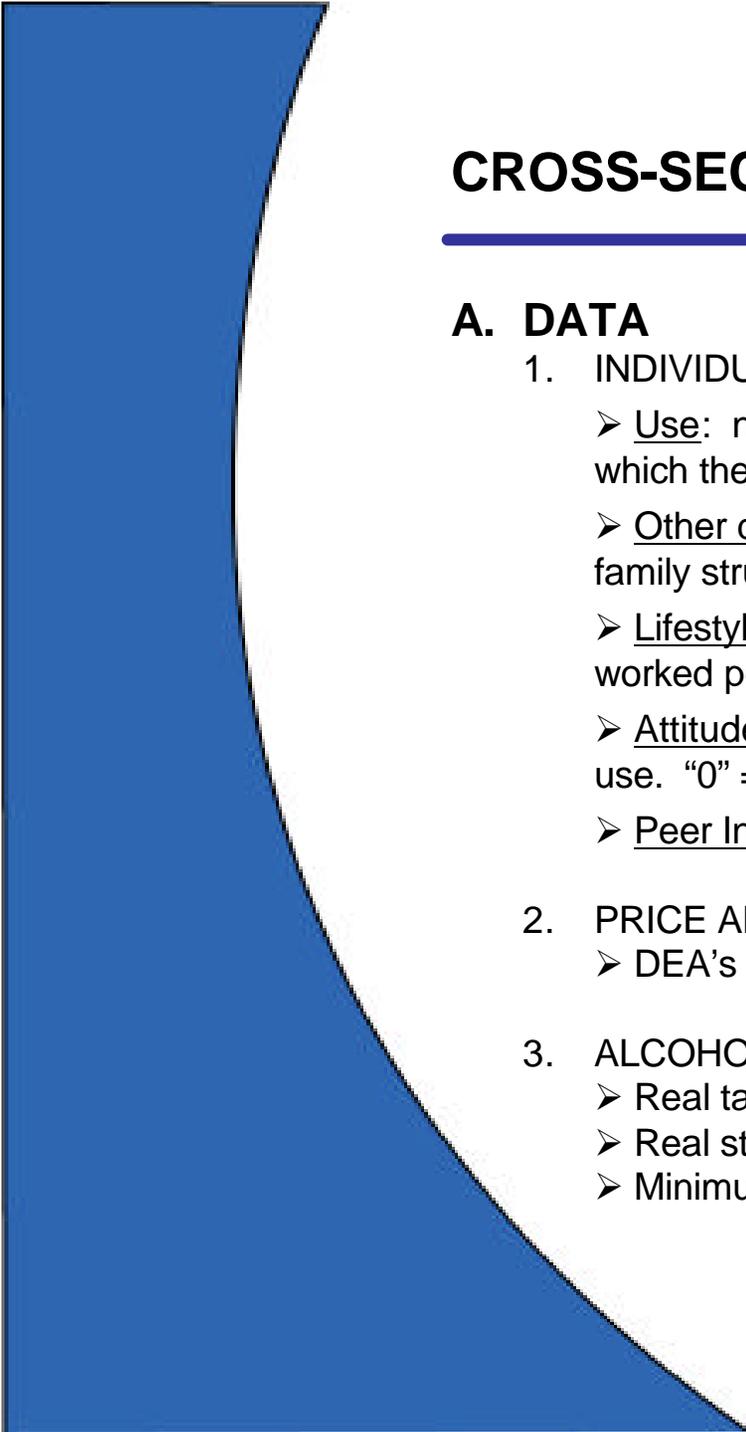
**TABLE 4**  
**PERCENTAGE-POINT IMPACTS OF PRICE, POTENCY,**  
**AND HARM ON MARIJUANA PARTICIPATION**

Panel A: Annual Participation									
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
<u>1982-1992, Observed Change in Participation = -22.40</u>									
Marijuana Price	-13.88	-13.72	-9.19				-10.43	-6.91	-7.04
Marijuana Potency	-4.52	-4.57	0.45				-0.29	-0.86	-0.46
Harm				-9.49	-12.02	-10.57	-8.32	-9.12	-7.81
Total Predicted Change	-18.41	-18.29	-8.74	-9.49	-12.02	-10.57	-19.04	-16.90	-15.31
Panel B: Thirty-Day Participation									
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
<u>1992-1998, Observed Change in Participation = -15.60</u>									
Marijuana Price	3.10	3.06	2.05				2.33	1.54	1.57
Marijuana Potency	8.31	8.40	-0.83				0.54	1.58	0.84
Harm				10.61	13.44	11.81	9.30	10.20	8.74
Total Predicted Change	11.41	11.46	1.22	10.61	13.44	11.81	12.16	13.33	11.15

## IMPLICATION OF TIME SERIES ANALYSES

---

- Quality adjusted real price and perceived harm are both important factors explaining trends in marijuana use over time.
- How important are price and perceived harm in contemporaneous demand analyses?



## CROSS-SECTIONAL ANALYSIS

---

### A. DATA

1. INDIVIDUAL-LEVEL DATA: 1985-1996 MTF HIGH SCHOOL SURVEY.
  - Use: number of occasions in the past year and past thirty-days on which they used marijuana or hashish. Any positive amount.
  - Other demographics: gender, race, age, parental education, siblings, family structure, mothers' work status, place of residence.
  - Lifestyle factors: marital status, attendance at religious services, hours worked per week, real weekly earned and unearned income.
  - Attitudes: index of the youth's perceived risk of harm from regular MJ use. "0" = no risk, "3" = great risk.
  - Peer Influences: Peer marijuana use.
2. PRICE AND POTENCY OF MARIJUANA
  - DEA's *IDPPR* 19-Cities Reports
3. ALCOHOL AND TOBACCO TAXES
  - Real tax on a pack of cigarettes Tobacco Institute
  - Real state tax on a case of beer from Beer Institute.
  - Minimum legal purchase age for beer.

# REPEATED CROSS-SECTIONAL ANALYSIS

---

## B. SPECIFICATION OF THE MODEL

$$\text{Prob}(M_{it} = 1) = f(X_{it} b) + v_{it}$$

### ISSUES:

- Measurement error in price.
- Harm and peer use are potentially endogenous.

Robust or Huber (1967) standard errors are calculated in all specifications and clustering is done for each state/year.

Results for annual prevalence in Table 6 and thirty-day prevalence in Table 7.

**TABLE 6 (CONTINUED)**  
**ANNUAL MARIJUANA PARTICIPATION LOGIT EQUATIONS<sup>a</sup>**  
**(N=135,975)**

	(1)	(2)	(3)
Other Income	0.009 (23.53)	0.009 (23.50)	0.009 (23.44)
Cigarette Tax	-0.042 (-0.08)	0.337 (0.69)	0.068 (0.26)
Beer Tax	-0.679 (-2.29)	-0.416 (-1.34)	-0.198 (-1.26)
Drinking Age	-0.129 (-3.64)	-0.063 (-1.65)	0.096 (2.74)
Marijuana Price	-0.145 (-7.95)	-0.103 (-5.15)	-0.027 (-1.77)
Marijuana Potency	0.181 (4.80)	0.331 (6.21)	0.002 (0.05)
Time		-0.043 (-3.78)	-0.286 (-17.68)
Time Squared			0.023 (16.52)
Pseudo R-squared	0.066	0.067	0.071
Chi-squared	8355.91	8425.21	8633.30
Price Elasticity <sup>b</sup>	-0.331	-0.235	-0.063

<sup>a</sup> All equations include state dummies. Asymptotic t-ratios are in parentheses. Huber (1967) or robust standard errors on which they are based allow for Huber (1967) or robust standard errors on which they are based allow for state/year clustering. Intercepts are not shown.

<sup>b</sup> Evaluated at sample means.

**impacTEEN**

A Policy Research Partnership  
to Reduce Youth Substance Use

**YES!** Youth,  
Education,  
& Society

TABLE 8 SELECTED LOGIT COEFFICIENTS FROM MARIJUANA PARTICIPATION EQUATIONS WITH HARM AND PEER MARIJUANA USE <sup>a</sup>			
Panel A: Annual Participation (N=71,452)			
	(1)	(2)	(3)
Marijuana Price	-0.092 (-6.80)	-0.064 (-4.65)	-0.053 (-3.37)
Marijuana Potency	-0.134 (-6.26)	-0.008 (-0.26)	-0.035 (-1.14)
Harm	-1.100 (-65.64)	-1.104 (-65.89)	-1.103 (-65.92)
Peer Marijuana Use	4.498 (30.59)	4.484 (30.14)	4.383 (27.97)
Pseudo R-squared	0.188	0.188	0.188
Price Elasticity <sup>b</sup>	-0.210	-0.146	-0.121
Market Price Elasticity <sup>b</sup>	-0.466	-0.322	-0.260

<sup>a</sup> All equations include state dummies, real cigarette and beer taxes, minimum legal drinking age, and the family and individual characteristics contained in the equations in Tables 6 and 7. Asymptotic t-ratios are in parentheses. Huber (1967) or robust standard errors on which they are based allow for state/year clustering.

<sup>b</sup> Evaluated at sample means.

TABLE 10 PERCENTAGE-POINT IMPACTS OF SELECTED VARIABLES ON MARIJUANA PARTICIPATION						
Model Number <sup>a</sup>	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Annual Participation						
<u>1982-1992, Observed Change in Participation = -22.40</u>						
Marijuana Price	-12.74	-9.18	-0.22	-18.89	-13.04	-10.53
Marijuana Potency	-3.92	-6.73	-0.06	4.46	0.32	0.97
Harm				-9.85	-9.87	-9.65
Total Predicted Change	-16.66	-15.91	-0.28	-24.28	-22.59	-19.21
<u>1992-1998, Observed Change in Participation = -15.60</u>						
Marijuana Price	2.84	2.05	0.05	4.21	2.91	2.35
Marijuana Potency	7.20	12.36	0.10	-8.19	-0.59	-1.78
Harm				13.05	13.08	12.78
Total Predicted Change	10.04	14.41	0.15	9.07	15.40	13.35

Model 1, 2, and 3 are based on the specifications in Tables 6 and 7. These specifications exclude harm and peer marijuana use. Model 1 omits a trend. Model 2 includes a linear trend. Model 3 includes a quadratic trend. Models 4, 5, and 6 are based on the specifications in Table 8 and on coefficients that take account of the effect of a given variable on peer marijuana use. Model 4 omits a trend. Model 5 includes a linear trend. Model 6 includes a quadratic trend.



## CONCLUSIONS AND POLICY IMPLICATIONS

- Like attitudinal variables, price is an important determinant of both the contemporaneous demand for marijuana as well as the trend in marijuana over time, although movements in price do a better job predicting downward trends in use than they do upturns in use.
- Given the findings and limitations of these models, we believe a conservative lower-bound estimate of the elasticity of demand for MJ participation among high school seniors is  $-0.30$ .
- Supply side policies that effectively raise the quality-adjusted price of marijuana will be successful at reducing marijuana use over time.