THE DEMAND FOR ILLICIT DRUGS

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This paper estimates the effects of alcohol prices, marijuana decriminalization, cocaine prices, and heroin prices on the demand for these four substances. Both own price effects and cross price effects are estimated. The estimated price elasticities for alcohol, cocaine, and heroin are, respectively, −.30, −.28 and −.94. Marijuana decriminalization was found to increase the probability of marijuana participation by about 8%. The results for the cross price effects provide general evidence of complementarity. It is estimated that decriminalization of cocaine and heroin might lead to about 260,000 new regular cocaine users and about 47,000 new regular heroin users. (*JEL* I10)

I. INTRODUCTION

Illicit drug use and alcohol abuse imposes significant costs on society and on the individual users. These costs include increased crime, health problems, and employment problems. Because of these considerable costs, government, at all levels, has made drug control and the control of alcohol abuse important priorities. The federal government has undertaken an aggressive program of interdiction of drug shipments and eradication of drug crops in the field. The federal government and the state governments have also increased their criminal justice efforts.

In analyzing the effect of government drug control programs, economists have applied the conventional supply and demand model to illicit drug markets. The model includes a demand function that is downward sloping with respect to price and a supply function that is upward sloping or horizontal with respect to price. Drug programs like interdiction and drug sanctions are assumed to reduce supply and raise equilibrium price. Other policy options such as some form of drug legalization could increase supply and reduce equilibrium price. The effect of these policies on equilibrium quantity is dependent on the elasticity of demand and on whether demand shifts. Since not much is known about drug price elasticities, the potential effects of various drug control policies remain a speculative exercise.

The purpose of this paper is to estimate the effects of alcohol and drug prices on alcohol use and drug participation. Both own price and cross price effects are estimated. There are few prior empirical studies of the effect of drug prices, because data have been difficult to acquire. This paper makes use of newly available data on drug prices and is the first paper to link these data to a nationally representative drug use data set of 49,802 individuals. Estimates of drug price elasticities are important empirical evidence that drug sales can be characterized by market forces. Drug price elasticities are also important in estimating the likely impact of policies that affect drug prices and in estimating the effects of drug prohibition. Cross price elasticities are important to estimate, since they suggest the likely effects of policies such as an increase in alcohol taxes on illicit drug participation and the effects of marijuana decriminalization on alcohol, cocaine, and heroin use.

II. PRIOR STUDIES

While there are a number of prior studies of the effects of alcohol prices and policies, there are few prior studies of drug prices and polices. The reason for so few prior drug stud-

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ies is the limited amount of data on drug prices and the limited options for linking these data to an individual record by residential area. This study uses a new data set of cocaine and heroin prices from the Drug Enforcement Agency that was linked to individual records by the Office of Applied Studies at the Substance Abuse and Mental Health Services Administration.

Leung and Phelps (1993) provide a review of a number of recent alcohol demand studies. The empirical literature provides considerable evidence that shows increasing the price of alcoholic beverages to decrease alcohol use. Alcohol demand studies generally estimate price elasticities for beer, wine, and spirits separately. Most studies employ aggregate data, but a few use individual data. Studies using aggregate data find price elasticities for beer from about −.2 to about −1.0, for wine from about −.3 to about −1.8, and for spirits from about −.3 to about −1.8. Studies using individual data estimate price elasticities for beer from about −.5 to about −3.0, for wine at about −.5, and for spirits from about −.5 to about −4.0.

The few prior studies of the effect of decriminalization on marijuana use generally find that marijuana decriminalization has no effect on participation. Pacula (1994), Thies and Register (1993), Dinardo and Lemieux (1992), and Johnston, O'Malley, and Bachman (1981) all used samples of young people and found no effect of marijuana decriminalization. Model (1992) found that decriminalization had a significant positive effect on property crimes and a significant negative effect on violent crimes, and Model (1993) found that decriminalization increases marijuana use.

There are also a few prior empirical studies of the effect of drug prices on drug use. Grossman and Chaloupka (1998) use a rational addiction model and find cocaine price elasticities for youth ranging from −.7 to −1.7. They also estimate cocaine participation elasticities for youth of −.45 to −1.28. Bretteville-Jensen and Sutton (1996) estimate a price elasticity of heroin of −1.23. van Ours (1995) finds a price elasticity of −.7 to −1.0 for opium use and −.3 to −.4 for opium participation. Dinardo (1993) finds no effect of price on cocaine use. Nisbit and Vakil (1972) estimate the price elasticity of marijuana at −.7 to −1.0.

III. DATA SET

The empirical models estimated in this paper are demand curves. The basis of these empirical demand curves is the same theoretical demand model that is used for legal goods. Theoretical drug demand curves are derived in the usual fashion by maximizing individual utility subject to a budget constraint consisting of the price of drugs and alcohol, other prices, and income. The derived demand curves show that drug consumption is negatively related to the own price and related, without a priori sign, to other prices, income, and taste. The demand curves in this study are estimated with a pooled set of data from the 1988, 1990, and 1991 National Household Surveys on Drug Abuse (NHSDA). The pooled data set consists of 49,802 observations, which is important since the larger sample increases the number of drug users surveyed and the precision of the estimates. The NHSDA are cross-sectional surveys of the U.S. household population aged 12 or older and contain information on socioeconomic characteristics as well as data on drug and alcohol use. These surveys exclude residents of noninstitutional group quarters (that is, college dormitories) and exclude residents of institutional group quarters (that is, prisons). Also excluded are those people with no permanent residence (that is, homeless and residents in transient hotels). Less than 2% of the population is excluded. The excluded 2% probably have a higher percentage of regular drug users than the included 98%. These surveys are likely to be more representative of occasional drug users rather than regular drug users. As a nationally representative survey, the NHSDA has an important advantage over the National Longitudinal Survey of Youth and Monitoring the Future surveys, which are limited to youth. In addition to information on alcohol and drug consumption, the surveys contain information on the gender, race, ethnicity, personal income, and marital status for each individual surveyed. County-level alcohol prices and state-level data on marijuana decriminalization and drug prices have been appended to the individual records.[1]

1. We are indebted to the Office of Applied Studies, Substance Abuse and Mental Health Administration, for merging the price and decriminalization data to the individual records in the NHSDA. With the exception of one primary sampling unit in 1990 and six PSUs in 1991, no locational identifiers are available due to confidentiality issues.

The 1988, 1990, and 1991 surveys are very similar, except for size. The 1991 survey is over three times as large as the 1988 and 1990 surveys. The 1991 survey is larger, in part, because six primary sampling units were oversampled. Each survey also oversamples persons aged 12–17, Hispanics, and blacks. A summary of the variable definitions and means are included in Table I. The means presented in this table are weighted so that they are comparable to a random sample of the United States.[2]

The dependent variables in this study are a continuous measure of alcohol consumption and two dichotomous measures of marijuana, cocaine, and heroin participation. The alcohol consumption variable measures the number of days in the past 31 days that the individual had consumed alcohol. Marijuana, cocaine, and heroin represent most of the illicit drug use in the United States. The first illicit drug participation variable is equal to one if the individual reports that he or she had used the substance during the past year, and the second illicit drug participation variable is for use in the past month.[3] The number of individuals that report participation in the past year is about double the monthly participation for all three drugs. Annual participation may be interpreted as reflecting more occasional use, while participation in the past month may be interpreted as more regular use.

The price of alcohol consists of the prices of beer, wine, and distilled spirits. Data on the prices come from the American Chamber of Commerce Research Association's quarterly *Inter-City Cost of Living Index* (1988, 1990, 1991). This index contains prices, inclusive of taxes, for over 250 cities each quarter and was used to construct county-level prices. These data were merged with the NHSDA on a PSU level.[4] A single alcohol price variable, the price of one pure liter of alcohol, was created from the beer, wine, and spirits prices. This computation was done by first computing the price per liter for each beverage. The price of beer is reported for a six-pack. The price was divided by 2.13, which is the number of liters in a six-pack. Since the price of wine is reported for a 1.5-liter bottle the wine price was divided by this number. Spirits prices are reported for a liter bottle. Next, the these liter prices were divided by the percent alcohol in each beverage (.04 for beer, .11 for wine, and .41 for spirits). A weighted average price of pure alcohol can now be computed. The weights are the share of pure alcohol consumption represented by each beverage. These weights are .569 for beer, .113 for wine, and .318 for spirits. These weight data come from the Brewer's Association of Canada International Survey. The price was then adjusted to the real value in 1982–84 dollars.

Prices for cocaine and heroin come from the U.S. Department of Justice, Drug Enforcement Agency's (DEA) STRIDE (System to Retrieve Information from Drug Evidence) data set.[5] DEA agents and police narcotics officers purchase illicit drugs regularly. The price, purity, weight, and other information are recorded in the STRIDE data set. One reason these price data are collected is so that DEA agents will know how much to offer when negotiating to buy from drug dealers. The price data are fairly accurate, since inaccurate data would endanger these agents. The STRIDE data set provided by the DEA to the National Bureau of Economic Research (NBER) contains cocaine and heroin data from 1977 through 1989 and 1991 for approximately 144 cities or towns. This data set has over 23,000 cocaine price observations and over 15,000 heroin price observations.

2. The data are weighted using the analysis weight variable in each survey. The individual data are multiplied by the weight variable and then divided by the sum of the weight variable for the survey. The means for combined data are computed as a weighted average of weighted means for the three surveys. These weights are defined as the sample size divided by the total size of the three samples.

3. There is some continuous quantity data, but they do not use standard measurement units, that is, bongs per day. There is also number of days used during the past 30 days. A number of trial regressions done with these number of days variables produced unstable and inconsistent results. For these reasons these data were not used.

4. There was no American Chamber of Commerce Research Association data available for Washington, D.C., so an average price from urban Virginia and urban Maryland was used.

5. There are price data for marijuana from the Drug Enforcement Agency's *Domestic Cities Report.* These prices are for retail and wholesale commercial grade marijuana for 19 cities in 16 states. Use of these data required a significant reduction in the number of observations used in the analysis. A number of alternative estimates of the price of marijuana were made with these data. The resulting price variables were inconsistent with all other price data in the data set and resulted in unstable coefficients when used in a series of alternative demand specifications. For these reasons, these marijuana price data were not used.

TABLE I
Weighted Average Means from the Combined National Household Survey of Drug Abuse 1988, 1990, 1991

Variable	Definition and Mean
Alcohol Use	The number of days alcohol was used in the past 31 days, $\mu = 3.49$.
Heroin Participation	Dichotomous indicator equal to one if a respondent reports using heroin in the past year, $\mu = .0011$; and past month $\mu = .0004$.
Cocaine Participation	Dichotomous indicator equal to one if a respondent reports using cocaine in the past year, $\mu = .02$; and past month, $\mu = .0085$.
Alcohol Price	The price of a liter of pure alcohol in 1983 dollars, $\mu = \$24.78$.
Marijuana Participation	Dichotomous indicator equal to one if a respondent reports using marijuana in the past year, $\mu = .071$; and past month, $\mu = .045$.
Marijuana Decriminalized	A dichotomous indicator equal to one for states that have eliminated incarceration as a penalty for most marijuana possession offenses, $\mu = .303$.
Heroin Price	Price of one pure milligram of heroin in 1983 dollars, $\mu = \$8.36$.
Cocaine Price	Price of one pure gram of cocaine in 1983 dollars, $\mu = \$111.47$.
Real Income	Total personal income in 1983 dollars, $\mu = \$12{,}425$.
Gender	A dichotomous variable equal to one for males, $\mu = .479$.
Marital Status	A dichotomous variable equal to one if married, $\mu = .569$. A dichotomous variable equal to one if marital status was missing is also included, $\mu = .033$.
Age 12–20	A dichotomous variable equal to one if an individual is 12–20 years of age, $\mu = .155$.
Age 21–30	A dichotomous variable equal to one if an individual is 21–24 years of age, $\mu = .197$.
Black	A dichotomous variable equal to one if an individual self-reports that they are black, $\mu = .116$.
Hispanic	A dichotomous variable equal to one if an individual self-reports that they are Hispanic, $\mu = .078$.

Notes: Final sample size when missing values were excluded is 49,802. All data are weighted. The elasticities were computed with unweighted data.

Information on the date and city of purchase, its total cost, total weight in grams, and purity (as a percentage) are recorded in STRIDE. The data must be adjusted because total cost rather than price is recorded. If total cost were proportional to weight, price could be calculated as the former divided by the latter. In fact, this is not the case, because larger purchases tend to be wholesale purchases. Variation in purity and imperfect information about purity on the part of purchasers further complicate the issue. Therefore, the price of one gram of pure drug was obtained, by year and city, from a regression of the natural logarithm of the total purchase cost on the natural logarithm of weight, the natural logarithm of purity, and dichotomous variables for each city and year in STRIDE except one. Imperfect information about purity is addressed by predicting purity based on the other regressors. To identify the total cost model, the coefficient of the natural logarithm of predicted purity is constrained to equal the coefficient of the natural logarithm of weight. The natural

logarithm of the price of one gram of pure drug is then given as the sum of the intercept, the relevant city coefficients, and the relevant time coefficients. This procedure eliminated variations in price or unit cost due to variations in weight or purity. The antilogarithm of this predicted price is the price of one unit of 100% pure drug. The local level prices were aggregated to the state level. This aggregation was computed as a weighted average of all the represented cites in the state. The population weights for each city were computed by dividing the city population by the total population of all represented cities in the state. The population data come from the *City and County Databook* (1993), published by the U.S. Department of Commerce. Prices were adjusted to their real value in 1982–84 dollars.

There are two issues regarding the price data that are important. The first issue is the exogeneity of price. If drug supply is upward sloping, then price and quantity would be endogenous. Since the predicted price variable used in the regressions comes from a reduced form model, however, it is uncorrelated with the error term in the demand equation. The second issue is measurement error. Merging individual level data with state level prices introduces a potential for measurement error due to matching. Any measurement error created by the matching problem is probably small since, in each state, most drug users are in the larger urban areas and, for each state, the drug price data comes mostly from the larger urban areas. If there is any matching measurement error in the price data, it will bias the coefficient and t-ratio downward. Thus, the reported coefficients and t-ratios are conservative lower bound estimates.

Marijuana decriminalization is a law that specifically eliminates criminal sanctions for possession of small amounts of marijuana. Decriminalization of marijuana eliminates possible imprisonment for most first offense possession violations. Oregon, in 1973, was the first state to decriminalize marijuana. By 1978, 10 other states had followed, substantially reducing the penalties associated with marijuana possession. Decriminalization, by lowering the penalties associated with marijuana use, is expected to increase marijuana demand.

Income and a group of dichotomous demographic variables have also been defined. Total personal income is defined as income from all sources including wages, self-employment, social security, public assistance, child support and other pension income. These are age, race, gender, and marital status. Two dummy age variables have been included to allow for differential age effects. These dummies are for ages 12–20 and 21–30, with over 30 the omitted age category. Three dichotomous variables equal to one if the individual reports that they are black, Hispanic, or male, respectively, have also been defined. Marital status may also affect drug use. A dichotomous variable equal to one if the individual is married has been defined. Since there are a number of missing values for this variable, a second variable was defined. The second variable is defined as equal to one if the marital status data are missing and the missing data on marital status are recoded to zero.

IV. REGRESSION RESULTS

Tables II–V present the estimation results for alcohol, marijuana, cocaine and heroin, respectively.[6] The alcohol use equations were estimated using ordinary least squares and the drug participation equations were estimated using probit.[7] Five specifications for each substance are presented. These specifications include alternative combinations of the own price and other prices, or decriminalization, along with a set of demographic variables and time dummies. These alternatives are important since there is some collinearity between prices. The first specification includes only the own price. The next three specifications include the own price and one other price, or decriminalization. The final specification includes all three prices and decriminalization. For illicit drugs, the five specifications were estimated for both participation in the past month and for participation in the past year. The results for the economic variables, for each substance, are discussed first. Since there is a fair amount of redundancy in the demo-

6. Several state fixed effects models, which resulted in insignificant price coefficients, were also estimated. The inclusion of state dummies tends to eliminate the effect of variables measured at the state level, such as price.

7. According to Maddala (1983), weighted regressions are not necessary since the sample design is based on exogenous variables.

TABLE II
Alcohol

Variable	Days Used in Past Month				
Intercept	4.099 (19.19)	4.039 (17.98)	4.557 (19.33)	4.177 (19.51)	4.676 (17.00)
Alcohol Price	–0.045 (5.93)	–0.043 (5.52)	–0.035 (4.41)	–0.029 (3.52)	–0.029 (3.51)
Marijuana Decriminalization	–	–0.051 (0.87)	–	–	–0.129 (1.92)
Cocaine Price	–	–	–0.0061 (4.58)	–	–0.0049 (2.81)
Heroin Price	–	–	–	–0.068 (5.10)	–0.052 (3.31)
Income	0.000057 (17.45)	0.000057 (17.44)	0.000057 (17.58)	0.000056 (17.25)	0.000057 (17.36)
Gender	1.637 (29.23)	1.637 (29.22)	1.634 (29.17)	1.639 (29.27)	1.639 (29.22)
Marital Status	–0.807 (12.13)	–0.806 (12.11)	–0.805 (12.09)	–0.798 (11.98)	–0.800 (12.01)
Dummy for Marital Status	–1.813 (18.33)	–1.813 (18.33)	–1.815 (18.35)	–1.819 (18.40)	–1.817 (18.38)
Age 12–20	–1.531 (17.97)	–1.530 (17.94)	–1.517 (17.80)	–1.526 (17.91)	–1.520 (17.84)
Age 21–30	0.035 (0.51)	0.035 (0.51)	0.039 (0.57)	0.036 (0.53)	0.039 (0.56)
Black	–0.580 (8.84)	–0.577 (8.78)	–0.583 (8.89)	–0.579 (8.83)	–0.590 (8.98)
Hispanic	–0.564 (8.52)	–0.568 (8.56)	–0.647 (9.43)	–0.633 (9.38)	–0.673 (9.76)
1990	–0.574 (6.03)	–0.569 (5.98)	–0.551 (5.79)	–0.615 (6.45)	–0.599 (6.23)
1991	0.079 (1.06)	0.077 (1.04)	0.035 (0.47)	0.018 (0.24)	0.0025 (0.033)
R-Square	0.0767	0.0767	0.0771	0.0772	0.0774
N	44889	44889	44889	44889	44889
Elasticity	–0.38	–0.36	–0.29	–0.24	–0.24

graphic variables, these variables are discussed for all four substances as a group.

Table II presents the results for alcohol use. The own price is negative and significant in all five specifications. Marijuana decriminalization is insignificant in one specification and negative and significant in the other. The negative sign suggests substitution between alcohol and marijuana. Cocaine and heroin prices are negative and significant in all four specifications, suggesting complementarity. The income variable is positive and significant in all five specifications.

Table III presents the results for marijuana participation. Decriminalization is positive and significant in all 10 specifications. The cross price effect of marijuana decriminalization with alcohol is insignificant in three of

TABLE III
Marijuana

Variable	Participation in Past Month					Participation in Past Year				
Intercept	−1.688 (46.90)	−1.654 (20.44)	−1.527 (20.65)	−1.631 (32.92)	−1.529 (15.44)	−1.528 (47.97)	−1.413 (20.03)	−1.351 (21.01)	−1.470 (33.91)	−1.271 (14.76)
Alcohol Price	–	−0.0013 (0.48)	–	–	0.00073 (0.24)	–	−0.0047 (1.90)	–	–	−0.003 (1.15)
Marijuana Decriminalization	0.154 (7.85)	0.149 (7.21)	0.124 (5.42)	0.142 (6.83)	0.118 (4.91)	0.152 (8.86)	0.145 (8.07)	0.119 (5.95)	0.140 (7.70)	0.113 (5.40)
Cocaine Price	–	–	−0.0013 (2.48)	–	−0.0012 (1.84)	–	–	−0.0014 (3.16)	–	−0.0014 (2.60)
Heroin Price	–	–	–	−0.0076 (1.66)	−0.0043 (0.75)	–	–	–	−0.0078 (1.95)	−0.00095 (0.19)
Income	−0.00000017 (0.15)	−0.00000013 (0.10)	−0.00000001 (0.086)	−0.00000024 (0.21)	−0.00000001 (0.085)	0.00000027 (2.60)	0.00000027 (2.59)	0.00000028 (2.69)	0.00000026 (2.54)	0.00000028 (2.67)
Gender	0.293 (15.10)	0.292 (14.67)	0.293 (15.08)	0.294 (15.11)	0.292 (14.65)	0.271 (16.01)	0.270 (15.55)	0.270 (15.97)	0.271 (16.02)	0.269 (15.51)
Marital Status	−0.403 (16.25)	−0.397 (15.62)	−0.403 (16.23)	−0.401 (16.17)	−0.396 (15.59)	−0.419 (19.26)	−0.407 (18.25)	−0.418 (19.22)	−0.417 (19.16)	−0.406 (18.22)
Dummy for Marital Status	−0.833 (17.31)	−0.823 (16.87)	−0.833 (17.31)	−0.834 (17.32)	−0.824 (16.88)	−0.798 (21.60)	−0.787 (20.92)	−0.797 (21.60)	−0.798 (21.62)	−0.787 (20.92)
Age 12–20	0.246 (8.33)	0.255 (8.37)	0.248 (8.39)	0.247 (8.36)	0.256 (8.42)	0.410 (15.77)	0.422 (15.70)	0.413 (15.86)	0.412 (15.81)	0.424 (15.78)
Age 21–30	0.453 (18.55)	0.458 (18.24)	0.454 (18.57)	0.454 (18.56)	0.450 (18.25)	0.529 (24.34)	0.534 (23.90)	0.530 (24.39)	0.529 (24.36)	0.536 (23.94)
Black	0.013 (0.58)	0.012 (0.52)	0.010 (0.45)	0.011 (0.50)	0.010 (0.42)	−0.075 (3.77)	−0.077 (3.72)	−0.078 (3.91)	−0.076 (3.85)	−0.079 (3.83)
Hispanic	−0.217 (8.68)	−0.209 (8.17)	−0.233 (9.03)	−0.225 (8.83)	−0.226 (8.56)	−0.260 (12.00)	−0.257 (11.59)	−0.277 (12.42)	−0.268 (12.15)	−0.274 (11.98)
1990	−0.162 (5.13)	−0.175 (5.31)	−0.162 (5.12)	−0.170 (5.31)	−0.176 (5.28)	−0.141 (5.07)	−0.158 (5.44)	−0.141 (5.05)	−0.149 (5.29)	−0.156 (5.32)
1991	−0.137 (5.41)	−0.144 (5.49)	−0.146 (5.70)	−0.144 (5.61)	−0.155 (5.82)	−0.101 (4.50)	−0.114 (4.91)	−0.110 (4.89)	−0.108 (4.77)	−0.123 (5.25)
R-Square	0.083	0.127	0.083	0.083	0.1275	0.087	0.134	0.088	0.087	0.135
N	49802	47224	49802	49802	47224	49802	47224	49802	49802	47224
Percentage Change due to Decriminalization	0.09	0.09	0.08	0.09	0.07	0.09	0.08	0.07	0.08	0.06

four specifications and negative and significant in one. The one significant negative coefficient suggests complementarity. The cross price effects of cocaine and heroin with marijuana are negative and significant in six specifications and insignificant in two specifications. These two insignificant coefficients are both for heroin, and both occur in the specifications that include all three prices and decriminalization. The lack of significance is probably due to collinearity between prices and between prices and decriminalization. The significant cross price effects suggest marijuana is a complement with both cocaine and heroin. Income is insignificant in all five monthly participation equations and positive and significant in all five yearly participation equations.

Table IV presents the results for cocaine. The price of cocaine is negative and significant in 7 of 10 specifications. The three insignificant coefficients are in specifications that include the price of heroin. The cross price effect of alcohol with cocaine is negative and significant in three of four specifications and insignificant in one specification. The cross price effect of heroin with cocaine is negative and significant in all specifications. The cross price effect of marijuana with cocaine is insignificant in three of four specifications. It is positive and significant in one yearly participation specification. The significant coefficients suggest complementarity between cocaine and the three other substances. The income variable is insignificant in all monthly participation equations and positive and insignificant in all but one yearly participation equations.

Table V presents the results for heroin participation. The price of heroin is negative and significant in all 10 specifications. The cross price effects of all three alternative substances with heroin are insignificant in all specifications with the exception of alcohol in the yearly participation equations. In these specifications alcohol is negative and significant suggesting complementarity. The income variable is negative and significant in 7 of 10 specifications.[8]

8. The effects of income for all four substances might be affected by education. The results for the remaining demographic variables confirm the results found in other studies of alcohol and drug use.

V. DISCUSSION

The regression results provide consistent evidence that alcohol use and illicit drug participation respond to economic forces. The results for the cross price effects provide evidence of complementarity, except for alcohol and marijuana. The results can be used to estimate the alcohol price elasticity, the effect of decriminalization on marijuana participation, and the participation price elasticities for heroin and cocaine.[9] These estimates are reported in the last row of tables II–V. The average alcohol price elasticity is −.30 and is consistent with other studies of alcohol price elasticities. The effect of marijuana decriminalization was computed and the results show that decriminalization increases marijuana participation in the past month by about 8.4% and participation in the past year by about 7.6%. Using only significant price coefficients, the average elasticity of cocaine participation for the past month is −.28 and for the past year −.44. The average elasticity of heroin participation for the past month is −.94 and for the past year −.82.[10]

The fairly consistent pattern of complementarity between substances casts doubt on the gateway or domino theory of drug use. This gateway or domino theory holds that use of one drug, such as marijuana, increases the probability of going on to a stronger drug, such as cocaine or heroin. If this theory were true, it is more likely that these drugs would be substitutes. Complementarity suggests that

9. The alcohol price elasticity was calculated as the price coefficient times the mean alcohol price over mean alcohol use. The effect of decriminalization was estimated by calculating the difference between two distribution functions. The first distribution function is computed using all the estimated coefficients and the mean values of all the variables except for the decriminalization variable, which is set equal to one. The second distribution function is identical with the exception that the decriminalization variable is set equal to zero. Cocaine and heroin price elasticities are estimated by multiplying the normal density function of the estimated equation by the price variable coefficient and then by the ratio of the mean price to mean participation. The unweighted means were used in all these computations rather than the weighted means which are reported in Table I. The unweighted means were used, since the estimated regression coefficients are based on unweighted data.

10. Rational addiction models cannot be estimated with the NHSDA, since past and future drug participation is not measured in the data set. Studies of alcohol, cigarette and cocaine demand based on rational addiction models, however, find long-run price elasticities that are larger than those estimated by single-period models.

TABLE IV
Cocaine

Variable	Participation in Past Month					Participation in Past Year				
Intercept	–2.018 (18.66)	–1.763 (12.15)	–2.069 (16.04)	–2.013 (18.68)	–1.828 (10.55)	–1.596 (19.50)	–1.375 (12.45)	–1.729 (17.75)	–1.596 (19.55)	–1.534 (11.69)
Alcohol Price	–	–0.013 (2.70)	–	–	–0.010 (1.91)	–	–0.010 (2.69)	–	–	–0.0062 (1.56)
Marijuana Decriminalization	–	–	0.029 (0.72)	–	0.0018 (0.042)	–	–	0.075 (2.50)	–	0.044 (1.37)
Cocaine Price	–0.0017 (2.12)	–0.0012 (1.38)	–0.0013 (1.43)	–0.000039 (0.04)	0.000063 (0.057)	–0.0029 (4.78)	–0.0027 (4.12)	–0.002 (2.77)	–0.0015 (2.04)	–0.00094 (1.11)
Heroin Price	–	–	–	–0.029 (2.94)	–0.024 (2.28)	–	–	–	–0.024 (3.22)	–0.022 (2.85)
Income	–0.000002 (0.99)	–0.0000022 (1.02)	–0.000002 (1.01)	–0.0000024 (1.17)	–0.0000025 (1.18)	0.0000022 (1.49)	0.0000026 (1.75)	0.0000021 (1.45)	0.0000019 (1.30)	0.0000023 (1.51)
Gender	0.273 (8.10)	0.260 (7.51)	0.273 (8.11)	0.274 (8.14)	0.261 (7.54)	0.265 (10.35)	0.266 (10.15)	0.265 (10.35)	0.266 (10.39)	0.268 (10.19)
Marital Status	–0.451 (10.43)	–0.444 (9.96)	–0.450 (10.42)	–0.447 (10.32)	–0.442 (9.91)	–0.420 (13.15)	–0.416 (12.66)	–0.419 (13.13)	–0.415 (12.99)	–0.413 (12.55)
Dummy for Marital Status	–0.913 (6.69)	–0.901 (6.57)	–0.913 (6.69)	–0.917 (6.70)	–0.906 (6.58)	–0.826 (10.06)	–0.840 (9.94)	–0.826 (10.07)	–0.828 (10.07)	–0.842 (9.97)
Age 12–20	–0.110 (2.21)	–0.086 (1.66)	–0.110 (2.20)	–0.111 (2.22)	–0.088 (1.70)	0.022 (0.57)	0.050 (1.26)	0.023 (0.60)	0.022 (0.57)	0.049 (1.23)
Age 21–30	0.271 (6.88)	0.286 (7.00)	0.272 (6.89)	0.270 (6.86)	0.285 (6.96)	0.373 (12.16)	0.387 (12.23)	0.373 (12.16)	0.373 (12.15)	0.386 (12.19)
Black	0.120 (3.17)	0.112 (2.83)	0.122 (3.21)	0.118 (3.11)	0.114 (2.87)	–0.0066 (0.22)	–0.018 (0.59)	–0.0023 (0.077)	–0.0076 (0.25)	–0.013 (0.41)
Hispanic	0.094 (2.31)	0.108 (2.60)	0.096 (2.35)	0.085 (2.08)	0.102 (2.43)	–0.053 (1.64)	–0.058 (1.75)	–0.049 (1.52)	–0.060 (1.88)	–0.061 (1.86)
1990	–0.164 (3.04)	–0.171 (3.04)	–0.163 (3.03)	–0.190 (3.47)	–0.189 (3.32)	–0.136 (3.42)	–0.159 (3.83)	–0.135 (3.38)	–0.158 (3.89)	–0.174 (4.14)
1991	–0.164 (3.80)	–0.163 (3.61)	–0.163 (3.77)	–0.178 (4.10)	–0.174 (3.82)	–0.212 (6.45)	–0.229 (6.73)	–0.209 (6.36)	–0.224 (6.76)	–0.237 (6.94)
R-Square	0.081	0.133	0.081	0.082	0.134	0.077	0.123	0.077	0.078	0.124
N	49802	47224	49802	49802	47224	49802	47224	49802	49802	47224
Elasticity	–0.34	–0.24	–0.27	–0.01	0.01	–0.57	–0.53	–0.39	–0.30	–0.19

TABLE V
Heroin

Variable	Participation in Past Month					Participation in Past Year				
Intercept	−2.592 (11.12)	−2.738 (7.09)	−2.532 (9.52)	−2.742 (8.74)	−2.931 (5.37)	−2.377 (14.49)	−1.878 (7.31)	−2.291 (12.49)	−2.484 (11.40)	−1.849 (5.24)
Alcohol Price	–	0.011 (0.71)	–	–	0.011 (0.71)	–	−0.024 (2.38)	–	–	−0.025 (2.49)
Marijuana Decriminalization	–	–	−0.052 (0.48)	–	0.052 (0.39)	–	–	−0.082 (1.09)	–	−0.067 (0.73)
Cocaine Price	–	–	–	0.0021 (0.72)	0.0017 (0.48)	–	–	–	0.0015 (0.74)	0.00094 (0.40)
Heroin Price	−0.066 (2.37)	−0.076 (2.36)	−0.073 (2.29)	−0.079 (2.31)	−0.081 (2.09)	−0.059 (3.23)	−0.041 (2.05)	−0.068 (3.31)	−0.068 (3.04)	−0.055 (2.22)
Income	−0.000014 (2.03)	−0.000011 (1.54)	−0.000014 (2.03)	−0.000014 (2.07)	−0.000011 (1.56)	−0.000011 (2.36)	−0.0000077 (1.63)	−0.000011 (2.36)	−0.000011 (2.37)	−0.0000079 (1.66)
Gender	0.322 (3.28)	0.251 (2.41)	0.322 (3.28)	0.324 (3.29)	0.252 (2.42)	0.217 (3.24)	0.161 (2.31)	0.218 (3.24)	0.218 (3.24)	0.162 (2.32)
Marital Status	−0.279 (2.24)	−0.233 (1.81)	−0.278 (2.24)	−0.277 (2.23)	−0.232 (1.80)	−0.260 (2.92)	−0.229 (2.47)	−0.260 (2.92)	−0.259 (2.91)	−0.229 (2.46)
Dummy for Marital Status	−0.512 (1.77)	−0.463 (1.60)	−0.509 (1.76)	−0.512 (1.77)	−0.467 (1.61)	−0.281 (2.04)	−0.277 (1.99)	−0.282 (2.04)	−0.282 (2.05)	−0.277 (1.99)
Age 12–20	−0.292 (2.13)	−0.228 (1.55)	−0.293 (2.14)	−0.294 (2.14)	−0.229 (1.55)	−0.134 (1.40)	−0.050 (0.50)	−0.136 (1.42)	−0.135 (1.41)	−0.053 (0.53)
Age 21–30	−0.040 (0.35)	−0.034 (0.28)	−0.040 (0.36)	−0.039 (0.35)	−0.034 (0.28)	−0.037 (0.45)	−0.046 (0.52)	−0.038 (0.46)	−0.037 (0.44)	−0.047 (0.52)
Black	0.192 (1.83)	0.062 (0.52)	0.188 (1.78)	0.188 (1.79)	0.064 (0.53)	0.024 (0.33)	−0.064 (0.78)	0.018 (0.24)	0.022 (0.30)	−0.069 (0.83)
Hispanic	0.048 (0.42)	0.027 (0.23)	0.048 (0.42)	0.061 (0.53)	0.038 (0.31)	−0.128 (1.51)	−0.151 (1.71)	−0.126 (1.48)	−0.118 (1.37)	−0.142 (1.58)
1990	−0.253 (1.48)	−0.251 (1.46)	−0.257 (1.51)	−0.263 (1.54)	−0.256 (1.47)	−0.085 (0.73)	−0.139 (1.16)	−0.094 (0.81)	−0.094 (0.80)	−0.154 (1.28)
1991	−0.128 (1.03)	−0.198 (1.54)	−0.129 (1.04)	−0.124 (1.00)	−0.194 (1.51)	−0.039 (0.42)	−0.089 (0.94)	−0.040 (0.43)	−0.036 (0.38)	−0.090 (0.95)
R-Square	0.079	0.203	0.079	0.079	0.203	0.058	0.138	0.059	0.058	0.139
N	49802	47224	49802	49802	47224	49802	47224	49802	49802	47224
Elasticity	−0.82	−0.98	−0.90	−0.98	−1.03	−0.88	−0.60	−1.02	−1.02	−0.81

drug users prefer to use various drugs together rather than to substituted one for the other.

The elasticities can be used to predict the effect of legalizing cocaine and heroin. These estimates should be viewed with caution, since several assumptions must be made in order to do the calculations.[11] Legalization could take a number of alternative forms, depending on whether only sanctions against buyers or sanctions against both buyers and sellers were reduced and the magnitude of the reductions in sanctions. The reduction of price is indirectly a policy option, since price is a positive function of the level of sanctions. The potential price reduction is considerable, since current sanctions result in a retail price that is more than 10 times production costs, according to Reuter [1988]. Decreasing sanctions for possession of large quantities drugs or for selling drugs would shift the supply curve downward. Assuming that the demand curve remained fixed, the own price elasticity could be used to estimate the change in participation of a given decrease in price resulting from a change in sanctions. Assume that the policy changes resulted in a decrease in the price of both drugs by 50%. Under these assumptions the number of regular cocaine users would increase by about 260,000 and the number of occasional cocaine users would increase by about 1,400,000. In 1991 there were about 1.9 million regular cocaine users and about 6.4 million occasional cocaine users. Also, under these assumptions the number of regular heroin users would increase by about 47,000 and the number of occasional heroin would increase users by about 615,000. In 1991 there were about 100,000 regular heroin users and about 1.5 million occasional heroin users.[12]

These predictions could to some degree understate or overstate changes in the number of drug users. The increase in drug use could be understated if demand shifts to the right. Any change in drug sanctions or enforcement that shifts the supply curve downward will probably also shift the demand function to the right. On the other hand, the increase in drug use could be overstated, since demand elasticities decrease at lower prices. The demand elasticity is likely to be considerably lower at a 50% lower price. Whether the estimates are overstatements or understatements, the potential increase in public health problems are not the extremes that some analysts predict. A complete analysis of drug legalization should account for the costs of drug prohibition as well as the benefits of drug prohibition.

11. The calculations involve only own price effects because the own price effects are estimated with more precision than cross price effects.

12. The number of frequent heroin users is difficult to estimate, since the sample excludes people with no permanent address and prison inmates. The incidence of frequent heroin users is likely to be higher in the excluded population than it is in the included population.

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