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Introduction

Frank J. Chaloupka, Michael Grossman,
Warren K. Bickel, and Henry Saffer

A growing number of economists, including several in the National Bureau of Economic Research's Health Economics Program, directed by Michael Grossman, have focused on projects dealing with "anti-health behavior," to use the term coined by Frank Chaloupka (1995), since the late 1970s. This behavior includes the use and abuse of such substances as cigarettes, alcohol, cocaine, marijuana, and heroin. These substances have two common properties. First, they are addictive in the sense that increases in past consumption lead to increases in current consumption. Second, their consumption harms the consumer and others. The existence of external costs (harm to others) and ignored internal costs (harm to self) justifies government intervention and research on the effects and benefits of alternative policies to curtail use and abuse.

The United States government and the government of many other countries have chosen to regulate some addictive substances (e.g., cigarettes and alcohol) via taxation; minimum purchase-age laws; curbs on advertising; restrictions on consumption in schools, the workplace, and other public places; and stiff fines for driving under the influence of alcohol. They have chosen to outlaw other substances (e.g., cocaine, marijuana, and heroin). Taxation, other forms of regulations, and bans raise the prices of these substances. In addition, bans create black markets and encourage criminal activities that may harm innocent victims. The "full price" of an addictive good can be defined broadly to include not only the money price but also such additional elements as the monetary

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value of the travel and waiting time required to obtain the good and the monetary value of the expected penalties for possession of illegal drugs or conviction of drunken driving. The responsiveness of these substances to full price is an important parameter in determining the optimal level of taxation, the effects of other types of regulations, and the impacts of legalization.

Michael Grossman began the NBER's research on substance abuse in the late 1970s, initially focusing on the effects of cigarette taxes and prices on teenage smoking and the effects of alcoholic beverage taxes, prices, and legal drinking ages on overall alcohol consumption, excessive consumption, and drunken driving by teenagers and young adults (Lewit, Coate, and Grossman 1981; Grossman, Coate, and Arluck 1987; Saffer and Grossman 1987; Coate and Grossman 1988). The focus on youth and young adults is important because smoking and heavy drinking are addictive behaviors that generally begin early. Thus, policies designed to prevent their onset may be the most effective way to discourage them in all segments of the population. Grossman's hypothesis that price might be an important determinant of teenage smoking and alcohol abuse was initially treated with a great deal of skepticism by noneconomists and many economists who accepted the then conventional wisdom that the demand for addictive substances is unlikely to be responsive to price.

Research by Grossman and his colleagues at the NBER has helped to change the conventional wisdom concerning the effects of price on substance use and abuse and related outcomes. With support from the National Science Foundation, the National Institute on Alcohol Abuse and Alcoholism, the National Institute on Drug Abuse, the National Cancer Institute, the Centers for Disease Control, the Robert Wood Johnson Foundation, and others, NBER researchers have clearly demonstrated that increases in the full price of addictive substances lead to reductions in both the number of people using these substances and the quantity consumed by users, as well as in numerous outcomes related to use and abuse. Recent research, for example, includes Chaloupka and Grossman (1996) on youth smoking; Grossman, Chaloupka, and Sirtalan (1998) on young adult drinking; Chaloupka, Saffer, and Grossman (1993) on drinking and driving; Saffer (1991, 1997) on alcohol advertising and alcohol use and abuse; Saffer and Chaloupka (forthcoming) and Grossman and Chaloupka (1998) on illicit drug use; Joyce, Racine, and Mocan (1992) on maternal drug use and infant health; Corman and Mocan (1996) on drug-related crime; Mullahy and Sindelar (1993, 1996) on the relationship between alcohol use and earnings; and Kaestner (1991, 1994) on similar relationships between drug use and labor market outcomes.

A number of the conclusions contained in research conducted by the staff of the NBER Health Economics Program are supported by research in the relatively new and rapidly developing behavioral economics literature on substance abuse (for example, Bickel and DeGrandpre 1996a). The use of behavioral or experimental methods in economics has increased exponentially over the past 60 years. Economists have used these methods to test hypotheses stem-

ming from game theory, auctions, industrial organization, and expected utility theory. But the behavioral economic analysis of substance abuse, which began in the past decade, has been conducted by behavioral psychologists with no formal training in economics. In a laboratory setting, these researchers have shown that the consumption of licit and illicit substances by animal and human subjects falls when their relative prices are increased.

The application of behavioral economics to drug abuse was spearheaded by Warren Bickel and colleagues at the University of Vermont's Human Behavior Pharmacology Laboratory (Bickel et al. 1990, 1991) and was largely influenced by the work of Hursh (1980) in his application of consumer demand theory to food-maintained behavior in nonhumans. Early developers of behavioral economics of drug abuse have included Marilyn Carroll (University of Minnesota), Leonard Epstein (SUNY-Buffalo), Kenneth Perkins (University of Pittsburgh), Rudy Vuchinich (Auburn University), and Gail Winger (University of Michigan), among others. This work, although viewed as controversial at times, has been supported by research grants from the National Institute on Drug Abuse.

The initial effort of this application of behavioral economics was to combine it with the drug self-administration research paradigm. Drug self-administration is the laboratory paradigm that demonstrated that abused drugs share the common effect of serving as reinforcers in both animals and humans (Young and Herling 1986). Moreover, the results of this paradigm demonstrate a high concordance between drugs that are self-administered (function as reinforcers) by animals and those that are abused by humans (Schuster and Thompson 1969). When combined with the drug self-administration paradigm, behavioral economics permits drug use to be examined as consumer demand (Bickel and DeGrandpre 1996b; Hursh 1991). This combined approach recognizes that drugs enter an individual's personal economy through the allocation of resources to obtain and take drugs, and that the concepts of consumer demand may be an effective means by which to organize factors pertinent to drug dependence. Specifically, the price of drugs, income, and the availability of other meaningful goods, services, and activities may all strongly impact the distribution of a drug user's resources toward drug taking versus other nondrug activities. The success of behavioral economics in the laboratory setting has led to its application to the treatment of drug dependence (see Higgins, chap. 6 in this volume, and Silverman and Robles, chap. 10 in this volume) and to other health disorders (see Bickel and Vuchinich, forthcoming), as well.

The economists and behavioral psychologists studying these issues are applying the same basic principles of economics to studying the determinants and consequences of the use of addictive substances, but are doing so with very different data and methods. Perhaps the most fundamental principle of economics that underlies this research is the law of the downward-sloping demand curve that states that as the price of a good rises, the quantity of that good consumed will fall. However, for years, the conventional wisdom was that

the demands for addictive substances, including tobacco products, alcoholic beverages, and illicit drugs, were unresponsive to price. However, nearly two decades of econometric research and nearly a decade of behavioral economic research has clearly demonstrated that the demands for addictive substances are not exceptions to the basic laws of economics.

The econometric and behavioral economic approaches employed by these researchers each have their own strengths and weaknesses in addressing the impact of price and other influences on substance use, abuse, and related outcomes. In many cases, however, a shortcoming of one approach is a strength of the other. Table 1 compares and contrasts the behavioral economic and econometric approaches to substance use and abuse. One major difference, for example, between the econometric and behavioral economic analyses of the impact of price on demand relates to the measure of price employed. As described above, the research by economists on this issue uses a fairly broad definition of price that includes not only the monetary price but also the time costs associated with obtaining and using the substance, and the expected legal and health consequences associated with use. However, the economist's ability to study the impact of price on demand and related behaviors is limited by the existing, typically limited, variation in prices that exists in the real world. In contrast, the measure of price employed by the behavioral economist reflects the effort a user is required to expend in order to receive a dose of the substance being

Table 1 Comparing and Contrasting Econometric and Behavioral Economic Approaches to the Analysis of Substance Use and Abuse

	Econometric Analyses	Behavioral Economic Analyses
Data	Aggregate time-series data; aggregate cross-sectional data; pooled cross-sectional time-series data; individual-level, cross-sectional data from large surveys; longitudinal survey data	Individual-level data
Respondents	Current, former, future, never users	Current users
Sample sizes	Typically large	Generally small
Methods	Variety of econometric methods	Controlled laboratory experiments
Outcomes	Sales, expenditures, prevalence, conditional use, mortality and fatality rates, accidents, crime, violence, labor market outcomes, health consequences, and many more	Conditional use
Price	Taxes, monetary prices, time costs, expected legal costs, expected health consequences, other "costs" of substance use	Effort
Variation in price	Limited to observed variability	Unlimited, subject to researcher's manipulation

studied. For example, in the behavioral economic studies of cigarette smoking, price reflects the number of presses on a lever that a smoker must complete in order to receive a puff on a cigarette. Thus, the behavioral psychologist can manipulate price over a much wider range than is ever observed in the real world, providing information on the likely effects of very large changes in prices that fall well outside of the range of the data used by economists, and helping to resolve issues concerning the shape of the demand curve that cannot be addressed by economists. In contrast, however, behavioral psychologists are less able to address the impact of changes in other aspects of “full price” on the use and abuse of addictive substances, while economists can take advantage of the natural experiments that occur around changes in these factors.

Similarly, the behavioral psychologist has the advantage of being able to control all aspects of the experiment being conducted in order to isolate the impact of price on behavior. Relatively small samples can be carefully selected for the controlled laboratory experiments that then look at the impact of price and other economic influences on substance use. In contrast, economists generally rely on large survey and aggregate data collected by others for different purposes that often do not contain everything that would ideally be included. In addition, the econometric analyses employing these data must attempt to control for the variety of other factors that are also likely to affect behavior and that are varying in the real world from which these data are drawn but for which good measures are often not available. However, the economist has the advantage of being able to study a variety of substance use outcomes that the behavioral psychologist, for ethical and other reasons, cannot, including initiation of substance use, substance abuse related morbidity and mortality, violence and other crime, and more.

Economists studying the determinants and consequences of the use of addictive substances, including the NBER Health Economics Program staff, are generally unaware of the innovative research being conducted by behavioral psychologists that merges concepts from microeconomic theory with behavioral psychology research methods. Similarly, behavioral researchers are generally unfamiliar with the economic literature on substance use and abuse. This volume contains papers presented at a conference organized to address this deficiency. The conference and the volume were made possible with very generous support from the Robert Wood Johnson Foundation. The origin of the conference can be traced to March 1995 when Warren Bickel and Frank Chaloupka shared a taxi cab to Washington National Airport following a NIDA Initial Review Group meeting. During a conversation on their current research, they were surprised to learn that they shared many common interests and paradigms. Indeed, it appeared as though Bickel and his colleagues would have been much more receptive to Michael Grossman’s notions concerning downward-sloping demand functions for addictive goods than the economists who reviewed his initial proposals in the late 1970s.

The aim of the conference was to provide a forum for economists and behav-

ioral psychologists to exchange methodological and empirical approaches to the research on the determinants and consequences of substance use and abuse. Six topics are treated in the volume: four pertaining to determinants and two pertaining to factors related to use and abuse. The papers on determinants focus on cigarettes, alcohol, cocaine and marijuana, and polydrug use. The papers on consequences focus on employment and income. Each of the six topics contains a paper authored by one or more economists and a paper authored by one or more behavioral psychologists. Each of the six sessions at the conference had two discussants, usually one economist and one behavioral psychologist, although other disciplines were also represented. They were asked to comment on both papers at the session rather than only on the one from their discipline. Their published comments reflect attempts to point out similarities and differences taken by the two disciplines in approaches to substance use and abuse and efforts to integrate these approaches.

Part I of this volume contains papers and comments on the demand for tobacco products. Robert L. Ohsfeldt, Raymond G. Boyle, and Eli I. Capilouto present an econometric analysis of the effects of prices and tobacco control policies on the probability of cigarette smoking and other tobacco use among adults. Their estimates confirm the findings of previous research showing that higher cigarette taxes and restrictions on smoking in workplaces and various public places reduce the likelihood of smoking. Similarly, they conclude that the probability of snuff use is inversely related to taxes on smokeless tobacco products. In addition, they provide the first econometric estimates on the substitutability of various tobacco products, concluding that higher cigarette tax rates increase the likelihood of snuff use, while higher snuff tax rates do not affect the probability of cigarette smoking.

Warren K. Bickel and Gregory J. Madden confirm the inverse relationship between price and cigarette smoking in their discussion of behavioral economic analyses of smoking. In particular, they address three questions relevant to the economic analysis of cigarette smoking: (i) Are economic principles applicable to the smoking behavior of individuals? (ii) Are the estimates from behavioral economic studies consistent with those from the econometric literature? and (iii) Can this research inform public policy on cigarette smoking? In response to the first question, they present strong and consistent evidence from their behavioral research demonstrating that cigarette smoking is inversely related to the price of cigarettes. Perhaps most interesting is their conclusion that consumption positively decelerates as a function of price as price increases, implying that cigarette demand becomes more price sensitive as price rises. Their answer to the second question is not as clear. Bickel and Madden's estimates for the price elasticity of demand at relatively low prices are consistent with those from a variety of econometric studies. However, less consistency is observed between their findings for various subpopulations and the comparable econometric studies (which are not that consistent themselves). Finally, given their first two answers, they respond with a qualified yes to the third

question. While Bickel and Madden are cautious regarding the policy implications of their findings in the behavioral laboratory, readers are likely to clearly see the policy relevance of their research.

Part 2 of this volume provides a somewhat different perspective on alcohol use and abuse. In the first paper, economists Jeffrey K. Sarbaum and Solomon W. Polachek and psychologist Norman E. Spear present the findings from their experimental analysis of alcohol consumption in rats. They conduct two experiments designed to compare the price sensitivity of demand for addictive and nonaddictive commodities. Their experiments confirm the idea that alcohol consumption is a habit-forming or addictive behavior. Moreover, they find that changes in price have significant effects on alcohol consumption and that the magnitude of these effects depends on past consumption. Their experiments with rats, however, fail to produce evidence of rational behavior in the sense that current alcohol consumption by rats does not respond to anticipated changes in future alcohol prices.

Rudy E. Vuchinich and Cathy A. Simpson also consider the rationality of alcohol consumption in a review of their experimental studies on the relationship between temporal discounting and drinking. One interesting finding from these experiments is that heavy social and problem drinkers have higher discount rates than light social or light drinkers, with the most pronounced differences between problem and light drinkers. As they note, these findings are consistent with dynamic models of addiction, including the Becker and Murphy (1988) model, that predict a positive relationship between discount rates and addiction. Vuchinich and Simpson go on to note that their experiments cannot determine the direction of causality in this relationship—that is, whether more present-oriented individuals are more likely to be heavy or problem drinkers or whether the level of drinking is a determinant of an individual's discount rate. A second finding from their experiments relevant to behavioral and economic research on alcohol use and abuse is that hyperbolic discount functions, rather than the exponential functions typically used by economists, better describe the nature of time discounting.

Part 3 of this volume contains econometric and behavioral analyses of the demand for illicit drugs, focusing on the demands for cocaine and marijuana. Frank J. Chaloupka, Michael Grossman, and John A. Tauras describe their econometric analysis of youthful demand for cocaine and marijuana. Their paper is the first to examine the impact of prices and illicit drug control policies using nationally representative data on youth drug use. Their findings confirm those from the literature on the youthful demand for licit addictive substances (i.e., cigarettes and alcohol). In particular, they find that probability of youth cocaine use and the frequency of use by young cocaine users are inversely related to price. Moreover, they conclude that youth drug use is more sensitive to price than is adult drug use, based on a comparison of their estimates to those obtained by Saffer and Chaloupka (forthcoming) for adults. Similarly, they find a negative effect of stronger monetary penalties for cocaine and mari-

juana possession on youth cocaine and marijuana use, but conclude that very large increases in these penalties would be necessary to achieve meaningful reductions in use.

Stephen T. Higgins discusses the implications of behavioral economic research for strategies aimed at reducing cocaine use. As he describes, the findings from a number of behavioral experiments using both animals and humans confirm those from the relatively recent econometric studies using large data sets concluding that higher prices reduce cocaine use. Higgins goes on to describe the implications of this for the clinical treatment of cocaine and other drug use and abuse. As he notes, the finding that price affects cocaine demand provides an explanation for the apparent efficacy of contingency-management approaches used in treating individuals dependent on cocaine, two of which are described in detail. In these plans, continued abstinence from cocaine leads to greater and greater rewards, thus increasing the price for cocaine use. Based on the demand and treatment studies, Higgins discusses other approaches to reducing cocaine use based on the importance of economic factors as determinants of demand.

Part 4 of this volume considers the relationships between the demands for the various substances discussed in the first three parts. Henry Saffer and Frank J. Chaloupka examine the effects of alcohol, marijuana, cocaine, and heroin prices on the demands for these substances both in the overall population as well as in various subpopulations based on race, age, and/or gender. They find consistent evidence of negative own-price effects for the various substances, consistent with the earlier studies, and find little evidence of differences in price sensitivity among the various subpopulations. Moreover, they find few differences in the demands for alcohol and marijuana across groups, but they do find distinct differences in cocaine and heroin demand. Most interestingly, they generally observe complementary relationships between alcohol, marijuana, cocaine, and heroin, with increases in the price of one substance leading to reductions in not only the use of that substance but also in the use of other licit and illicit substances.

The behavioral economic research described by Nancy M. Petry and Warren K. Bickel provides support for some of Saffer and Chaloupka's findings, while contradicting others. Petry and Bickel conduct several experiments using heroin abusers in which the effects of changes in relative prices and income on the use of heroin, valium, marijuana, cocaine, and alcohol are examined. As in the prior studies, they conclude that increases in the own-price of a substance—heroin in their experiments—lead to reductions in the use of that substance. In addition, they find a generally positive relationship between income and the demands for heroin and cocaine but conclude that income has little impact on alcohol, marijuana, and valium use. In contrast to Saffer and Chaloupka's research, however, their experiments imply that valium, marijuana, and cocaine are weak substitutes for heroin. This inconsistency, however, is consistent with the mixed findings from econometric studies of polysubstance

use and points to the need for additional econometric, behavioral, and other research to clarify the relationships between tobacco, alcohol, and illicit drug use.

The emphasis shifts in the last two parts of this volume to the relationships between employment and income and substance use and abuse. In the fifth part, economists Donald S. Kenkel and Ping Wang and behavioral psychologists Kenneth Silverman and Elias Robles approach the relationship between employment and substance use from opposing perspectives. Kenkel and Wang consider the impact of the drinking choices made by young adults on their future jobs and lifetime earnings. Their analysis extends the economic research on the productivity effects of alcohol use and abuse to consider the nonwage job attributes that had not been included in prior studies. Several interesting findings emerge from their analysis. Kenkel and Wang find that male alcoholics are more likely to be in blue-collar than white-collar jobs. Among blue-collar workers, alcoholics receive fewer fringe benefits, are more likely to be injured on the job, and are more likely to work in smaller firms. Overall, they estimate a total loss in compensation for alcoholics of \$2,380 per year, with nearly 20 percent resulting from the loss of nonwage benefits. In contrast, they find little difference between total compensation of white-collar alcoholics and nonalcoholics.

In contrast, Silverman and Robles consider the potential for using employment to enhance the success of drug treatment programs. They propose three economic mechanisms through which employment can affect drug use: (i) by reducing the time available for drug use; (ii) by raising the income available for purchasing drugs; and (iii) by raising the opportunity costs of drug use, particularly in jobs where drug use reduces wages and/or can lead to termination. Their review of the behavioral economics research suggests that the efficacy of employment as a drug abuse treatment intervention depends in large part on the employment-related opportunity costs of drug use, consistent with Higgins's discussion of the use of contingency-management approaches to treating cocaine dependency. Silverman and Robles conclude that employment-based interventions, if appropriately designed, can be among the most effective drug abuse treatments currently being used.

The papers in part 6 consider the relationships between drug use and income. Marilyn E. Carroll reviews a number of experimental laboratory studies looking at the effects of income, price, and the availability of nondrug alternatives on drug use. Many of the recent econometric studies of substance use (including the studies in this volume by Ohsfeldt, Boyle, and Capilouto on tobacco use, and by Saffer and Chaloupka on illicit drug use), find a strong inverse relationship between income and drug use. To some extent, this is confirmed by Carroll's finding that preferences between drugs and nondrugs change as income increases, with increases in income having a greater impact on nondrug consumption than on drug consumption. In addition, Carroll's review confirms the conclusions of the earlier studies that found an inverse rela-

tionship between price and drug use. Finally, she concludes that greater availability of nondrug alternatives would also be effective in reducing drug use.

Robert Kaestner considers the converse of this relationship. That is, he attempts to answer the question, Does drug use cause poverty? Using data from large, nationally representative surveys, Kaestner's econometric analyses support the hypothesis that increased cocaine and marijuana use significantly increase the probability of being poor. In particular, he finds that drug use is associated with both lower family incomes and greater participation in public assistance programs. Interestingly, this relationship holds up even when a variety of family background characteristics typically thought to influence drug use and poverty are controlled for in his econometric models. For women, Kaestner concludes that the primary mechanisms through which drug use causes poverty are through its effects on marriage and fertility. In contrast, the effects of drug use on marriage and fertility for men were relatively small; instead, he concludes that the key mediating factor is education.

To summarize, the conference provided a unique forum for economists, behavioral psychologists, and researchers from other disciplines to discuss their research applying economic principles to the analysis of substance use and abuse. Lively and stimulating discussions occurred in every session and participants came away with an increased awareness of and appreciation for the research taking place in other disciplines. Everything didn't go smoothly; there was occasional confusion related to differences in the language used by different disciplines—the use of *rational addiction* by economists, for example—as well as some disagreements over the methods and data used by the diverse group of researchers. Nevertheless, the conference has sown the seeds for future multidisciplinary collaborations that can extend the frontiers of research on substance use and abuse.

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I

Cigarette Smoking and Other Tobacco Use

