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A SURVEY OF ECONOMIC MODELS OF ADDICTIVE BEHAVIOR

Contents

In economic analyses of addictive behavior, the consumption of a certain good is termed to be an addiction if an increase in past consumption of the good leads to an increase in current consumption. From policy, legal, and public health perspectives, addictive goods are of interest because the consumption of many of these goods harms the consumer and others. The U.S. government and those of many other countries have chosen to regulate such addictive substances as cigarettes, alcohol, cocaine, and marijuana by means of policies that raise their prices. Consequently, the responsiveness of these substances to price is an important parameter in determining the optimal level of taxation or the impacts of legalization of cocaine or marijuana. The economics of addiction is very relevant to these issues because recent theoretical advances predict that addictive goods should be more sensitive to price than previously believed. Current empirical studies confirm this prediction.

Introduction

In economic analyses of addictive behavior, the consumption of a certain good is termed to be an addiction if an increase in past consumption of the good leads to an increase in current consumption. From policy, legal, and public health perspectives, addictive goods are of interest because the consumption of many of these goods harms the consumer and others. Clearly, this is not always the case. A person can be addicted to jogging, classical music, detective novels, attending church, and other activities that do not harm others and may yield future benefits to the individual in addition to increases in current utility. But the consumption of such substances as cigarettes, alcohol, cocaine, marijuana, and heroin can harm the consumer and others. For example, cigarette smoking has been labeled as the largest preventable cause of death by the last three annual U.S. Surgeon General's reports on smoking and health. Motor vehicle accident mortality is the leading cause of death of persons between the ages of 1 and 35, and alcohol is involved in almost 50% of these fatal accidents. The consumption of cocaine and other illicit substances results in deaths due to drug overdoses and the violence that accompanies the purchase and sale of illegal drugs. The existence of external costs (harm to others) and ignored internal costs (harm to self) suggests a possible justification for governmental intervention. This policy may not, however, be justified if it generates substantial external costs, or if the costs of eliminating the harms are greater than the costs arising from the harms.

The U.S. government and those of many other countries have chosen to regulate some addictive substances (for example, cigarettes and alcohol) via taxation; minimum purchase age laws; restrictions on consumption in schools, the workplace, and public places; and stiff fines for driving under the influence of alcohol. They have chosen to outlaw other substances (for example, cocaine, heroin, opium, and marijuana). Taxation, other forms of regulation, 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 addictive goods can be defined broadly to include such elements as the monetary 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 drunk driving. The responsiveness of these substances to full price is an important parameter in determining the optimal level of taxation and the impacts of legalization. The economics of addiction is very relevant to these issues because recent theoretical advances predict that addictive goods should be more sensitive to price than previously believed. Current empirical studies confirm this prediction.

Basic Concepts

An increase in past consumption of an addictive good raises current consumption because it increases the marginal utility of current consumption of that good (the increase in satisfaction or utility caused by an increase in consumption of the good). This is the reinforcement property of an addictive good stressed by psychologists. A harmful addiction, the focus of our discussion, is one in which past consumption has detrimental effects on current utility, such as reductions in health and, therefore, in utility caused by cigarette smoking, excessive alcohol use, and the use of cocaine. Harmful addictions exhibit the physiological property of tolerance in the sense that the utility from a given amount of current consumption is lower when past consumption is higher. Note that we follow most of the literature in using the terms addiction and habit as synonyms.

Consumers are myopic if they ignore the effects of current consumption on future utility when they determine the optimal or utility-maximizing quantity of an addictive good in the present. On the other hand, they are rational or farsighted if they take account of future effects of current consumption when they determine the optimal quantity of an addictive good in the present.

Interest in addictive behavior by economists dates to Alfred Marshall. Writing in 1920, he noted: "Whether a commodity conforms to the law of diminishing or increasing return, the increase in consumption arising from a fall in price is gradual; and, further, habits which have once grown up around the use of a commodity while its price is low are not quickly abandoned when its price rises again" (Marshall 1920:807). In this quote Marshall anticipates the differences between long-run and short-run price responses that play an important role in rational models of addiction. Most economists who have studied this behavior since Marshall have assumed myopia or imperfectly rational behavior. We classify two types of models under the general rubric of myopia. In one consumers ignore the effects of current consumption on future utility when they determine the optimal quantity of an addictive good in the present period. In this class of models, past consumption affects current consumption through an accumulated stock of past consumption (for example, Houthakker and Taylor 1970; Pollak 1970). In the second class of models, consumers have inconsistent short-run and long-run preferences (for example, Schelling 1978; Thaler and Shefrin 1981). At any one point in time the individual is both a "far-sighted planner and a myopic doer" (Thaler and Shefrin 1981:392), with the planner and the doer in conflict.

Empirical applications of myopic addiction focus on the first class of models and are based on the pioneering work by Houthakker and Taylor (1970). They argue that the stock of a commodity should have a positive impact on its current consumption in the presence of habit formation if the commodity is nondurable. If it is durable, a negative stock effect is possible due to inventory adjustment. Houthakker and Taylor fit demand functions for a variety of goods for the United States and several countries in Western Europe using annual time-series data. They find a considerable amount of evidence in support of habit formation.

More recent examples of myopic demand functions are contained in studies by Grabowski (1976), Johnson and Oksanen (1977), and Baltagi and Levin (1986). The first two studies report positive and significant impacts of past consumption of alcohol on current consumption of alcohol. The third study contains the same finding for cigarette consumption.

In sharp contrast to the myopic addiction studies, Becker and Murphy (1988) assume that consumers take account of future effects of current consumption when they determine the optimal amount of an addictive good in the current period. They use this notion to construct a model of rational addiction that among other things contains the first explicit derivation of long- and short-run demand functions for addictive goods in the case of far-sighted consumers. The conventional wisdom is that addictive goods are not sensitive to price possibly because small changes in the consumption of these goods cause large changes in the marginal benefit of consumption. Contrary to this conventional wisdom, Becker and Murphy stress that the demand for addictive goods may be responsive to price in the long run. They also stress that the quantity demanded of an addictive good is negatively related not only to the current price of the good but also to its past and future price. Economists define a set of goods to be complements if a reduction in the price of one good causes consumption of all of them to rise. In the Becker-Murphy model of rational addiction, the quantities of an addictive good consumed in different periods are complements.

Becker et al. (1994) show that the Becker-Murphy model generates a demand function for consumption of an addictive good in period t (C_t) of the form

$C_t = alpha C_{t-1} + beta alpha C_{t+1} + theta P_t$, (1)

Here, P_t is the price of C_t. Other determinants of current period consumption are suppressed. Because alpha and beta are positive and theta is negative, current consumption is positively related to past and future consumption (C_{t-1} and C_{t+1}, respectively) and negatively related to current price. In particular, alpha measures the effect of an increase in past consumption on the marginal benefit of current consumption. This parameter also measures the effect of an increase in future consumption on the marginal benefit of current consumption. The larger the value of alpha the greater is the degree of reinforcement or addiction. Equation (1) highlights the source of intertemporal complementarity in the rational addiction model. It arises because increases in past or future consumption (caused by reductions in past or future prices) cause current consumption to rise.

Equation (1) also implies that the short-run price elasticity, which holds past consumption constant, must be smaller than the long-run price elasticity, which allows past consumption to vary. (The price elasticity of demand is defined as the percentage change in consumption caused by a 1% change in price.) This property does not hold in general for a non-addictive good. Hence, comparisons between the price elasticities of the two types of goods may be misleading if they are not based on long-run price elasticities. Put differently, because past consumption reinforces current consumption, the price response grows over time in the case of an addictive good. For example, a price increase in 1998 would reduce consumption in 1998, which in turn would cause consumption in 1999 and in all future years to fall ceteris paribus. Indeed, the long-run price response is greater the higher the degree of addiction or reinforcement.

The parameter beta in equation (1) is the time discount factor and is equal to 1/(1 + r), where r is the rate of time preference for the present. Typically, economists and psychologists assume that this discount factor is smaller than one because people are impatient. They prefer to consume 100 units of a good today instead of consuming 100 units of the same good tomorrow. The smaller the time discount factor (the greater the rate of time preference for the present) the smaller is the effect of future consumption or future price on current consumption. In the case of perfectly myopic behavior, beta equals zero (r equals infinity), and future variables have no impact on current decisions.

Time preference for the present enters this and other models of optimal consumption over the life cycle because consumers are assumed to maximize a lifetime utility function defined as the discounted sum or present value of utility in each period or at each age, where beta is the discount factor. Although the discount factor is usually taken to be exogenous or given, Becker and Mulligan (1997) point out that consumers have incentives to make investments that lower the rate of time preference for the present. This is because the present value of utility is higher the smaller the rate of time preference for the present. Becker and Mulligan provide examples of such investments. They write (1997:735): "Purchases of particular goods, such as newspapers, can distract one's attention away from current pleasures and toward future ones. A person ... may spend additional time with his aging parents in order to better appreciate the need for providing for his own old age. People may also purchase disciplinary devices, such as a piggy bank or membership in a Christmas Club which help a person sacrifice current consumption."

There are important interactions between time preference and addiction. On the one hand, people who discount the future more heavily are more likely to become addicted (Becker and Murphy 1988). On the other hand: "Since a decline in future utility reduces the benefits from a lower discount on future utilities, greater consumption of harmful substances would lead to higher rates of time preference by discouraging investments in lowering these rates" (Becker and Mulligan 1997: 744). Thus, "... harmful addictions induce even rational persons to discount the future more heavily, which in turn may lead them to become more addicted" (Becker and Mulligan 1997:744).

Extensions of the above framework imply differential price responses by age, income, and education in the case of addictive goods (Becker et al. 1991). The total cost of addictive goods to consumers equals the sum of the good's price and the money value of the future adverse effects, such as the negative effects on earnings and health from smoking, heavy drinking, or heavy dependence on cocaine. Future costs tend to be less important to poorer, less educated, and younger consumers because they generally place a smaller monetary value on health and other harmful future effects than richer, more educated, and older consumers who have higher wage rates. Moreover, the poor, youths, and the less educated are likely to have lower time discount factors (higher rates of time preference for the present) than the rich, adults, and the more educated (Becker and Mulligan 1997). It follows that the poor, youths, and the less educated are more sensitive to changes in money prices of addictive goods, whereas the middle or upper income classes, adults, and the more educated respond more to changes in the perceived or actual harmful consequences that take place in the future. Becker (1992) also shows that interactions between peer pressure, which is much more important for youths than for adults, and addiction predict greater price sensitivity by youths.

Empirical Evidence of Rational Addiction

The Becker-Murphy (1988) rational addiction model has been applied successfully to the demand for cigarettes by Chaloupka (1991), Keeler et al. (1993), and Becker et al. (1994). It also has been applied successfully to the demand for alcohol by Chaloupka et al. (1993) and by Grossman et al. (1998) and to the demand for cocaine by Grossman and Chaloupka (1998). All these studies report negative and significant price effects, positive and significant past and future consumption effects, and larger long-run than short-run price elasticities.

The cigarette and alcohol studies capitalize on the substantial variation in prices across the United States that exists due primarily to the very different state excise tax rates on these goods. The cocaine study draws on cocaine prices based on local purchases made by drag enforcement agents to apprehend drug dealers. These prices are higher in cities and states that both impose relatively stiff fines and prison terms on persons convicted of selling

cocaine and allocate more resources to apprehending and convicting dealers. Typical short-run and long-run price elasticities of demand in these studies are -0.40 and -0.75 for cigarettes, -0.41 and -0.65 for alcohol measured by the number of drinks in the past year, -0.79 and -1.00 for alcohol measured by cirrhosis mortality (a standard index of excessive alcohol consumption), and -0.70 and -1.35 for cocaine consumption.

The studies just mentioned and others contain additional support in favor of the economic approach to addictive behavior. Chaloupka (1991) finds that smoking by the less educated is considerably more responsive to changes in cigarette prices than is smoking by the more educated; a similar result has been obtained by Townsend (1987) with British data. Lewit et al. (1981), Lewit and Coate (1982), and Chaloupka and Grossman (1996) report that youths respond more to cigarette prices than adults. By contrast, the information that began to emerge in the early 1960s about the harmful long-run effects of smoking has had a much greater effect on smoking by the rich and more educated than by the poor and less educated (Farrell and Fuchs 1982 for the United States.; Townsend 1987 for Britain).

As in the case of cigarettes, cocaine consumption by teenagers and young adults appears to be more price sensitive than consumption by adults (Saffer and Chaloupka 1996; Chaloupka et al. 1997; Grossman and Chaloupka 1998). These three studies do not consider consumption by the homeless and by prison inmates, who may behave very differently from the population at large. Caulkins (1996), however, reports an even larger price elasticity of demand for cocaine of -2.50 using data on the percentage of persons arrested and brought to booking facilities in different cities within the United States who tested positive for cocaine based on urinalysis. Bretteville-Jensen and Sutton (1996) obtain a price elasticity of demand for heroin of -1.23 in a sample of non-dealing heroin users who participated in a needle exchange program in Oslo, Norway.

Historical data indicate that opium users responded to price during periods when its consumption was legal. Van Ours (1995) estimates a short-run price elasticity of demand of -0.70 and a long-run price elasticity of -1.00 in the Dutch East Indies (now Indonesia) during Dutch colonial rule, for the years 1922 to 1938.

Excessive alcohol consumption is perhaps the most common example of a legally addictive good next to cigarette smoking. The two goods are not, however, linked to adverse health outcomes and to addiction in the same way. There is overwhelming evidence that smoking has detrimental health effects. One can usually focus on whether and how much an individual smokes because these measures are highly correlated with the smoking-related costs of interest. With alcohol, the situation is more complex. Unlike cigarettes, many persons regularly consume small quantities of alcohol. Most individuals who consume alcohol do not harm themselves or others; indeed, moderate alcohol consumption has been shown to lower the risk of coronary heart disease in men. Instead, the adverse effects of alcohol spring from the overuse (cirrhosis of the liver) or misuse (drunk driving crashes).

Given the above, the following findings are particularly notable. The short-run and long-run price elasticities of the number of drinks of alcohol in a panel sample of young adults are substantial, yet are smaller than the corresponding elasticities of cirrhosis mortality in a time series of state cross sections (Grossman et al. 1998; Chaloupka et al. 1993). Cook and Tauchen (1982) report that a $1 increase in the state excise tax on distilled spirits lowers the age-adjusted cirrhosis mortality rate by approximately the same percentage as it lowers per capita consumption of distilled spirits. Using a similar methodology and a time series of countries, Saffer (1991) finds that the price elasticity of cirrhosis mortality is three times larger than the price elasticity of per capita ethanol consumption.

Kenkel (1993) reports large price elasticities for the number of days with five or more drinks in the past year, which is another standard measure of the incidence of heavy consumption: -0.92 for persons of all ages and -2.24 for youth between the ages of 18 and 21. This suggests that young drinkers, like young smokers and young consumers of cocaine, are quite sensitive to price. Kenkel also reports a strong positive association between the measure of heavy drinking and the reported number of occasions of drunk driving in the past year. This provides a plausible mechanism for the negative relationship between fatal motor vehicle crashes (many of which are alcohol related) and the price of alcohol, which is found in many studies (see Grossman et al. 1994 for a summary).

Evidence on the effects of other components of the total price of an addictive good on consumption are more limited. State and local bans on cigarette smoking in the workplace and in other public places curtail smoking in the United States (Wasserman et al. 1991). Increases in state minimum legal ages for the purchase and consumption of alcohol in the late 1970s and 1980s lowered the frequency and quantity of heavy drinking and the motor vehicle accident mortality rate of 18 to 20 year olds (Kenkel 1993; Grossman et al. 1994). Minimum age effects tend to be smaller than the price effects possibly because drinking age laws are difficult (costly) to enforce. Some state laws that increase the certainty that a drunk driver will be apprehended and convicted, and the penalty paid if convicted, both lower the incidence of drunk driving and the motor vehicle accident mortality rate (Chaloupka et al. 1993; Kenkel 1993; Ruhm 1996). The evidence is mixed, however, and the effects are modest, possibly because the perceived probabilities of apprehension and conviction are small.

Eleven U.S. states decriminalized the possession of small amounts of marijuana between 1973 and 1978. Some studies find that this increased the use of marijuana, while others do not (see Chaloupka et al. 1997 for a summary and new estimates). These mixed results may arise because nearly every state liberalized its treatment of marijuana possession in the 1970s. Chaloupka et al. (1997) report that marijuana use and cocaine use by U.S. high school seniors are inversely related to state fines for conviction of possession. These effects are weak most likely because the probability of apprehension and conviction is low.

Policy Implications

Because harmful addictions are sensitive to price, the government can discourage these behaviors by taxation or by bans. In the United States, Federal and state excise taxes account for approximately 30% of the price of cigarettes and approximately 20% of the price of alcohol. Cocaine may sell for as much as 20 times its free market price (Miron and Zwiebel 1995). Our discussion implies that cigarette smoking, alcohol abuse, and the consumption of illicit substances would rise substantially if tax rates were lowered or cocaine, marijuana, and heroin were legalized. But this observation does not justify the current policies. Revenue considerations aside, taxation of harmful addictions is justified only if there are external costs or ignored internal costs associated with these behaviors. Bans can be viewed in a similar manner. We illustrate these issues with respect to cigarette and cocaine consumption because alcohol control is discussed in detail by Grossman et al. (1994).

Consider the optimal tax on cigarettes. There is widespread agreement that smoking has the potential to generate external costs because the premiums paid by smokers for health and life insurance do not fully reflect their excess use of medical care services and their higher probability of death (Manning et al. 1991; Viscusi 1995). The lower Social Security and pension payments to smokers who die earlier offset some of these costs.

Some parents behave in ways that harm their children's health, and the health of spouses or unrelated persons can be worsened by the actions of smokers. The best example of these external costs is the harm done to their fetuses by pregnant women who smoke. Numerous studies show that these

women are more likely to miscarry and to give birth to low-weight infants. Some of these infants die within the first month of life. Many more require extensive neonatal intensive care and suffer long-term impairments to physical and intellectual development. According to some, maternal smoking during pregnancy should not be treated as a cost imposed on one person by another and ignored by the smoker, because pregnant women may already have taken into account the impacts of their behavior on their infants. Because they still choose to smoke, the benefits to them outweigh the potential costs. Others argue that at least some pregnant women who smoke do so because they lack information about the effects of their behavior or heavily discount the future consequences of their current actions.

Similar issues arise in considering the detrimental health effects suffered by nonsmokers from secondhand smoke. The U.S. Environmental Protection Agency estimates that these effects include annually roughly 3,000 additional lung cancer deaths, between 9,000 and 17,000 additional deaths due to heart disease, as well as a host of other respiratory illnesses. When these effects are attributed to the smoking behavior of a spouse, the costs are internal because most economists consider the family as the relevant economic decision-making unit. Although children are members of this unit "... they are relatively powerless to affect consumption decisions that may influence their health, especially when they are very young" (Warner et al. 1995:382). Increases in morbidity and mortality suffered by nonsmokers in the workplace and other public places clearly are external costs of smoking.

As we indicated above, smoking generates ignored internal costs if consumers have imperfect information about the risks of smoking or behave in a myopic fashion. In response to the first U.S. Surgeon General's report on smoking and health in 1964, smoking participation rates of more educated consumers declined rapidly in the late 1960s and early 1970s. In this period educated consumers were more likely to quit smoking and less likely to begin than less educated consumers. These data imply differential ability to process new information as a function of education and possibly some government action. It is still true today, after more than 30 years of providing information, that the more educated are less likely to smoke than the less educated despite the massive antismoking campaign that has been mounted by Federal and state governments.

It is tempting to attribute the recent data to more future oriented behavior by the more educated rather than to differences in information. Indeed, a survey taken by Viscusi (1995) shows that both smokers and nonsmokers overestimate, not underestimate, the probability of death and illness from lung cancer due to tobacco. Teenagers, who have less information and are less future oriented than adults, actually attach much higher risks to smoking than the rest of the population. Schoenbaum (1997), however, finds that, among current heavy smokers in the Health and Retirement History Survey, expectations of reaching age 75 were nearly twice as high as actuarial predictions. Moreover, other risks of cigarette smoking, including the risk of becoming addicted, may be underestimated.

The addiction studies previously summarized suggest that smokers and consumers of other addictive goods are farsighted in the sense that they anticipate the expected future consequences of their current actions. Consumers who behave in this manner reduce their current consumption in response to an increase in future price. This is exactly what these studies find. Yet some persons, particularly the young and the poor, may discount the future much more heavily than other segments of the population.

The story with regard to cocaine consumption is somewhat similar. Consumption by pregnant women harms their fetuses. Cocaine use, like excessive alcohol use, may cause motor vehicle fatalities and violent behavior and crime. On the other hand, Miron and Zwiebel (1995) argue convincingly that drug prohibition, rather than drag consumption, promotes violence. We disagree, however, with their prediction of modest increases in consumption if drugs were legalized, based on the U.S. experience with alcohol prohibition from 1920 to 1933. More recent research suggests sharper increases. For example, Grossman and Chaloupka (1998) predict that a 10% reduction in the price of cocaine would increase consumption by young adults by almost 14% in the long run.

The endogenous nature of time preference and interactions among time preference, addiction, and peer pressure are the strongest justifications for government concern with the cigarette and cocaine decisions of its citizens. Some persons may lack information about the process and outcomes of investments in time preference. The existing distribution of income and imperfections in the capital market may limit the ability of certain individuals to make these investments. Given society's concern with the welfare of its children, these issues are particularly troublesome if some parents ignore or are unaware of the benefits of making their children future oriented. Similar issues arise if poor pregnant women or young children smoke or use cocaine because they have high rates of time preference for the present.

These concerns justify government information and education programs, taxation, and other policies to curtail consumption, especially by youths. Such policies are often second-best solutions because they impose welfare costs on others. For example, taxing cigarettes to curtail consumption by children or pregnant women imposes costs on other smokers in the form of higher prices. Perhaps the first-best solution is to encourage investments designed to make persons more future oriented because such investments will simultaneously curtail the use of a variety of addictive substances. But much more research dealing with the determinants of time preference is required before this policy can be offered as a substitute for taxation and other forms of regulation.

We have not provided enough information in this paper to compute the optimal tax on cigarettes or to evaluate whether the use of cocaine, marijuana, or heroin should be legalized. With cigarette taxes, a primary unresolved issue relates to what harmful consequences should be treated as external. For legalization, a cost-benefit analysis of many effects is needed to decide between a regime in which cocaine and other drugs are legal and a regime in which they are not. What we can conclude is that permanent increases in price caused by excise tax increases or permanent reductions in price caused by legalization will have substantial effects on the use of addictive goods. These strong price effects have been proven over and over in the literature and should not be ignored in the policy debate.

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