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The Demand for Marijuana, Cocaine, and Heroin

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I. INTRODUCTION

In the last fifteen years, the "War on Drugs" has led to a large increase in the incarceration of individuals due to drug use. Drug-related convictions have increased at a faster rate than convictions for violent crimes (Reid, 2000). The severity of the epidemic is obvious in California where 75% of incarcerated individuals are there due to drug-related convictions. As the drug problem worsens, police find themselves shifting their focus away from violent and serious property crimes. In addition, the influx of drug-related convicts has caused the parole rate for other inmates to increase, sending violent criminals away from prison prior to their sentenced release date. Obviously, illegal drugs carry a large economic and social burden to our society. Billions of dollars are spent annually on incarceration, prevention and rehabilitation for users.

After looking at some of the numbers related to drug use, it is easy to see why illegal drugs are so costly to our society. The Office of National Drug Control Policy monitors drug use trends and patterns. In their 1998 survey they find that 11 million Americans used marijuana at least once in the month prior to being surveyed. Also, about 3.3 million Americans were heavy cocaine users while 3.2 million were occasional users. In fact, Americans consumed roughly 290 metric tons of cocaine in 1998 alone. Additionally, 980,000 Americans were hardcore heroin users and another 500,000 were occasional heroin users ("What America's Users Spend on Illegal Drugs", 2000). How much money do these individuals collectively spend on illegal drugs? In 1998, Americans spent approximately $11 billion on marijuana, $39 billion on cocaine, and $2.3 billion on other substances (including heroin) ("What America's Users Spend on Illegal Drugs", 2000).

What causes people to use illegal drugs? How do the prices of drugs affect consumers' demand for them? This paper addresses these questions by developing a model to estimate the demand for marijuana, cocaine, and heroin. Past studies focus on measuring the demand for one specific drug. This paper expands that notion by measuring demand for marijuana, cocaine, and heroin separately. I use three models; one for marijuana, one for cocaine, and one for heroin. The purpose of the three models is to determine whether there are different demand behavior patterns for each of the types of drugs. For example, social stereotypes label cocaine as an "upper-class" drug used frequently by wealthy executives while heroin is typically thought of as a street drug used by hard-core addicts in America's cities. The three models test the effect of prices and income on the demand for the drugs. In addition, each model also includes demographic variables such as gender, race, and education level to test for different patterns of use among the three types of drugs. If strong differences in demand patterns emerge, more specific policies geared toward each of the drugs will be needed to slow use and help America win its "War on Drugs".

Looking at each of the drugs separately makes it possible to establish whether general policies can be applied to curb all drug use. In the past, supply-side policies have been used in an attempt to reduce drug use. In other words, policy makers reduce supply to increase the prices of illegal drugs with the idea that drug users will demand less at higher prices. By studying the effects of prices, income, and demographic factors on the demand for drugs, this paper will determine whether supply-side policies will be effective in decreasing drug use. If the demand for drugs is not sensitive to price, then demand-side policies will be more effective in decreasing illegal drug use.

Consumer demand theory provides the economic framework for the model. Section II presents the theoretical framework and findings of past researchers. The model and data are presented in section III. Section IV explains the results of the regressions and Section V discusses conclusions and policy implications.

II. BACKGROUND

This section provides a framework for the model through the discussion of past research and economic theory. The model I develop uses several types of independent variables to estimate use of marijuana, cocaine, and heroin. The rest of this section is split into five sub-sections that discuss theory and past literature for the independent variables in the model.

A. Price Variables

Consumer demand theory provides the background for the study of how drug use is related to changes in price and income levels. Each individual reacts to changes in prices differently. In general, the quantity of the drug demanded should decrease as the price increases (Pinydyck and Rubinfeld, 2001). That is, an increase in price should have a negative effect on use regardless of the drug.

The degree to which the use of a drug decreases with an increase in its price is measured by the price elasticity of demand. If the demand for the drug is inelastic, use will not decrease drastically with an increase in the price of the drug. On the other hand, if demand for the drug is elastic, an increase in the price of the drug will cause a large decrease in the use of that drug.

Typically, the demand for a good is inelastic if there are few good substitutes available (Pinydyck and Rubinfeld, 2001). Since there are no good substitutes for

marijuana, cocaine, or heroin, I expect demand for each drug to be relatively inelastic. Also, I expect heroin and cocaine to be more price inelastic than marijuana because of the highly addictive nature of those drugs. Individuals who are addicted to any of the drugs will not change their demand pattern as much in response to a change in prices because of their physical need for the drug.

Several previous studies estimate the effect of prices on drug use. In one, Saffer and Chaloupka (1998) find that price negatively affects consumption for marijuana, cocaine, and heroin. In another study, they calculate the price elasticities of heroin and cocaine. The price elasticity of heroin is estimated to be between -1.80 and -1.60 and the price elasticity of cocaine is found to be between -1.10 and -.72 (Saffer and Chaloupka, 1995).

In their study, Michael Grossman, Frank Chaloupka, and John A. Tauras (1998) discover that the real price of cocaine has a negative and significant effect on cocaine use. Looking at demand by youth, they find that the price elasticity of cocaine is -1.28 while the price elasticity of marijuana is -.008. Thus, they conclude that marijuana demand is very price inelastic while cocaine demand is price elastic.

Stephen Higgins (1998) applies behavioral economics to the study of cocaine use in order to test for the effect of prices on cocaine use. He explains one lab study in which individuals were first asked to choose between cocaine and a placebo. Those who chose cocaine over the placebo seven or more times participated in the second phase of the study in which they were given the choice between cocaine and money. In each round, the amount of money offered increased by $2. Unanimously, the choice of cocaine decreased as the amount of money offered increased (Higgins, 1998). The study

establishes a negative relationship between price and cocaine use. Clearly, as the price of using the drug increases, drug use decreases.

It is interesting that past research finds that marijuana demand is price inelastic and heroin demand is very price elastic. Since heroin and cocaine are more addictive substances than marijuana, I expect users of those drugs to continue purchasing them regardless of the price. Past research finds the price elasticity of heroin is between -1.8 and -1.6. They estimate the price elasticity of cocaine to be between -1.28 and 0.72. These findings contradict my expectations. The highly elastic nature of heroin and cocaine could be attributed to the high price of those drugs. Since they are very expensive to begin with, an increase in the price may be enough to prevent users from purchasing them. Past research finds that the price elasticity of demand for marijuana is 0.008. I expected marijuana to be more price elastic since it is not as addictive as cocaine or heroin. The inelastic demand for marijuana could be due to the relatively low price of marijuana. The price of ten grams of marijuana ranges from $5.00 to $17.00 so an increase in the price of marijuana may not affect demand because the cost of marijuana is low enough that a small increase in the price does not make a big difference in use (www.whitehousedrugpolicy.org).

Although past researchers make various conclusions regarding the effect of prices on drug use, it is necessary to discuss several factors that may make measuring the demand for illegal drugs difficult. First of all, there is a lack of reliable price data. Since marijuana, cocaine, and heroin are all illegal substances, measuring and recording their prices is a very difficult task. Current price information is collected either through user surveys or by undercover police officers who purchase the drugs from dealers. User

surveys are problematic because there is no guarantee that the prices they report are accurate. The collection of price information by undercover police officers is expensive and time consuming so only small samples of price information are collected.

In addition to problems with price data collection, prices for illegal drugs also vary greatly among transactions. Dealers charge different prices to different buyers depending on their relationship with that buyer and the amount they have available to sell. Because of this phenomenon, prices of illegal drugs can vary greatly from one city block to the next. Finally, the heterogeneity of drugs creates a problem with measuring prices. Illegal drugs are sold at varying levels of purity and quality. Also, drugs like cocaine and heroin come in multiple forms. For example, cocaine is sold in multiple distinct chemical forms including cocaine base and powder cocaine. Dealers charge different prices for various forms and there may be different patterns of consumption between the types of cocaine. Current data do not distinguish between the specific forms of drugs individuals use. One price is reported for all forms of the drugs even though different prices are charged for the various forms of drugs (Manski, et. al, 2001).

B. Economic Variables

The quantity of a good demanded also depends on an individual's income. The effect of income on demand can be either positive or negative. If illegal drugs are normal goods, the quantity of drugs demanded will increase as income increases. On the other hand, if illegal drugs are inferior goods, the quantity demanded will decrease as income increases (Pinydyck and Rubinfeld, 2001). It is possible that demand for drugs increases as income increases because as income increases, individuals have more income to spend on all goods, including illegal drugs. On the other hand, illegal drugs could be inferior

goods. As income increases, the opportunity cost of using drugs also increases because the individual risks losing a higher quantity of money if he is caught using drugs.

It is difficult to predict whether the demand for marijuana, cocaine, and heroin all react the same way to an increase in income. Typically, marijuana is considered a gateway drug. In other words, individuals start using it and then eventually switch to other more addictive drugs. Since marijuana is a gateway drug and the cheapest illegal drug, it is possible that it is an inferior good. As income increases, the individual may be more likely to switch from marijuana to a more expensive drug.

Since cocaine is typically considered an "upper-class" drug, it is probably a normal good. As income increases, the quantity of cocaine demanded will also increase because the individual has more income to spend on all goods, including cocaine. Also, based on the assumption that cocaine is the drug of choice for wealthy executives, individuals with higher income should demand more cocaine.

Heroin could either be an inferior or normal good. It could be that as income increases, the demand for heroin also increases due to an overall increase in spending power. On the other hand, heroin is highly addictive and carries a large risk of addiction and physical affliction. Therefore, it could be that the demand for heroin decreases as income increases because of the large opportunity cost associated with using heroin.

Grossman, Chaloupka, and Tauras (1998) find that the demand for both marijuana and cocaine increases as income increases. They measure youth income elasticity of demand and find that it is 0.26. Youth cocaine demand is relatively more income elastic. The income elasticity of demand for cocaine is 0.55. According to this study, both marijuana and cocaine are normal goods.

C. Policy Variables

Many past policies have focused on increasing the prices of illegal drugs in order to decrease use. These supply-side policies may not be effective if price does not significantly affect patterns of use. Instead, policy makers may need to focus on demand-side policies aimed at decreasing use through social programs.

Past research does not focus on finding demand-side policies that will effectively decrease drug use. This paper will establish a group of variables to test for the effectiveness of demand-side policies. Specifically, it will look at youth participation in extracurricular activities. One way to reduce or prevent drug use is to prevent youth from ever using. By establishing programs to encourage youth to get involved in some sort of activity, policymakers may be able to prevent youth from ever using drugs. This is especially important for children whose parents both work or who do not have the ability to enroll the children in activities. For example, if communities establish youth sports programs and after school activities for young children, they may provide a foundation for those children to gain a strong interest in the activity. This may prevent the children from using drugs because they will want to participate in the activities.

D. Background Variables

A number of studies include variables measuring past experiences in their models. Specifically, education and religious preferences are often studied. First of all, Gary Becker and Kevin Murphy (1988) conclude that individuals who heavily discount the future are more likely to become heavy drug users. This argument can be applied to the study of how education influences drug use. People who have shown a willingness to forego current income for a higher future income by getting more education discount the

future less. People who invest in many years of education face higher expected future income, the opportunity for career advancement in the future, and a variety of opportunities that they would not have if they did not invest in more education. Therefore, individuals with high education levels do not heavily discount the future. Thus, as the number of years of school an individual completes increases, the perceived opportunity cost of using drugs increases and demand decreases.

Past research shows that parents' education also plays a big role in determining whether an individual will use illegal drugs. Grossman, Chaloupka, and Tauras include a variable that measures parents' education and find that as parents' education increases, youth are less likely to use cocaine and marijuana (1998). Sickles and Taubman (1991) also find that drug use is negatively related to parents' education.

Religious preference receives varied treatment among past researchers. Grossman, Chaloupka, and Tauras (1998) conclude that individuals who frequently attend religious services are significantly less likely than their counterparts to use both cocaine and marijuana. Sickles and Taubman (1991) find drug use to decrease with either Catholic or no religious affiliation while Charles Manski (2001) finds that participation in church-related activities decreases the likelihood of drug use among individuals.

E. Demographic variables

In addition to studying the effects of background on drug use, a number of studies also include various demographic variables. These variables help indicate whether there are different patterns of use between races, genders, and other demographic characteristics. Gender is included in most past research. Saffer and Chaloupka (1998)

find women are less likely than men to use cocaine. In another study, Grossman, Chaloupka, and Tauras (1998) find that male youths are significantly more likely than females to use marijuana but that there is no difference in cocaine use between males and females.

Race is another important demographic characteristic that can help measure differences in use among groups. Race is measured differently in almost every study. Because of this, past researchers disagree on the effect different races have on drug use. Saffer and Chaloupka (1998) include dummy variables for a number of race categories including Black, Asian, Native American, Hispanic, Puerto Rican, Mexican, and Cuban. They find that Asian individuals are least likely to consume cocaine while African Americans, Native Americans, and Hispanic individuals are most likely to consume Heroin. In contrast, another study concludes that young African Americans are least likely to consume both cocaine and marijuana (Grossman, Chaloupka, and Tauras, 1998). Sickles and Taubman (1991) measure race as a single dummy variable with white and non-white as the categories. They conclude that being non-white is negatively related to drug use. Finally, another study finds that there is no statistically significant difference in drug use between whites, blacks, and Hispanics (Drucker, 1999).

Researchers are often interested in determining whether living in an urban area makes an individual more or less likely to use illegal drugs. There is some disagreement on the effect of where an individual lives on drug use. Grossman, Chaloupka, and Tauras (1998) determine that youth who live in rural areas are significantly less likely than urban youth to consume cocaine and marijuana. In contrast, an article published in *Economist*

finds that rural youth are twice as likely to use cocaine and 34% more likely to smoke marijuana than urban youth (2000).

III. EMPIRICAL MODEL

This paper uses data from the 1997 *National Household Survey on Drug Abuse* (NHSDA). The NHSDA is an annual self-report study conducted by the United States Department of Health and Human Services, the Substance Abuse and Mental Health Services Administration, and the Office of Applied Statistics. The survey provides information on the use of illicit drugs, alcohol, and tobacco among members of U.S. households aged 12 and older. The survey includes demographic data as well. It is important to mention the potential problems with self-report surveys related to illegal activities. Individuals may be reluctant to report accurate information regarding their participation in illegal activities because they might be scared that they will be punished. Thus, the data may not provide a completely accurate measure of drug use since respondents may not accurately report their history of use.

Three separate double-log models are established in this section. In a double-log models all the variables except dummies are in log form. The independent variables in each of the models are the same. The dependent variables are different in each model. They measure marijuana use, cocaine use, and heroin use respectively. I use a double-log regression because the coefficients in a double-log regression are elasticities that can easily be interpreted. Table 1 includes each of the variables and their definitions.

Table 1: The Variables

Type of Variable	Variable Name	Definition	Predicted Sign
Dependent	MJUSE	Number of days respondent used marijuana in past 12 months. (See Table 2)	
	COKEUSE	Number of days respondent used cocaine in past 12 months. (See Table 2)	
	HERUSE	Number of days respondent used heroin in past 12months. (See Table 2)	
Price	MJPRICE	Price of <10 pure grams of Marijuana (See Table 3)	Negative
	COKEPRICE	Price of <1 pure gram of Cocaine. (See Table 3)	Negative
	HERPRICE	Price of <1 pure gram of Heroin. (See Table 3)	Negative
Economic	INCOME	Total Family Income. (Midpoints of Income ranges)	Uncertain
	EMPLOY	Is respondent employed? (0: no, 1: yes)	Negative
Policy	YOUTH	Is respondent under 20? (0: no, 1: yes)	Uncertain
	YSPORT	Did youth participate in sports? (Interaction with YOUTH)	Negative
	YBAND	Is youth in band? (Interaction with YOUTH)	Negative
	YSCOUTS	Is youth in scouts? (Interaction with YOUTH)	Negative
Back-Ground	RELIGION	Are religious beliefs important to subject? (0: no, 1: yes)	Negative
	EDUCATION	What is highest grade completed by subject? (measured in years)	Negative
	PEOPLE	How many people live in respondent's household?	Positive
Demographic	FEMALE	Is respondent female? (0: no, 1: yes)	Uncertain
	MINORITY	Is respondent non-white? (0: no, 1: yes)	Uncertain
	AGE	Age of respondent (measured in years)	Uncertain
	URBAN	Does respondent reside in urban area? (0: no, 1: yes)	Uncertain
	MARRIED	Is respondent married? (0: no, 1: yes)	Negative

A. Dependent Variables

There are three separate models with different dependent variables. The NHSDA measures drug use based on the number of times an individual has used a drug in their

lifetime, in the past year, and in the past thirty days. I use the variable that measures use in the past year for all three of the drugs.

The NHSDA variables measure drug use in the past year as the number of days the individual used marijuana in the past 12 months. However, responses are then categorized into ranges. Hence, I calculate the midpoints of all of the categories and assign them to the individuals based on which group they are in. Individuals who marked "never used" or "did not use in past 12 months" are coded as zero. The ranges and midpoints are listed in Table 2.

Table 2: Measurement of Marijuana, Cocaine, and Heroin Use

Range (in days)	Midpoint
1 – 2	1.5
3 – 5	4
6 – 11	8.5
12 – 24	18
25 – 50	37.5
51 – 100	75.5
101 – 200	150.5
201 – 300	250.5
300 – 365	332.5

B. Price Variables

Information on drug prices comes from the "What America's Users Spend on Illegal Drugs" report (www.whitehousedrugpolicy.gov). The report is an overview of drug spending in America between 1988 and 1998. The price data are listed in the appendix of the report and come from the *System to Retrieve Information on Drug Evidence* (STRIDE) database maintained by the Drug Enforcement Agency.

The report includes prices for three quantity ranges of marijuana, cocaine, and heroin. According to law enforcement officials, typical street users will buy 1-5 grams of marijuana, less than one gram of cocaine, and less than one gram of heroin. Given this

information and the prices available, I use reported prices for less than ten grams of marijuana, less than one gram of cocaine, and between 0.1 and 1.0 grams of heroin.

The price data report prices for one year based on a region of the country. The country is split into six regions; East Central, West Central, Southeast, Mountain, Northeast, and Pacific. My model uses 1997 prices since I am using the 1997 NHSDA. The prices for each of the regions are presented in Table 3. The NHSDA reports on the respondents' census region. I created the price variables by assigning the price in their region based on the census region reported in the NHSDA. Unfortunately, since there are only six possible prices for each of the drugs, the variability of the price variables is limited. Due to the illegal nature of illicit drugs, price information is difficult to maintain because transactions are made in the underground economy. As discussed in Section II, drug prices vary from transaction to transaction so only having six possible prices does not capture that variability. It would be better to at least have state data but this is the best data I could access. Despite the shortcomings of the price variables, I include them in order to measure the price elasticity of demand for marijuana, cocaine, and heroin. Based on consumer demand theory, I hypothesize that prices will be negatively related to frequency of drug use.

Table 3: Price Data

Region	Marijuana	Cocaine	Heroin
East Central	$6.52	$236.13	$731.62
Mountain	$10.12	$230.79	$583.80
Northeast	$17.15	$253.04	$467.79
Pacific	$11.45	$230.68	$523.18
Southeast	$4.89	$280.75	$940.92
West Central	$10.17	$223.61	$1,213.05

C. Economic Variables

Income and employment status variables are both included as independent variables in this study. The income variable measures total family income. I use family income instead of personal income because of potential problems with the personal income variable. Since the sample includes individuals ages twelve and older, younger respondents may not earn any income, but they may receive money from their parents and use that for drugs. Also, total family income allows for situations where only one spouse works.

The NHSDA variable for income places respondents into categories based on the range into which their income falls. The variable would be better if it reported each individual's income but the NHSDA only reports income in ranges. Also, since the NHSDA is a self-report study there are potential problems with the income variable. First, there is no way to guarantee that the income an individual reports is accurate. Secondly, it is not clear whether they include income earned from illegal activities. If they do not report that income, the results could be inaccurate because individuals who are using drugs may be paying for them with illegal income.

In order to transform the variable into a pseudo-continuous variable, I calculate the midpoints for the income categories and assign them to the respondents based on the category into which they fall. By taking the midpoints, some of the variability is removed because individuals in each range are all assigned the same income.

The employment status variable is a dummy variable measuring whether individuals have jobs. Since Higgins (1998) establishes that individuals are less likely to use drugs if the opportunity cost of using them increases, I hypothesize that individuals

who have jobs will be less likely to use drugs. The dummy variable is coded zero if the respondent is unemployed, retired, a full-time student, or a homemaker and one if he or she has a job.

D. Policy Variables

This group of variables is present to test for the effectiveness certain demand-side policies might have in reducing drug use. In the past, researchers and policy makers have proposed setting up programs to get youth off the streets and interested in different types of activities. The rationale behind these programs is that they will allow kids to develop an interest in something constructive at an early age and thus protect them from street life and drugs. These programs are particularly advocated in lower-income neighborhoods where parents may not have the resources to pay for activities for their children.

I first create a dummy variable for youth (YOUTH) which equals zero if the individual is over 20 years old and 1 if the individual is under 20. Typically policy makers propose starting programs in the arts, sports, and other organized activities for children. These programs are meant to establish an interest in the activities at an early age and to prevent them from using drugs. In order to test these policies, I calculate three interaction variables. The first one (YSPORTS) is an interaction between the youth variable and another dummy variable that equals one if the youth participates in varsity sports. The second interaction variable is YBAND. It is an interaction between YOUTH and a dummy variable equaling one if the youth participates in the band program at school. Finally, the third interaction variable (YSCOUTS) is an interaction between YOUTH and a dummy variable if the youth is part of a scouts program. Each of the interaction variables indicates whether the youth has taken part in the program in the past

twelve months. It would be better if it measured how long they have participated in the activities but I will use this as a proxy to test the demand-side policies.

Each of the coefficients of these interaction variables will be the marginal effect for youth of participating in the activities. If any of them are significant, they will support the policies that advocate starting programs aimed at getting children interested in constructive activities at early ages. For example, if the coefficient for the YSPORTS interaction is negative, then programs that start youth sports programs in the community will be effective in reducing or preventing drug use.

Since I use a double-log regression model, the policy variables are weak measures because the double-log form drops all individuals who have not used any drugs from the sample. Thus, it will not be able to effectively test whether these policies do reduce or prevent drug use because youth who do not use drugs are not included in the sample.

E. Background Variables

I include three background variables in my model. The first background variable relates to religion. Past research disagrees on how to measure the effect of religion on an individual. Some researchers test whether belonging to various denominations affects individual drug use. Others test how the importance of religion to an individual affects drug use. I use the latter method by creating a dummy variable that measures how important religious beliefs are to the individuals in the database. The survey asks respondents whether their religious beliefs are important to them. The variable is coded zero if they answer "strongly disagree" or "disagree" to the survey question. It is coded one if the respondent answered "agree" to the religion question. I expect that people

whose religious beliefs are important to them are less likely to use illegal drugs because of the taboo religion puts on substance abuse.

The final background variable measures the number of people in each respondent's household. It is a proxy for family size and I include it to test for the effects of having a large family on drug abuse. I am not sure how this variable will behave. It could be that individuals from a large family are more likely to use drugs because they do not receive as much attention from their parents as individuals with smaller families. The idea is that people from larger families turn to drugs because they receive more attention from other users than they do at home or because the drugs offer an escape.

F. Demographic Variables

I include several demographic variables in my model to test for differences in drug use patterns between groups. Specifically, I include variables for gender, race, and whether the individual resides in a rural or urban area. The gender variable (FEMALE) is a dummy variable equaling zero if the respondent is male and one if the respondent is female. It is difficult to predict how FEMALE will be related to drug use.

The race variable (MINORITY) is also a dummy variable equaling zero if the respondent is white and one if the respondent is non-white. Past researchers disagree on how to measure race in models relating to drug use. Some researchers separate the races into multiple dummy variables while others include a single dummy variable. I include the single dummy variable for simplicity. While it may not provide the most accurate results due to the many races included, it allows for interpretation of race using one variable.

I also include a variable measuring age (AGE) to determine whether different age groups use different types of drugs. There is not much in the literature about the effects of age on the demand for drugs because many of the past studies use data from studies that only survey youth. Since the NHSDA includes all individuals over the age of 12, I include the age variable to test for differences in the patterns of use among individuals of different ages. It is unclear how this variable will relate to the dependent variables.

Due to the varied results past researchers have regarding variables testing for the effect of living in an urban area, I include a dummy variable for urban and rural. It is coded zero if the respondent lives in a rural area and one if the respondent resides in an urban area. The codebook for the NHSDA database does not explain how they define an urban area so I am unable to do so here. I am not sure how the urban variable will behave in the regressions.

IV. RESULTS

A. Marijuana Results

The results of the regressions are presented in this section. I run three regressions for marijuana. The first regression includes all of the variables discussed in Section III. For marijuana, the first model produces weak results, as illustrated in Table 4.

Table 4: Results for Marijuana Regressions

Type of Variable	Variable	Regression 1	Regression 2
Constant		5.252	5.972
		(3.873)	(6.327)
Price	MJPRICE	0.0027	0.0645
		(0.018)	(0.489)
Economic	INCOME	-.0432	-0.156**
		(-0.639)	(-2.746)
	EMPLOY	-0.222**	-0.143
		(-1.919)	(-1.483)
Policy	YOUTH	0.0479	
		(0.225)	
	YSPORT	-0.421**	
		(-2.656)	
	YBAND	-0.08741	
		(-0.373)	
	YSCOUTS	0.198	
		(0.457)	
Background	RELIGION	-0.559***	-0.483***
		(-4.777)	(-4.856)
	EDUCATION	-1.060**	-0.896***
		(-2.954)	(-3.022)
	PEOPLE	-0.01192	-0.01687
		(0.085)	(0.140)
Demographic	FEMALE	-0.443***	-0.457***
		(-4.314)	(-5.222)
	MINORITY	0.158	0.0561
		(1.317)	(0.486)
	AGE	0.458	0.414**
		(1.593)	(2.038)
	URBAN	-0.06595	-0.03597
		(-0.421)	(-0.264)
	MARRIED	-0.214	-0.177
		(-1.425)	(-1.245)
N		1,554	2,121
R^2		0.039	0.034

Notes: T-statistics shown in parentheses. *: .05 significance, **: .01 significance, ***: .001 significance

The coefficient for PRICE is positive and insignificant. The coefficient for INCOME has a negative sign, but it is also insignificant. The purpose of the first regression is to test for all of the variables, including the policy variables. According to

the results, the youth/sports interaction is the only youth variable that significantly impacts the quantity of marijuana demanded by youth. While setting up sports programs may help prevent youth from using marijuana, these results do not support the establishment of music or scouting programs to prevent marijuana use. It is not surprising that the policy coefficients are not significant due to the exclusion of non-users from the sample as discussed in the previous secion.

Since the price and income coefficients are insignificant in regression one, I run a second regression that excludes the insignificant policy variables. The results from that regression are similar to regression one so they are not included in Table 4. Since the policy coefficients are weak, I completely remove them in the final regression. The results of that regression are presented in Table 4.

In this case, PRICE is still insignificant and has the wrong sign. One possible explanation for the positive sign is that marijuana is not a homogeneous good. In other words, the higher priced marijuana is may be of a higher quality. Thus, users may be more willing to spend more money on higher-priced marijuana.

The fact that the PRICE variable is insignificant is not surprising. Grossman, Chaloupka, and Tauras (1998) estimate that marijuana's price elasticity of demand equals -0.008. Although their estimate is significant, it is very close to zero. Thus, they find that price has very little effect on the demand for marijuana. The results of this regression show that the coefficient for PRICE is insignificant and therefore does not affect the demand for marijuana.

As previously discussed in Section III, the price data used in this study are weak and problematic. The price data only breaks the country up into six regions but users in

two separate areas of one city could face different prices based on their dealer and their relationship with that dealer. There are inherent problems in trying to measure the demand for any illegal drug. Since prices are regulated by the whims of dealers and not recorded anywhere, it is very difficult to find valid price data.

After taking out all of the policy variables, the income coefficient becomes very significant and has a negative sign. According to the results, the income elasticity of demand is -.156. In other words, as income increases, the demand for marijuana decreases. Also, the negative sign shows that marijuana is an inferior good. As discussed in Section II, it is difficult to say whether individuals at higher incomes do not use any drugs or if they switch to more expensive drugs, such as cocaine.

A few of the other coefficients are significant in the final marijuana regression. First, older respondents use marijuana. This is somewhat surprising since marijuana is typically thought of as a drug used by high-school students and young adults. One thing to consider with the age variable is the range of ages for marijuana users. In this sample, the age of marijuana users ranges from 13 to 68. The mean age for marijuana users in this sample is 21, and the majority of users fall between the ages of 16 and 40. This indicates that drug use increases with age and then decreases for individuals over the age of 40. Since the NHSDA does not survey the same individuals every year, I cannot conclude that older individuals have definitely stopped using. Due to the nature of the data, older individuals either never used marijuana or have stopped using it.

Education is also strongly related to drug use. As the level of education an individual has increases, the demand for marijuana decreases. This supports the rational

choice model established by Becker. Individuals with higher education value their futures more and therefore are less likely to become addicted to marijuana.

This model also shows that females are significantly less likely to use marijuana than males. Also, individuals who highly value their religious beliefs demand less marijuana than individuals who do not. Finally, the marijuana model shows that marijuana demand is not significantly different between married and unmarried people, whites and non-whites, or individuals living in urban or rural areas.

B. Cocaine Results

Several regressions were also run to test for Cocaine. The results are presented in Table 5. The first regression includes all of the policy variables. In this case none of them are significant. In other words, demand-side programs aimed at getting youth involved in constructive activities such as sports, band, or scouting will not significantly reduce their demand for cocaine. Again, these results are weak because non-users are not included in the sample. It could be that these policies do work in reducing or preventing drug use but since the double-log regression drops individuals who use absolutely no cocaine, it is impossible to truly know if the policies do work. Since all of the policy variables are insignificant, I remove them in regression two.

Table 5: Results for Cocaine Regressions

Type of Variable	Variable	Regression 1	Regression 2
Constant		-9.205	-7.483
		(-1.313)	(-1.244)
Price	COKEPRICE	1.541	1.411
		(1.209)	(1.271)
Economic	INCOME	- 0.03298	-0.06586
		(-0.345)	(-0.695)
	EMPLOY	-0.150	-0.04334
		(-0.761)	(-0.278)
Policy	YOUTH	0.161	
		(0.462)	
	YSPORT	- 0.360	
		(-1.064)	
	YBAND	-0.524	
		(-0.945)	
	YSCOUTS	0.203	
		(0.224)	
Background	RELIGION	-0.263	-0.234
		(-1.343)	(-1.451)
	EDUCATION	-0.925**	-0.812**
		(-2.291)	(-2.266)
	PEOPLE	0.511**	0.395**
		(2.223)	(2.025)
Demographic	FEMALE	-0.0187	- 0.0313
		(0.105)	(-0.211)
	MINORITY	0.536**	0.502**
		(2.480)	(2.662)
	AGE	1.462***	1.256***
		(3.200)	(4.293)
	URBAN	0.326	0.111
		(1.173)	(0.474)
	MARRIED	-0.412*	-0.451*
		(-1.776)	(-2.051)
N		349	466
R^2		0.090	0.071

Notes: T-statistics shown in parentheses. *: .05 significance, **: .01 significance, ***: .001 significance

For cocaine, PRICE is positively related to demand and is insignificant. This can be explained similarly to the PRICE result for marijuana. Higher-priced cocaine could be

of higher quality and thus users demand more of the higher-priced cocaine. Also, the same problems with measuring prices for cocaine apply. Prices change rapidly based on the dealer and the user's relationship to that dealer so it is impossible to find completely accurate price data. Since the coefficient is insignificant, cocaine use does not significantly increase or decrease with changes in the price.

This model shows that INCOME is negatively related to the demand for cocaine but that it is not significant. In other words, an individual's demand for cocaine is not dependent on his or her income level. This makes sense due to the addictive nature of cocaine. Addicts will continue to demand cocaine regardless of their income level because of their physical dependence on the drug. Also, this result does not support the stereotype that cocaine is an "upper-class" drug used by America's executives.

Education is highly significant in predicting cocaine use. As the level of education increases, the demand for cocaine decreases. Again, the Rational Addiction assumptions made by Becker hold true. Individuals who value the future more are less likely to use cocaine because they face higher opportunity costs of using. Individuals who invest in high levels on education do not highly discount the future and therefore are not as likely to use drugs and individuals with less education.

For cocaine, non-whites are significantly more likely than whites to use cocaine. Also, individuals who are married are less likely to use cocaine. As family size increases, the demand for cocaine increases. This variable is not significant in the marijuana model so it is interesting that family size affects the demand for cocaine and not marijuana. Unlike marijuana, religious beliefs do not significantly reduce an individual's demand for

cocaine. Also, there is no significant difference in cocaine demand between males and females.

Like in the marijuana regression, age is highly significant in predicting cocaine use. Again, age is positively related to drug use so the age of cocaine users should be taken into consideration. The youngest cocaine user in this sample is 12 and the oldest is 57. The mean age of cocaine users is 23 and the majority of users fall between the ages of 16 and 34. It appears that the age/cocaine use relationship is curved. That is, use increases with age to a point and then decreases. Since the NHSDA is not a longitudinal survey, I cannot conclude that older individuals have stopped using. Instead, I can conclude that they either never used or have stopped using.

C. Heroin Results

I use the same regressions for heroin as I use for cocaine and marijuana. The results are presented in Table 6. In the first regression, the policy variables should be included, however the youth/band and youth/scouts interaction variables had to be dropped because the data do not include any youth in those activities that use heroin. It is important to note the small sample size for this regression. The sample size is only 30 so it makes sense that there are not many youth in band or scouts who use heroin. Therefore, only the youth/sports variable is included. Again, this variable is insignificant and the results of the first regression are pretty weak. The weak youth/sports coefficient is not surprising do to the problems associated with the policy variables that are discussed in previous sections. Only education and age are barely significant in the first regression.

Table 6: Results for Heroin Regressions

Type of Variable	Variable	Regression 1	Regression 2
Constant		-16.110	-16.060
		(-1.019)	(-1.884)
Price	HERPRICE	.363	-0.388
		(0.233)	(0.427)
Economic	INCOME	1.017	0.812**
		(1.566)	(2.036)
	EMPLOY	0.643	0.0453
		(0.656)	(0.085)
Policy	YOUTH	-0.406	
		(-0.221)	
	YSPORT	-0.377	
		(-0.230)	
Background	RELIGION	0.614	0.580
		(0.670)	(1.111)
	EDUCATION	-3.959*	-3.459**
		(-2.040)	(-2.538)
	PEOPLE	-0.877	-0.273
		(-0.788)	(-0.400)
Demographic	FEMALE	-0.269	-0.596
		(-0.283)	(-1.123)
	MINORITY	0.980	0.464
		(0.606)	(0.583)
	AGE	4.865*	5.008**
		(2.090)	(4.507)
	URBAN	0.900	0.603
		(0.666)	(0.696)
	MARRIED	0.288	0.632
		(0.269)	(0.924)
N		30	45
R^2		0.254	0.430

Notes: T-statistics shown in parentheses. *: .05 significance, **: .01 significance, ***: .001 significance

Regression two removes the policy variables and comes up with somewhat stronger results. In the case of heroin, price has the right sign but is insignificant. The insignificance can be attributed to the same rationale that explains the positive price variable in the cocaine and marijuana models. Due to the strong addictive nature of

heroin, it is not surprising that price does not affect use. Addicts will continue purchasing heroin regardless of the price because they need it to satisfy their physical addiction. Unlike the other two drugs, heroin proves to be a normal good. As an individual's income increases, the demand for heroin also increases. This makes some sense given the very high price of heroin. Since it is so expensive, it could be that individuals with higher incomes consume more heroin because they are more able to afford it.

Like marijuana and cocaine, education is negatively related to the demand for heroin. Again, as education increases, the demand for heroin decreases. Thus, Becker's theory also holds true for the demand for heroin. The coefficient for education is also relatively large. In other words, a one- percent increase in the years of education an individual has decreases the demand for heroin by quite a bit.

The only other significant predictor of heroin demand is age. Age is positively related to heroin use, so older individuals demand more. The ages of heroin users follow a very similar to the pattern established for marijuana and cocaine. The youngest heroin user in this sample is 13 and the oldest is 49. Most of the heroin users are between the ages of 17 and 21. Therefore, heroin use increases with age to a point and then decreases. Due to the highly addictive nature of heroin, it is hard to conclude that older individuals have all stopped using. Since the NHSDA surveys different people each year, older people have either stopped using heroin or never used it. Also, it could be that individuals who use heroin are killed from the drug at relatively young ages and therefore provide another explanation for the small age range of heroin users.

Since none of the other demographic or background variables are significant in this model, I can conclude that race, gender, marital status, family size, and living in an urban area has no effect on the demand for heroin. In other words, the demand for heroin is the same among each of these groups.

D. Results Overview

This section presents an overview of the best results for each of the regressions. These results are presented in Table 7.

As illustrated in the table, there are some differences in the behavior of the variables among the three types of drugs. Income behaves differently in each of the regressions. It is negatively and significantly related to marijuana use, indicating that marijuana is an inferior good. Income does not significantly affect cocaine use. It has a negative sign but is insignificant in the cocaine model. The results show that heroin is a normal good since the income regression is positive and significant.

Table 7: Overall Results

Type of Variable	Variable	Marijuana	Cocaine	Heroin
Constant		5.972	-7.483	-16.060
		(6.327)	(-1.244)	(-1.884)
Price	PRICE	0.0645	1.411	-0.388
		(0.489)	(1.271)	(0.427)
Economic	INCOME	-0.156**	-0.0659	0.812**
		(-2.746)	(-0.695)	(2.036)
	EMPLOY	-0.143	-0.04334	0.0453
		(-1.483)	(-0.278)	(0.085)
Policy	YOUTH			
	YSPORT			
	YBAND			
	YSCOUTS			
Background	RELIGION	-0.483***	-0.234	0.580
		(-4.856)	(-1.451)	(1.111)
	EDUCATION	-0.896***	-0.812**	-3.459**
		(-3.022)	(-2.266)	(-2.538)
	PEOPLE	-0.0169	0.395**	-0.273
		(-0.140)	(2.025)	(-0.400)
Demographic	FEMALE	-0.457***	-0.0313	-0.596
		(-5.222)	(-0.211)	(-1.123)
	MINORITY	0.0561	0.502**	0.464
		(0.486)	(2.662)	(0.583)
	AGE	0.414**	1.256***	5.008**
		(1.593)	(4.293)	(4.507)
	URBAN	-0.0360	0.111	0.603
		(-0.264)	(0.474)	(0.696)
	MARRIED	-0.177	-0.451*	0.632
		(-1.245)	(-2.051)	(0.924)
N		2,121	466	45
R^2		0.034	0.071	0.430

Notes: T-statistics shown in parentheses. *: .05 significance, **: .01 significance, ***: .001 significance

Looking at the background variables, there are some differences between the three drugs. First of all, RELIGION is only significant in the marijuana regression. That is, religion does not affect whether an individual uses cocaine or heroin. The education variable is highly significant in each of the models. This supports Becker's theory that individuals who discount the future less are less likely to be heavy drug users. It also indicates that policies aimed at promoting education and keeping youth in school may help improve the drug problem.

The demographic variables establish a couple of interesting patterns. First of all, females are significantly less likely than males to use marijuana but gender does not significantly affect the use of cocaine or heroin. Also, non-whites are significantly more likely than whites to use cocaine. However, race does not significantly affect the use of marijuana or heroin. The results of all three models establish the same pattern for the age variable. The coefficients for each age variable are positive and significant. Of course, as previously discussed, it is likely that use increases with age to a point and then starts to decrease. Since the NHSDA is not a longitudinal study, it is not clear whether older individuals never used drugs or if they no longer use them. Future models could try to test for a turning point in the Age line. Finally, the results show that there is no significant difference in use between individuals who live in rural and urban area and that marital status does not significantly affect drug use.

VI. CONCLUSION

The results of this study do not show that prices significantly affect the demand for marijuana, cocaine, or heroin. Of course, this could be due to the data problems discussed. However, these results do not offer support for supply-side policies that increase the prices of illegal drugs in order to reduce the use of illegal drugs.

None of the youth variables that are meant to test whether children involved in various activities are less likely to use drugs are significant, either. The only exception is that youth who play sports demand significantly less marijuana than youth who do not play sports. Again, the results offer little support for these demand-side policies but this is not surprising since the variables started out as weak measures.

Policy makers should focus on keeping children interested in education and find ways to help underprivileged children not only receive quality educations but also help them to become more educated. In all three of the models, education has a strong negative relationship with drug demand. Hence, programs that focus on increasing the education of individuals in our country should help decrease drug use in our country and may help solve the drug problem.

Overall, this study shows that measuring demand for illegal drugs is very difficult and problematic. In order to improve future research, a better method for recording drug prices should be developed. Future researchers could expand this study to include other popular drugs such as Ecstasy and methamphetamines. Also, it would be interesting to test more family background variables against the demand for each of these drugs to see how strongly an individual's past can predict whether or not they will use illegal drugs. By focusing on more family background issues, researchers may find that policies relating to family structure or background may help improve the drug problem in this country. Future researchers could change the functional form of this regression model so that non-users are included in the sample. Doing so will allow them to better test for some of the demand-side patterns including the policy variables established in this study. Finally, it would be interesting to test a more detailed location variable. Specifically, future studies could include a variable testing for a difference in use between individuals who live in the inner city, the suburbs, and smaller communities.

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