

“The Effects of Macro-level Interventions on Addictive Behavior”

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**Abstract:**

Drug addictions are often viewed as compulsive behaviors, not sensitive to the typical rules of self-discipline or market forces. Nonetheless, many governments try to discourage consumption of addictive substances through macro policy tools, such as taxation, regulation and prohibition, in an effort to reduce the harmful consequences that result from their consumption. The government's ability to discourage this type of behavior through these macro policies depends critically on the responsiveness of addictive consumption to market interventions. This paper reviews the growing literature that applies economic principles to the analysis of substance abuse. Specifically we review the impact of prices and public policies on the demands for tobacco, alcohol and illicit drugs. The findings from these studies clearly demonstrate that even addictive behaviors are sensitive to changes in the price of substances being abused. When the full price of the addictive good rises, consumption of that good falls even among abusers. Therefore, public policies that raise the full price of a drug to a consumer, particularly youth, are likely to result in long run reductions in rates of addiction.

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## **I. Introduction**

Drug addictions are often viewed as compulsive behaviors, not sensitive to the typical rules of self-discipline or market forces. Recent scientific evidence seems to reinforce this view; neuroscientists, for example, have begun to identify the exact areas of the brain that are influenced by specific drug dependencies and are examining the reaction of brain receptors during various drug highs, during craving states, and even upon sight of drug paraphernalia. Economists, however, argue that these seemingly irrational behaviors do respond to changes in prices, incomes, and other factors.

Given the health, economic, social and other consequences of addictions to nicotine, alcohol, and other drugs, nearly all governments employ a variety of macro-level policies to discourage addictive consumption. The most widely used policy tools include: taxation, which raises the monetary price people have to pay for the good; regulation, which impacts the availability and conditions for use and purchase of the good; and prohibition, which raises the price and legal risks associated with purchasing and using the good. The government's ability to discourage substance abuse through these macro-level interventions depends critically on the responsiveness of addictive consumption to them.

In this paper we review the growing literature that applies economic principles to the analysis of substance abuse and addiction. Specifically, we review the impact of price and public policies on the demands for tobacco, alcohol and illicit drugs. The findings from these studies clearly demonstrate that even addictive behaviors are sensitive to changes in the full price of the substance being abused, where the full price of a good reflects not only its monetary cost, but also the health costs, legal costs, and time costs involved in obtaining and using the good. When the full price of an addictive substance rises, consumption of that substance falls. As consumption falls, so do the negative consequences associated with excessive use and addiction. Therefore, macro-level policies that raise the full price of a drug can be effective at achieving long run reductions in the rates of addiction as well as the harmful consequences associated with tobacco, alcohol, and other drug use.

## II. Drug Addictions as “Rational Behaviors”

The economic theory of rational choice is based on the assumption that individuals have limitless desires but face limited budgets and are therefore forced to make choices among the different goods that they desire. The process by which they make these decisions is referred to as “constrained utility maximization,” and refers to the maximization of the individual’s happiness, represented by a utility function, subject to the individual’s budget constraint. Prices facilitate these choices by identifying how much of one’s limited budget must be dedicated to one good at the expense of other goods that might also have been purchased. From this theory of rational choice comes perhaps the most fundamental principle of economics, the law of demand. The law of demand postulates that as the price of a good rises, all else constant, an individual will consume less of it. This results from the fact that at the level of consumption given the individual’s budget, the individual will no longer be able to afford the same level of consumption given that the individual’s budget has not changed. This fundamental principle implies that an inverse relationship exists between the price of a good and the quantity of that good consumed, thus generating a downward sloping demand curve (see Figure 1).

The applicability of this fundamental principle of economics to the demand for addictive substances, such as tobacco, alcohol and illicit drugs, has been questioned by numerous researchers from several disciplines, including economics (Friedman, 1962; Elster, 1979; Winston, 1980; Thaler and Shefrin, 1981; Schelling, 1984). Most critics have argued that because these goods are addictive, individuals cannot control their level of consumption and therefore will not reduce their consumption when price goes up.

The concept of addiction, however, can be, and has been, incorporated into traditional economic models of behavior. Recent models of substance use and abuse explicitly model addiction by making current consumption decisions dependent on the past level of consumption in addition to current prices, income, and individual tastes. By linking consumption over time, these models capture the psychological concepts of reinforcement, tolerance, and withdrawal that are associated with addictive behaviors. Reinforcement is demonstrated in these models when an increase in the past consumption of an addictive

good increases the current satisfaction, or marginal utility, from consuming that good. Tolerance implies that a given level of current consumption provides less overall satisfaction, or total utility, when past consumption is higher. Withdrawal refers to the physical or emotional discomfort, or disutility, associated with cessation or interruptions in consumption.

Since economists approach addiction from a behavioral perspective, much of the research done by economists has focused on developing a generalizable model of behavior that embodies the concepts above. Two different frameworks for empirically modeling addictive behavior have been developed: myopic models and rational models. Myopic models assume that individuals are naïve (Pollack, 1970, 1976, 1978; Hammond 1976; Houthakker and Taylor, 1966 and 1970; El-Safty, 1976). Although they recognize the dependence of current consumption on past consumption, individuals in these models ignore the impact of current and past choices on future consumption of the addictive good. They therefore focus on the short-run consumption decision as opposed to the long run. The standard utility-maximizing, rational choice model is employed in myopic models, but the individual only values current satisfaction (utility) and does not consider future happiness. Because they only consider current utility, only current consumption (a “short-run” outcome) is determined from the utility-maximizing problem. Some of these models treat tastes for the addictive good as endogenous, implying that past and current consumption of the addictive substance changes the individuals’ future preferences for that substance. Other models treat tastes and preferences as fixed, or exogenous, and assume that changes in the quantity of the substance consumed over time are due to the addictive nature of consumption.

Rational models of addiction differ from myopic models by assuming that individuals consider future consequences of past and current consumption when making decisions regarding current choices (Becker and Murphy, 1988; Iannaccone, 1984; Stigler and Becker, 1977). The individual is said to maximize his lifetime utility function, not just his current level of happiness. Therefore decisions about consumption today (the “short-run” decision) and consumption in the future (“long run” decisions) are made simultaneously. These models do not assume that future consumption decisions are fixed from the current period forward. When the person gets to the next period, they go through the same utility-

maximizing problem incorporating any new information that is revealed at that time. The models also do not rule out relatively high discount rates for addicted individuals when considering the future consequences of their addictive consumption. Although an individual's taste for the addictive good is assumed not to change over time, the quantity demanded may change due to tolerance and reinforcement.

Several important implications regarding individual behavior come out of these economic models of addiction. First, these models predict that, because of reinforcement, addictive consumption will demonstrate "adjacent complementarity," which means that the quantities of the addictive good consumed in different time periods will be economic complements. Two goods are considered to be economic complements when a price increase for one good causes the consumption of both goods to decrease. What this means for addictive goods is that current consumption of the addictive good will be inversely related to all past and expected future prices of the good as well as the current price. Consequently, an increase in the price of the addictive good today will reduce consumption of that good in all future periods as well as consumption in the current period. Second, permanent changes in the price of an addictive good will have a larger impact on consumption than temporary changes in price. Third, strong adjacent complementarity, which would reflect a strong addiction, can lead to unstable steady states, manifested through binge behavior and "cold turkey" quit behavior. These unstable steady states imply that we may observe a bimodal distribution of consumption among addicts. Fourth, price responsiveness will vary with time preference. Addicts with very high discount rates on future events will be relatively more responsive to changes in price than addicts with low discount rates because the effect of a change in current consumption on future consumption will have less of an effect. In contrast, addicts with greater preferences for the future will be relatively less responsive to changes in monetary prices, but will be more responsive to changes in the perceived health and other future consequences of their addiction.

Whether the addiction is modeled assuming myopic or more farsighted behavior, empirical tests of these models using both aggregate data and individual level data conclude that addicted individuals are responsive to changes in price. Aggregate data differ from individual level data in that the unit of analysis is a state or nation instead of an individual, so these studies focus on general prevalence rates

within a specified geometric boundary. The finding from these studies that consumption is responsive to changes in price is consistent with those from more traditional econometric analyses of the demands for tobacco, alcohol, and other drugs. Furthermore, studies consistently find that consumption by addicts is also responsive to non-monetary changes in price, such as restrictions on use and new information on the health consequences of consumption. The following reviews the expanding literature analyzing addiction and substance abuse in the economics literature.

### **III. Are Addicts Responsive to Price? A Review of the Economics Literature**

#### *A. Tobacco*

Most of the earliest econometric analyses of cigarette demand that incorporated addiction assumed that individuals behaved myopically, implying that they ignored the future consequences of their current consumption decisions (Farrell, 1952; Houthakker and Taylor, 1966 and 1970; Young, 1983; Baltagi and Levin, 1986; Pekurinen, 1989). The majority of these early models employed country or state-level aggregate data on tobacco sales and found that price has a negative and significant effect on current consumption even after controlling for past levels of consumption. For example, Baltagi and Levin (1986) estimated cigarette demand using a time-series of annual state cross-sections from the U.S. for the period 1964-1980. In their model, changes in cigarette consumption over time depended on the divergence between "desired" cigarette consumption and actual consumption, where desired consumption depended on prices, income, current and lagged advertising and other factors. They found that lagged consumption has a positive and significant effect on current cigarette smoking, which they interpreted as evidence of addiction. Their estimate of the own-price elasticity of cigarette demand, which measures the percent change in demand associated with a one-percent rise in price, was -0.22. This implies that a 10% increase in the price of cigarettes would lead to a 2.2% reduction in the demand for cigarettes, holding other factors in the model constant. Similarly Jones (1989) estimated both a traditional model of cigarette demand and one incorporating habit formation using quarterly data from the U.K. Although he found that the traditional model, which ignored the effects of prior consumption, had a better statistical fit than the

habit model, he still concluded that addiction was an important factor in cigarette smoking. The own-price elasticity obtained from the model incorporating habit formation, -0.60, was approximately double that from the traditional model, -0.29.

Mullahy (1985) was the first to estimate an addictive model of cigarette demand treating smokers as myopic employing individual level data. Using data from the 1979 National Health Interview Survey (NHIS), Mullahy estimated a two-part model of U.S. cigarette demand that included a measure of an individual's past cigarette consumption. He used an instrumental variables approach to account for unobserved individual heterogeneity that was likely to be correlated with past smoking experience. The instrumental variable approach employs a proxy, in this case the past price of cigarettes, that is highly correlated with the variable of interest (past cigarette consumption) but is independent of the unobserved factor that is represented in the error term. Mullahy found strong support for the hypothesis that cigarette smoking is an addictive behavior in the two equations he estimated for smoking prevalence and average daily cigarette consumption among smokers. The estimates he obtained for price were surprisingly consistent with those obtained from traditional models of individual cigarette demand. The general consensus estimate of the price elasticity of U.S. demand for cigarettes among the general population lies in the range of  $-0.3$  to  $-0.5$  (for more detailed discussions of the economics literature that ignores the addictive aspects of consumption, see: National Cancer Institute, 1993; USDHHS, 1989, 1992; Chaloupka and Warner, forthcoming). The overall price elasticity of demand obtained by Mullahy was centered on -0.47. In addition, he found that men were more price responsive than women (total price elasticities of -0.56 and -0.39, respectively). Finally, using an interaction between the addictive stock and price, Mullahy concluded that more-addicted smokers (defined as those with a larger addictive stock) were less responsive to price than their less-addicted counterparts.

As in the case of myopic models, empirical applications of the rational model of cigarette addiction also began with models employing aggregate data. Pashardes (1986) conducted an empirical test of the rational model versus a myopic model using British data for nine groups of commodities, including tobacco products, for 1947 through 1980. In his model, consumption was determined by past consumption and

current preferences with full knowledge about the impact of current decisions on the future costs of consumption. Pashardes found considerable evidence supporting rational behavior across all the commodity groups, as well as evidence that cigarette smoking is an addictive behavior. Finally, he noted that expectations concerning the future price and other costs of consumption played an important role in consumer behavior.

Becker et al. (1994) similarly conducted tests of the assumption of rationality by estimating myopic and rational smoking demand equations using U.S. annual state cross-sections for the period 1955-1985. They also found clear evidence that cigarette smoking is addictive as well as evidence of non-myopic behavior. However, their relatively high estimates of the discount factor imply less than fully rational behavior. The authors concluded upon further investigation that there was insufficient information in the data to accurately estimate the discount rate, but that their estimates clearly rejected myopic behavior. Estimates of the short-run price elasticity of demand from their models ranged from -0.36 to -0.44, which again are consistent with estimates from traditional demand models. However, they also found that, due to the addictive nature of smoking, the demand for cigarettes was nearly twice as responsive in the long-run (long-run elasticity estimates ranging from -0.73 to -0.79).

Several other applications of the Becker and Murphy rational addiction model applied to aggregate time-series data reject the assumption of myopic addiction (Bardsley and Olekalns, 1998; Sung et al, 1994; Keeler et al., 1993; Pekurinen, 1991). Relatively fewer studies examine rational addiction in individual demand equations. Chaloupka (1988, 1990, 1991, 1992) was the first to use individual level data to estimate cigarette demand equations derived from the Becker-Murphy model. He used retrospective data on cigarette consumption from the Second U.S. National Health and Nutrition Examination Survey to construct measures of past, current, and future cigarette consumption, enabling him to empirically test the assumption of rationality within this cross-sectional survey. In all of the models estimated, Chaloupka found that past consumption had a positive impact on current consumption, indicating addictive behavior, and that future consumption also had a positive and significant effect on current consumption, consistent with the hypothesis of rational addiction. Furthermore, Chaloupka

found that the implied rates of time preference from these models were relatively low and consistent with non-myopic or rational behavior. Estimates of the long-run price elasticity of demand were significantly larger than the short-run estimates, as well as elasticities obtained from traditional demand equations using the same data.

In addition to estimating the rational addiction demand equations for the full sample, Chaloupka also explored the implications of the Becker-Murphy model with respect to rates of time preference. It is widely believed that younger individuals and those less educated are more likely to behave myopically, while older and more educated individuals tend to a greater weight on future events. Chaloupka (1991) tested this hypothesis by estimating comparable rational addiction demand models by age and educational attainment and found significant support of it. Estimates from samples of younger individuals and those with less education showed that future consumption had little significant effect on the current demand for cigarettes while past consumption had a strong, positive and statistically significant effect, consistent with addictive but myopic behavior. For the older and more educated samples, both future and past consumption had a strong, positive effect, consistent with more farsighted addictive behavior. Further, he found that the less educated were even more price responsive, with long-run price elasticities ranging from  $-0.57$  to  $-0.62$ , than more educated persons who were generally unresponsive to price. Finally, Chaloupka (1990) estimated separate demand equations by gender and found that men behaved more myopically and were relatively more responsive to price (long-run price elasticity centered on  $-0.60$ ) than women.

### *B. Alcohol*

Unlike the case of cigarettes where several demand analyses have tested various models of addiction, much of the focus of economic research on alcohol centers on the effect of price and other policies on alcohol abuse and heavy drinking. The reason is likely attributed to the relatively larger costs heavy drinkers impose on society. Economists have known for some time that the responsiveness of drinking behavior to changes in the full price of alcohol varies by consumption level (Kenkel, 1996; Manning et al, 1995; Mullahy and Sindelar, 1994; Cook and Moore, 1993a; Grossman et al., 1994, 1987). There is considerable debate, however, regarding which set of drinkers are the most responsive. Some

studies show that heavy drinking is sensitive to changes in price where other studies show that it is unresponsive. Manning et al. (1995), for example, found using data from the 1983 National Health Interview Study (NHIS) that moderate drinkers are the most responsive to changes in the price of alcohol, with an estimated price elasticity of  $-1.19$ , while both lighter and heavier drinkers have price elasticities that are close to zero. Kenkel (1996) found somewhat different results using the 1985 wave of the survey. He calculated separate elasticity estimates for heavy drinking by gender and found that both men and women are responsive to changes in price, although women are much more so. He estimated the price elasticities of heavy drinking for men and women to be  $-0.52$  and  $-1.29$ , respectively.

Studies examining heavy drinking by youths and young adults are generally more consistent and show that heavy drinking is responsive to price. Grossman, Chaloupka, Saffer and Laixuthai (1994) reviewed the literature on the effects of increased prices and minimum legal purchase ages for alcoholic beverages on youth drinking based on a number of nationally representative data sets. Their review indicated that youth drinking, including heavy drinking, is significantly related to alcoholic beverage prices, taxes, and minimum legal drinking ages.

The mixed results with respect to the sensitivity of heavy drinking in different populations is somewhat surprising in light of the consistent finding that the harmful consequences associated with heavy drinking, such as liver cirrhosis, drunk driving, accidents, and crime, are sensitive to changes in the full price of alcohol. Several studies have found that increases in the full price of alcohol has a negative effect on liver cirrhosis mortality and other health consequences related to alcohol (Chaloupka, Grossman, Becker and Murphy, 1992; Saffer, 1991; Cook and Tauchen, 1982; Cook, 1981). Cook (1981) and Cook and Tauchen (1982) were the first to find the surprising result that increases in the price of hard liquor have an immediate negative and statistically significant effect on U.S. cirrhosis mortality rates. Cook and Tauchen (1982) estimated that a \$1 increase in the state excise tax on distilled spirits would have reduced the U.S. age-adjusted cirrhosis mortality rate by 5.4 to 10.8 percent during the period covered by their data. Saffer (1991) used a similar methodology on a time series of cirrhosis mortality

rates from different countries and found that the price elasticity of cirrhosis mortality is three times larger than the price elasticity of per capita ethanol consumption.

There are likewise numerous studies documenting the negative and statistically significant effect of the full price of alcohol on motor vehicle accidents and fatalities (Chaloupka and Laixuthai, 1997; Ruhm, 1996; Mullahy and Sindelar, 1994; Kenkel, 1993; Chaloupka, Saffer and Grossman, 1993; Saffer and Grossman, 1987a, 1987b). Saffer and Grossman (1987a), for example, examine youth motor vehicle accidents in the United States from 1975 through 1981. Their model predicts that a policy indexing the beer tax to the rate of inflation since 1951 would have reduced 18 to 20 year old motor vehicle accident fatalities by 15 percent, while a uniform legal drinking age of 21 years would have lowered fatalities by 8 percent. Using more current data from the U.S., Chaloupka, Saffer, and Grossman (1993) re-examined the effect of these policies on motor vehicle fatalities including additional measures of state-level drinking and driving policies. The drunk driving policies they examined reflect factors that influence the expected legal costs of drinking and driving by raising the probabilities of arrest and conviction for DUI, as well as the penalties imposed upon conviction. They concluded that increases in many aspects of the full price of alcohol, including increased beer taxes, higher legal drinking ages, and swift, certain, and severe penalties for drinking and driving would lead to significant reductions in motor vehicle accident fatalities among youths and adults.

Sloan, Reilly, and Schenzler (1994) found that other deaths related to alcohol use and abuse, including deaths where alcohol is the primary or contributing cause, suicides, drownings, and other accidents, decline as the monetary price of alcohol increases and/or the availability of alcohol declines. Similarly, Ohsfeldt and Morrisey (1997) found that the probability of a non-fatal workplace accident is inversely related to the price of alcoholic beverages.

Finally, several recent economic studies have shown that a statistically significant relationship exists between alcohol control policies and violence and other crime (Markowitz and Grossman, 1997; Sloan, Reilly, and Schenzler, 1994; Cook and Moore, 1993b; Chaloupka and Saffer, 1992). Cook and Moore (1993b), for example, examined state level data on violent crime rates for the period from 1979

through 1987 from the U.S. Uniform Crime Reports. They concluded that higher beer taxes would lead to significant reductions in rapes and robberies, but would have little impact on homicides and assaults. Using data from the same source for the period 1975 through 1990, Chaloupka and Saffer (1992) concluded that increases in the tax on beer and/or reduced availability of alcohol would lead to reductions in all measures of crime, including homicides, rapes, assaults, and various income producing crimes. Sloan, Reilly and Schenzler's (1994) analysis confirms that higher alcoholic beverage prices would reduce homicides.

Although fewer economic studies incorporate the addictive nature of alcohol consumption, those that have been done find, as in the case of cigarettes, that addicted individuals are sensitive to changes in the full price of alcohol. Andrikopoulos, Brox and Carvalho (1997) estimated myopic models of demand for different alcoholic beverages using aggregated data from Ontario, Canada, for the years 1958 to 1987. They found that past consumption levels of alcoholic beverages are important determinants of current consumption, thus supporting the theory of habit formation. Price elasticities varied significantly across alcoholic beverages, from  $-0.339$  for imported spirits to  $-1.023$  for imported beer. Only four of these estimated price elasticities were statistically different from zero.

Chaloupka, Grossman, Becker, and Murphy (1992) applied the rational addiction model to aggregate state level alcohol sales and cirrhosis mortality data from the U.S. for 1961 through 1984. Although their model of total alcohol consumption did not provide evidence of rational addiction, they did find empirical support in the heavy drinking equations, as reflected by the state's cirrhosis mortality rate. They estimate that a ten-percent increase in the price of alcoholic beverages would reduce cirrhosis mortality by 8.3 to 12.8 percent in the long run.

Studies examining the effects of habit formation and addiction using individual-level consumption data generally support the findings from the aggregate studies. Moore and Cook (1995) estimated both a myopic and rational model of addiction on a sample of young adults constructed from the U.S. National Longitudinal Survey of Youth (NLSY). Their empirical methods allowed them to explicitly control for unobserved individual and environmental characteristics that might also explain the persistence in

consumption. They found that most of the observed persistence in consumption is due to habit formation in both models, providing evidence of addiction. After controlling for the addictive nature of alcohol use, changes in the price of alcohol and restrictions on availability of alcohol were statistically significant predictors of consumption. Further, they found that the long run response of consumption to changes in price were significantly larger than that of the short-run elasticity of demand.

Grossman, Chaloupka and Sirtalan (1998) applied the Becker-Murphy model of rational addiction to the consumption of alcohol by young adults using panel data on over 7000 individuals from the Monitoring the Future Surveys of U.S. high school students. They found significant evidence that drinking in this age group is addictive in the sense that there is strong interdependency of past, current and future alcohol consumption. Controlling for the impact of addiction, they found that increases in the full price of alcohol, due to an increase in the monetary price or higher minimum legal purchasing ages, reduced drinking among young adults. They estimated an average long run price elasticity of demand of -0.65, which is over twice as large as the estimate they got when addiction is ignored (-0.29). Further, they found that the long run price elasticity of demand is approximately 60 percent larger than their estimate of the short-run elasticity.

### *C. Other Illicit Drugs*

There are significantly fewer empirical studies of the demand for illicit drugs by economists, and most of the work that has been done focuses on identifying the impact of policy on the prevalence of illicit drug use, not necessarily addictive consumption. Data limitations are the primary reasons for this. For example, aggregate data on illicit drug use comparable to the sales data available for cigarettes and alcohol are not available, and the few national population surveys that include questions pertaining to illicit drug use generally do not have detailed information regarding the abuse of these substances or use by the same individuals over time. Furthermore, reliable price data for most illicit drugs is not readily available. As a result, early studies tried to make inferences about the sensitivity of demand for illicit substances from small, local samples of users or aggregated, annualized crime and hospital data. These

studies generally employed imperfect proxies for price making it difficult to draw conclusions regarding the price responsiveness of illicit drug use.

More recent research, however, has taken advantage of the more appropriate data that has become available on illicit drug use, drug prices, and control policies. Still, the majority of these studies only examine the effect of policies on the general demand for particular substances. For example, numerous studies have examined the impact of state decriminalization status on the demand for marijuana in the United States (Chaloupka, Grossman and Tauras, 1998; Pacula, 1998a; Saffer and Chaloupka, 1997; Thies and Register, 1993; Model, 1993). States that have decriminalized marijuana have lower penalties for the possession of small amounts of the drug (typically less than one ounce), thus lowering the expected legal costs associated with using marijuana. Saffer and Chaloupka (1997) estimated that decriminalization increases the probability of using marijuana in the past month among the general population by 8.4 percent and in the past year by about 7.6 percent. These estimates are obtained from estimating prevalence equations using the 1988, 1990, and 1991 waves of the National Household Survey on Drug Abuse (NHSDA). Similarly, Model (1993) found that decriminalization significantly increased the number of marijuana-related emergency room visits.

Studies that focused on youth and young adult populations, however, have generally found that decriminalization status has no consistent impact on demand (Chaloupka, Grossman and Tauras, 1998; Pacula, 1998a; Thies and Register, 1993; and DiNardo and Lemieux, 1992). Although DiNardo and Lemieux (1992) and Chaloupka, Grossman and Tauras (1998) found some evidence in their analyses of the Monitoring the Future (MTF) data that youths living in a decriminalized state have significantly higher probabilities of using marijuana holding other factors constant, Thies and Register (1993) and Pacula (1998a, 1998b) found in their analyses of the National Longitudinal Survey of Youth (NLSY) that decriminalization had no statistically significant effect on the consumption of marijuana. These differences may be attributed to cohort effects since the NLSY data consists of individuals between the ages of 19-26 in 1984 while the MTF data is restricted only to high school seniors that were being examined throughout the 1980s and early 1990s. Further investigation is clearly needed to fully

understand the impact of this policy. The inconsistency in findings should not, however, be interpreted as evidence that youths are insensitive to changes in the price of marijuana.

Studies that employ other proxies for the full price of marijuana find that marijuana smoking by youths is indeed sensitive to price. Nisbet and Vakil (1972) used data from interviews with UCLA students to examine the demand for marijuana and estimated a price elasticity of marijuana at  $-0.40$  to  $-1.51$ . Similarly, Pacula (1998a) used data from the 1984 National Longitudinal Survey of Youth and found that changes in the crime-per-officer ratio, her proxy for the price of marijuana, did significantly influence current marijuana use among young adults.

Similar studies estimating the demand for cocaine and heroin find that current consumption of these drugs are generally sensitive to price. Using price data from the Drug Enforcement Agency's System to Retrieve Information from Drug Evidence (STRIDE) data set, Chaloupka, Grossman, and Tauras (1998) estimate an overall price elasticity of youth cocaine demand of  $-1.28$  for use in the past year and  $-1.43$  for use in the past month. Data for this model came from the 1982 and 1989 waves of the Monitoring the Future surveys of U.S. high school seniors. It is interesting to note, however, that when DiNardo (1993) estimated a similar model employing the aggregated state-level version of the data, he found that price had no significant effect on youth demand during the years 1977-1987.

Saffer and Chaloupka (1997) employed individual-level data on the general population from the 1988, 1990 and 1991 waves of the National Household Survey of Drug Abuse to estimate demand equations for cocaine and heroin. They estimated an average elasticity for the prevalence of cocaine use in the past month of  $-0.28$  and a comparable elasticity for use in the past year of  $-0.44$ . Prevalence elasticities differ from overall price elasticities in that they only examine the decision to use the drug, not the change in quantity consumed. Saffer and Chaloupka's estimates for the prevalence elasticities for heroin use in the past month ranged from  $-0.82$  to  $-1.03$ , while their estimates of the prevalence elasticities for use in the past year ranged from  $-0.60$  to  $-1.02$ . These estimates are consistent with findings from Bretteville-Jensen and Sutton (1996), who estimated the price responsiveness of 500 Norwegian heroin users using self-reported price and consumption data. They reported a price elasticity of heroin demand

of -1.23. Findings from these two more recent studies contradict two earlier studies that suggested that the demand for heroin is relatively inelastic (Silverman and Spruill, 1977; Brown and Silverman, 1974). These two earlier studies, however, employed data from a single city in the United State during a much earlier period (1970-1973).

Only three published studies to date have examined the demand for illicit drugs in the context of the economics models of addiction. van Ours (1995) used aggregated historical data to examine the demand for opium in Indonesia from 1923 through 1938. Estimates from his model show evidence of addiction. Further, these estimates suggested that the long run price elasticity of demand, estimated to be  $-1.00$ , is approximately 40% larger than the short-run price elasticity in the case of opium. In her examination of polysubstance use in a myopic addiction model, Pacula (1998b) included proxies for past consumption of alcohol and marijuana in her analysis of the current demand for these substance using data from the 1983-1984 National Longitudinal Survey of Youth. She found clear evidence of addiction for marijuana use in that prior marijuana use had a positive and statistically significant effect on the current demand for marijuana. She also found that price was still a significant predictor of the current demand for marijuana.

Grossman and Chaloupka (1998) used individual-level longitudinal data formed from the 1976 through 1985 Monitoring the Future Surveys of high school seniors to estimate the demand for cocaine by young adults using the Becker-Murphy model. Their findings were consistent with the hypothesis of rational addictive behavior. They estimated a short-run price elasticity of demand for cocaine of  $-0.96$  and a long run price elasticity of  $-1.35$  for young adults, indicating that the demand for this very addictive substance is quite sensitive to changes in price.

Two recent studies have examined the intertemporal relationship between the demands for different substances, both assuming myopic behavior. Pacula (1998b) examined the impact of prior alcohol and cigarette consumption on the current demand for marijuana using data from the 1984 National Longitudinal Survey of Youth. She found that prior use of cigarettes did have a positive and statistically significant effect on the current demand for marijuana although prior use of alcohol had no

significant effect. Further, she found significant own and cross-price effects after controlling for the potentially addictive nature of these two substances. DeSimone (1998) used later years of the same data to examine the effect of past marijuana use on the current demand for cocaine. He used detailed information about the individual and local price information as instruments in a two-stage estimation process, which enabled him to account for unobserved individual characteristics through an instrumental variables approach. His estimates suggest that preventing past marijuana use in 1984 decreased the likelihood of cocaine initiation four years later by twenty-nine percent.

#### **IV. Discussion and Policy Implications**

There are several shortcomings inherent in economic analyses of addictive behavior that lead many to question the value of the findings from this literature. The most obvious pitfall is the fact that economists generally work with large pre-existing data sets that often consist of aggregated data or insufficient data on individual behavior. This makes it impossible for economists to control for all relevant aspects of the individual's environment. Ongoing work has taken advantage of a number of new micro-level data sources that do collect more detailed information on the individuals, their family, their neighborhoods and their schools. Some economists are even engaged in their own data collection efforts. The findings from these ongoing studies will be very helpful in refining the economist's understanding of the impact of these environmental influences on substance use and abuse. In addition, econometric techniques have become increasingly more sophisticated so as to enable economists to control for factors that are not observed in the data they employ but likely to influence behavior. For example, fixed and random effects models enable economists to examine the impact of price while accounting for such unobservables as a biological disposition for addiction or a risk-loving nature.

Even with their shortcomings, economic analyses of addictive behavior have provided a number of important insights that have significant policy implications. First, these studies show that there is a clear inverse relationship between price and addictive consumption. Therefore, macro-level policies that either raise the price or reduce the availability of these substances will be effective in reducing cigarette

smoking and other tobacco use, drinking, and illicit drug use. Moreover, recent models that re-evaluate the sensitivity of demand taking into consideration the addictive nature of these substances reveal that demand may be even more sensitive to changes in price and other macro-level policies than previously believed.

Second, economic studies have shown that the impact of price on consumption will be greater in the long run than in the short run because of the interdependence of consumption over time that characterizes addictions. Sustained changes in price or other macro-level policies targeting availability, therefore, will have an increasing impact on consumption over time. The key implication of this is a sustained change in policy will produce greater effects as time passes. A one-time increase in the tax on beer or cigarettes, for example, will not have as large an impact on consumption in the long run as one that is indexed for inflation. The reason for this is that the latter is sustained in real terms while the former deteriorates as the purchase power of the dollar declines over time.

Third, analyses by economists consistently find that the consumption of addictive substances by youths and young adults is more sensitive to changes in price than consumption by adults. Macro-level policies that increase the full price of addictive substances and, consequently, significantly reduce youth and young adult substance use may be the most effective means of achieving large long-run reductions in substance use throughout the population.

Finally, recent studies that examine polysubstance use and the relationship between demands for different drugs over time reveal that there are significant cross-price effects for addictive substances. The small but growing number of econometric studies of polysubstance use and abuse has generally found that different substances are economic complements, not substitutes. Given this, policies targeted at reducing the consumption of one substance can also significantly reduce the consumption of other substances, even among addicts. This is particularly important to keep in mind when considering harm reduction strategies, which generally involve reducing the legal penalties associated with use of particular substances. It is likely that these policies will not only increase the consumption of the substances being targeted, but also other substances generally used in conjunction with the targeted substance.

## V. References

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**Figure 1**

