AN EMPIRICAL ANALYSIS OF ALCOHOL ADDICTION: RESULTS FROM THE MONITORING THE FUTURE PANELS

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In a panel of young adults, we find that alcohol consumption is addictive in the sense that increases in past or future consumption cause current consumption to rise. The positive and significant future consumption effect is consistent with the hypothesis of rational addiction. The long-run price elasticity is approximately 60% larger than the short-run price elasticity and twice as large as the elasticity that ignores addiction. Thus, a tax hike policy to curtail consumption or abuse may not have a favorable cost-benefit ratio unless it is based on the long-run price elasticity. (*JEL* I10)

I. INTRODUCTION

This paper aims to refine and enrich the empirical literature dealing with the price sensitivity of alcohol consumption by incorporating insights provided by Becker and Murphy's [1988] theoretical model of rational addictive behavior. Their model emphasizes the interdependency of past, current, and future consumption of an addictive good. In addition, we reexamine the relative potency of excise tax and drinking age hikes as policy instruments to curtail alcohol abuse by young

* This is a condensed version of Grossman, Chaloupka, and Sirtalan [1996]. The longer version, which is available on request, contains a detailed discussion of the model, data, and empirical results. It also considers a number of estimation issues and performs a variety of sensitivity analyses. In particular, we show that the choice between weighted regressions (to correct for oversampling of illegal drug users at baseline) and unweighted regressions is moot because the two sets of estimates are very similar. We also present results with alternative values for the open-ended alcohol drinking frequency category of 40 or more occasions in the past year of 45, 55, 60, 65, 70, 80, 90, 100, 200, and 300 (a value of 50 is used in the paper). The slope coefficient of the price of beer rises in absolute value as the value assigned to the open-ended category rises, but tests of significance and long- and short-run price elasticities are not affected. In addition, results with alternative assumptions about the number of drinks of alcohol that it takes to get pretty high are shown to be very similar to those in the paper. Finally, estimates obtained from a two-stage least squares fixed-effects model in which all time-varying variables are transformed into deviations from person-specific means and time-invariant variables are deleted confirm the estimates presented in the paper. Research for this paper was supported by grant 5 R01 AA08359 from the National Institute on Alcohol Abuse and Alcoholism to the National Bureau of Economic Research. We are extremely grateful to Patrick M. O'Malley, Senior Research Scientist at the University of Michigan's Institute for Social Research, for providing us with the Monitoring the Future panels and for agreeing to attach county identifiers to our tapes. We also are extremely grateful to Jerome J. Hiniker, Senior Research Associate at ISR, for creating the computer programs that produced these tapes. Part of the paper was written while Grossman was a visiting scholar at the Catholic University of Louvain in Belgium, and he wishes to acknowledge the financial support provided by that institution. We are indebted to Gary S. Becker, Randall K, Filer, Robert J. Kaestner, Theodore E. Keeler, Donald S. Kenkel, Lee A. Lillard, John Mullahy, Kevin M. Murphy, William S. Neilson, Jon P. Nelson, Thomas R. Saving, Frank C. Wykoff, Gary A. Zarkin, and two anonymous referees for helpful comments and suggestions. Preliminary versions of the paper were presented at the 1995 meeting of the American Economic Association and the 1994 meeting of the Western Economic Association and at seminars at Brigham Young University, the Catholic University of Louvain, Charles University in Prague, the University of Chicago, Erasmus University in Rotterdam, the Rand Corporation, the Stockholm School of Economics, and the United States Military Academy at West Point. We are indebted to the participants in those meetings and seminars for comments and suggestions. Finally, we wish to thank Patricia Kocagil, Hadassah Luwish, Geoffrey Joyce, Sandy Grossman, Esel Yazici, and Sara Markowitz for research assistance. This paper has not undergone the review accorded official NBER publications; in particular, it has not been submitted for approval by the Board of Directors.

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ABBREVIATION

ACCRA: American Chamber of Commerce Researchers Association

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adults. Our study is unique in that it addresses these issues in a panel of individuals. The panel is formed from the nationally representative cross-sectional surveys of high school seniors conducted each year since 1975 by the Institute for Social Research of the University of Michigan. The members of the panel range in age from 17 through 29. Since Grant et al. [1991] report that the prevalence of alcohol dependence and abuse is highest in this age range, addictive models of alcohol consumption may be more relevant to this sample than to a representative sample of the population of all ages. By testing for rational addiction, we address the issue of whether teenagers and young adults ignore the internal costs of alcohol use and abuse and whether these costs should be considered in formulating public policy.

Rachal et al. [1980] demonstrate a positive relationship between alcohol abuse at early and later stages of the life cycle, indicating that excessive consumption is an example of an addictive behavior. Yet the substantial empirical literature on the demand for alcohol does not incorporate insights from the Becker-Murphy theoretical model of this behavior.[1] The main element of this and other models of addiction is that an increase in past consumption of an addictive good raises the marginal utility of current consumption and therefore raises current consumption. A key feature of the Becker-Murphy model which distinguishes it from other models of addictive behavior is that addicts are rational or farsighted in the sense that they anticipate the expected future consequences of their current actions. This is in sharp contrast to myopic models of addiction in which consumers 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 period.

The Becker-Murphy model predicts intertemporal complementarity of consumption or negative cross price effects and a long-run own price elasticity of demand which exceeds the short-run elasticity (the former allows past consumption to vary while the latter does not). This model has been successfully applied to the addictive behavior of cigarette smoking in published research by Chaloupka [1991]; Keeler, Hu, Barnett, and Manning [1993]; and Becker, Grossman, and Murphy [1994]. These three studies report negative and significant price effects, positive and significant past and future consumption effects, and long-run elasticities which are larger than short-run price elasticities.

We find that alcohol consumption by young adults is addictive in the sense that increases in past or future consumption cause current consumption to rise. The positive and significant future consumption effect is consistent with the hypothesis of rational addiction and inconsistent with the hypothesis of myopic addiction. The long-run elasticity of consumption with respect to the price of beer (the alcoholic beverage of choice by young adults) is approximately 60% larger than the short-run price elasticity and twice as large as the elasticity that ignores addiction.

II. ANALYTICAL FRAMEWORK

Following Becker, Grossman, and Murphy [1994], we assume that consumers maximize a lifetime utility function given by

$$V = \sum_{t=1}^{\infty} \beta^{t-1} U(Y_t, C_t, C_{t-1}, e_t). \quad (1)$$

Here Y_t is consumption of a non-addictive good at time or age t, C_t is consumption of an addictive good (alcohol in our case) at age t, C_{t-1} is alcohol consumption at age $t-1$, e_t reflects the effects of unmeasured life cycle variables on utility, and β is the time discount factor [$\beta = 1/(1+r)$, where r is the rate of time preference for the present]. An increase in lagged alcohol consumption (C_{t-1}) lowers utility if the addiction is harmful ($\partial U / \partial C_{t-1} < 0$), while an increase in the lagged consumption raises utility if the addiction is beneficial ($\partial U / \partial C_{t-1} > 0$). Presumably, the partial derivative just defined is negative, although the model simply assumes that this term is nonzero. Regardless of the nature of the addiction, an increase in past consumption must raise the marginal utility of C_t in order for an increase in past consumption of C to increase current consumption.

1. For a review of this literature, see Leung and Phelps [1993]. For recent contributions, see Baltagi and Griffin [1995] and Manning, Blumberg, and Moulton [1995].

When the utility function is quadratic and the rate of time preference for the present is equal to the market rate of interest, equation (1) generates a structural demand function for consumption of C of the form

$$C_t = \theta C_{t-1} + \beta\theta C_{t+1} + \theta_1 P_t + \theta_2 e_t. \quad (2)$$

Here P_t is the price of C_t, and the intercept is suppressed. Since θ is positive and θ_1 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, θ measures the effect of an increase in past consumption on the marginal utility of current consumption. By symmetry, it also measures the effect of an increase in future consumption on the marginal impact of current consumption on next period's utility. The larger the value of θ the greater is the degree of reinforcement or addiction.

Equation (2) is the basis of the empirical analysis in this paper. Note that ordinary least squares estimation of the equation might lead to biased estimates of the parameters of interest. The unobserved variables that affect utility in each period are likely to be serially correlated. Even if these variables are uncorrelated, C_{t-1} and C_{t+1} depend on e_t through the optimizing behavior. These relationships imply that an ordinary least squares estimation of the equation might incorrectly imply that past and future consumption affect current consumption, even when the true value of θ is zero. Fortunately, the specification in equation (2) suggests a way to solve the endogeneity problem. The equation implies that current consumption is independent of past and future prices when past and future consumption are held constant; any effect of past or future prices on current consumption must come through their effects on past or future consumption. Provided that the unobservables are uncorrelated with prices in these periods, past and future prices are logical instruments for past and future consumption, since past prices directly affect past consumption, and future prices directly affect future consumption. Therefore, the empirical strategy amounts to estimating equation (2) by two-stage least squares, with past and future prices serving as instrumental variables for past and future consumption. This strategy can be modified when measures of some of the life cycle events that affect utility and therefore partially determine e_t, such as marital status and unemployment, are available. Then current marital status, for example, is a relevant regressor in the structural demand function given by equation (2), and past and future marital status are instruments for past and future consumption.

The statistical significance of the coefficient of future consumption provides a direct test of a rational model of addiction against an alternative model in which consumers are myopic. In the latter model they fail to consider the impact of current consumption on future utility and future consumption. That is, the myopic version of equation (2) is entirely backward looking. In this version, current consumption depends only on current price, lagged consumption, the marginal utility of wealth (which is one of the determinants of the current price coefficient), and current events. Because of these distinctions, myopic models and rational models have different implications about responses to future changes. In particular, rational addicts increase their current consumption when future prices are expected to fall, but myopic addicts do not.

Equation (2) implies that there are important differences between long- and short-run responses to permanent price changes (price changes in more than one period) in the case of addiction. The short-run price effect describes the response to a change in price in period t and all future periods that is not anticipated until period t. The long-run price effect pertains to a price change in *all* periods. Since C_{t-1} remains the same if a price change is not anticipated until period t, the long-run price effect must exceed the short-run price effect.[2]

III. DATA AND EMPIRICAL IMPLEMENTATION

Every spring since 1975 the University of Michigan's Institute for Social Research has conducted a nationally representative random

2. These results can be seen more formally by solving the second-order difference equation in (2). The solution, which is contained in Becker, Grossman, and Murphy [1994], results in an equation in which consumption in period t depends on prices and life-cycle variables in all periods. Formulas for the long-run and short-run price effects also are contained in the paper just cited.

sample of between 15,000 and 19,000 high school seniors as part of the Monitoring the Future research program. These surveys, which are described in detail by Johnston, O'Malley, and Bachman [1993], focus on the use of illegal drugs, alcohol, and cigarettes. Starting with the class of 1976, a sample of approximately 2,400 individuals in each senior class has been chosen for follow-up. Individuals reporting the use of marijuana on 20 or more occasions in the past 30 days or the use of any other illegal drug at least once in the past 30 days in their senior year are selected with a higher probability (by a factor of three). The 2,400 selected respondents are divided into two groups of 1,200 each; one group is surveyed on even-numbered calendar years, while the other group is surveyed on odd-numbered calendar years. As a result of this design, one group is resurveyed for the first time one year after baseline (the senior year in high school), while the other group is resurveyed for the first time two years after baseline. Subsequent follow-ups are conducted at two-year intervals for both groups.

We estimate alcohol demand functions using ten of the 20 panels formed from the high school senior surveys conducted from 1976 through 1985. We limit the panels to those in which the first follow-up occurred two years after baseline, so that each follow-up was conducted at two year intervals. The last follow-up in our data set, which contains approximately 12,000 persons, took place in 1989. We have between one and five observations on each person since we require information on current, past, and future consumption of alcohol. Since an annual measure of consumption is used in the regressions, past consumption coincides with the second annual lag and future consumption coincides with the second annual lead.

Information on county identifiers at baseline and at each follow-up allowed us to augment the data set with alcoholic beverage prices from the *Inter-City Cost of Living Index*, published quarterly by the American Chamber of Commerce Researchers Association [various years] for between 250 and 300 cities since the first quarter of 1968. This association, termed the ACCRA from now on, collects information on the prices of a number of consumer goods including beer, wine, and distilled spirits. In addition to prices, the ACCRA constructs a city-specific cost of living index for each of the cities with an average for all cities in a given quarter and year equal to one.

The baseline survey is conducted between March 15 and April 30 and takes place in the youth's high school. The follow-up surveys are mailed to the home addresses of respondents during the weeks of April 1-15. Respondents are requested to return the surveys promptly but do not always do so. Consequently, we assume that the annual alcohol consumption measure described below, which pertains to consumption during the last year, reflects consumption in the first two quarters of the year in which the survey was conducted (year t) and the last two quarters of the previous year (year $t-1$). Thus, the current annual price of alcohol described below is computed as a simple average of the prices over these four quarters. The second annual lead and lag, which are employed extensively in the regressions in Section IV, are given as a simple average of the price in the first two quarters of year $t+2$ and the last two quarters of year $t+1$ (second annual lead) and as a simple average of the price in the first two quarters of year $t-2$ and the last two quarters of year $t-3$ (second annual lag). The current, past, and future prices are annual averages of quarterly prices rather than prices as of a certain month within the year. Thus, they account fully for state excise tax changes that take place during the 12-month period for which consumption is measured.

The price assigned to each person comes from the ACCRA survey city nearest the person's county of residence. Similar comments apply to the computation of lags and leads of the price. For persons with different county residence codes in survey years t and $t+2$, prices from the third quarter of year t through the fourth quarter of year $t+1$ are computed as simple averages of the prices in each county. Since much of the cross-sectional variation in alcoholic beverage prices is due to variations in state excise tax rates on these beverages, persons are never matched to ACCRA cities outside their state of residence. This results in the deletion of some observations because not all states are represented in a given ACCRA survey.

Data on the consumption of specific alcoholic beverages (beer, wine, and distilled spirits) are not collected for four-fifths of the Monitoring the Future respondents. Therefore, the price of beer is used as the measure of the price of alcohol. This price is selected because beer is the most heavily consumed alcoholic beverage and because beer is the beverage of choice among teenagers and young adults. The specific price used is the price of a six-pack (six 12 ounce cans) of Budweiser or Schlitz. All quarterly nominal beer prices are averaged over the four relevant quarters to obtain the current annual nominal price of beer and the second annual lead and lag of the price. These prices are converted to real prices by dividing them by a year- and city-specific cost of living index. This index is the ACCRA city-specific cost of living index multiplied by the quarterly CPI for the U.S. as a whole (1982–84 = 1) and then averaged over the four relevant quarters.

A sample of 21,420 person-years or person follow-ups is employed in the empirical analysis. It is obtained by deleting persons who failed to respond to at least three consecutive questionnaires (including baseline) and by deleting observations for which the number of drinks of alcohol in the past year, the current real price of beer, or current real annual earnings are missing. Given three observations per person on average, there are approximately 7,140 respondents in the final sample.

The number of drinks of alcohol consumed in the past year is the dependent variable in all regressions in Section IV. This variable is given by the product of the number of drinking occasions during the last 12 months and the number of drinks consumed on a typical drinking occasion. The number of drinking occasions is an ordered categorical variable with seven outcomes: 0 occasions, 1–2 occasions, 3–5 occasions, 6–9 occasions, 10–19 occasions, 20–39 occasions, and 40 or more occasions. It is converted into a continuous variable by assigning midpoints to the closed intervals and a value of 50 to the open-ended interval.

The number of drinks on a typical drinking occasion is inferred from the response to the question: "On the occasions that you drink alcoholic beverages, how often do you drink enough to feel pretty high?" The response categories are none of the occasions, few of the occasions, half of the occasions, most of the occasions, and nearly all of the occasions. We assume that the second response category corresponds to 25% of all occasions, that the fourth corresponds to 75% of all occasions, and that the fifth corresponds to 100% of all occasions. We also assume that four drinks must be consumed to feel pretty high. Persons in the first response category are assumed to consume 1.5 drinks on a typical drinking occasion. Persons in the second category are assumed to consume $.75\times1.5 + .25\times4 = 2.125$ drinks on a typical occasion. Persons in third category are assigned a value of $.5\times1.5 + .5\times4 = 2.75$. Persons in the fourth category are assigned a value of $.25\times1.5 + .75\times4 = 3.375$, and persons in the fifth category are given a value of four drinks on a typical occasion.

The minimum legal drinking age for the purchase and consumption of low alcohol beer is a partial determinant of the full price of alcohol, especially for underage youths. Since no state has ever had a legal drinking age greater than 21, the drinking age is multiplied by a dichotomous variable that equals one for persons 21 years of age or younger. In addition to the own-state minimum legal drinking age, a dichotomous indicator equal to one if a respondent resides in a county within 25 miles of any state with a lower legal drinking age is employed as a regressor. It is interacted with the dichotomous indicator for persons whose age is less than or equal to 21 for the same reason that the drinking age is interacted with this indicator. The border age variable is included in the model to capture potential border crossings by youths from states with high drinking ages to nearby lower age states to obtain alcohol. With the own-state legal drinking age held constant, the coefficient of the border age variable in the demand function should be positive.

A variety of independent variables were constructed from the demographic and socioeconomic information collected in the surveys. These include sex; race (black or other); age (dichotomous indicators for ages 19, 21, 23, and 25); real annual earnings; years of formal schooling completed; college student status (full-time, half-time, or less than half-time); work status (full-time, part-time, or unemployed); religious participation (infrequent or frequent); marital status (married, engaged, or separated or divorced); and the respondent's number of children. Finally, all models include dichotomous variables for nine of the ten cohorts (the high school senior classes of 1976 through 1984). The time-varying variables serve as proxies for life-cycle variables that affect the marginal utility of current consumption.

Given the nature of the panel, we estimate equation (2) with the second lag of the annual number of drinks of alcohol as the measure of past consumption and the second lead of the annual number of drinks of alcohol as the measure of future consumption. Since past consumption and future consumption are endogenous, the equation is fitted by two-stage least squares (TSLS). The instruments consist of the exogenous variables in the model, the second lag of the annual real beer price, the second lead of the annual real beer price, the second annual lags of the two measures pertaining to the legal drinking age (legal drinking age × age ≤ 21 and lower border drinking age indicator × age ≤ 21), and the second leads and the second lags of all time-varying socioeconomic variables. These include real annual earnings, years of formal schooling completed, college student status, work status, religious participation, marital status, and number of children. The second leads of the two measures pertaining to the legal drinking age are not used as instruments because the values of these two variables are zero except at the first follow-up.

A problem with the use of leads and lags of the socioeconomic variables as instruments is that these variables may not be exogenous. While plausible arguments can be made for the endogeneity of all of them, the real issue is which ones are most likely to be caused by alcohol consumption or correlated with the disturbance term in the structural alcohol demand function given by equation (2). In our view, religious participation, marital status, and number of children are more likely to fall into the latter category. Therefore, demand functions are obtained with and without these variables.

IV. EMPIRICAL RESULTS

Panel A of Table I contains price, legal drinking age, and border age coefficients from standard alcohol demand functions that ignore addictive behavior. In particular, past and future consumption are excluded from these estimates. The regression in column 1 omits religious participation, marital status, and number of children, while the regression in column 2 includes these variables.

The most important findings in these regressions are the negative and significant price and legal drinking age effects and the positive and significant border age effect. The magnitude, but not the significance, of the price coefficient is sensitive to the inclusion of religious participation, marital status, and number of children. In particular, the price coefficient is cut in half when these variables are added to the set of regressors. At the weighted (to correct for oversampling of illegal drug users at baseline) sample means of consumption (60.630 drinks in the past year) and price ($2.789 in 1982–84 dollars for a six-pack of Budweiser or Schlitz), the price elasticity of demand equals –0.38 in the first regression and –0.20 in the second regression. The first estimate may be influenced by omitted variables bias, while the second may be influenced by simultaneous equations bias. Therefore, we regard these two figures as bracketing the true estimate. We consider their average of –0.29 as the benchmark price elasticity that emerges from a demand function for the number of drinks of alcohol in the past year that ignores addictive behavior, but we realize that the reader may want to use the range in comparing the non-addictive and addictive estimates.

Panel B of Table I tests the rational addiction model directly by estimating the structural demand function given by equation (2). The first two columns contain two-stage least squares (TSLS) regression coefficients of past consumption, future consumption, price, and the two drinking age variables from models in which past consumption (the second annual lag of consumption) and future consumption (the second annual lead of consumption) are endogenous. Religious participation, marital status, and number of children are excluded from the first regression and included in the second. The last two columns contain the corresponding ordinary least squares (OLS) coefficients. Panel B also contains F-ratios resulting from Wu's (1973) test of the hypothesis that the regressors are exogenous and thus that the OLS estimates are consistent.

In the model with religious participation, marital status, and number of children, the exogeneity of the regressors is rejected. In the

TABLE I
Selected Coefficients from Demand Functions for Annual Number of Drinks of Alcohol[a]

Panel A: Non-addictive Demand Functions

(n = 21,420)	(1)[b]	(2)[c]
Price	-8.158	-4.303
	(–6.48)	(–3.55)
Legal drinking age × age ≤ 21	–1.106	–1.217
	(–2.55)	(–2.92)
Lower border drinking age indicator × age ≤ 21	7.789	7.323
	(5.73)	(5.61)
R-squared	0.104	0.176
Price elasticity	–0.375	–0.198

Panel B: Structural Demand Functions

	Two-Stage Least Squares		Ordinary Least Squares	
(n = 18,473)	(1)[b]	(2)[c]	(3)[b]	(4)[c]
Past consumption	0.254	0.274	0.346	0.339
	(4.37)	(8.18)	(60.07)	(58.69)
Future consumption	0.656	0.345	0.474	0.454
	(9.12)	(11.14)	(76.30)	(72.60)
Price	–2.470	–2.155	–2.663	–1.744
	(2.40)	(2.24)	(–2.84)	(–1.87)
Legal drinking age × age ≤ 21	–1.038	–1.131	–1.015	–1.059
	(3.12)	(3.44)	(–3.14)	(–3.30)
Lower border drinking age indicator × age ≤ 21	1.597	3.379	2.139	2.203
	(1.42)	(3.24)	(2.12)	(2.21)
R-squared	0.191	0.292	0.568	0.576
Wu F-ratio	3.417	16.945	—	—
Long-run price elasticity	–1.265	–0.260	–0.681	–0.386
Short-run price elasticity	–0.857	–0.181	–0.384	–0.225

[a]Asymptotic t-statistics in parentheses. All regressions include gender, race, age, real annual earnings, years of formal schooling completed, work status, college student status, and cohort indicators. Price elasticities computed at weighted sample means of price and consumption.

[b]Religious participation, marital status, and number of children excluded.

[c]Religious participation, marital status, and number of children included.

model without these variables, the Wu test is inconclusive. The F-ratio of 3.18 is significant at the 5% level but not at the 1% level. Given these results and the potential endogeneity of religious participation, marital status, and number of children, it is useful to consider the OLS regressions as well as the TSLS regressions in evaluating the findings.

The estimated effects of past and future consumption on current consumption are significantly positive in the four regressions in Panel B, and the estimated price and legal drinking age effects are significantly negative in all cases. The positive and significant past consumption coefficient is consistent with the hypothesis that alcohol consumption is an addictive behavior. The positive and significant future consumption coefficient is consistent with the hypothesis of rational addiction and inconsistent with the hypothesis of myopic addiction.

Clearly, the estimates indicate that alcohol consumption is addictive in the sense that past and future changes significantly impact current consumption. This evidence is inconsistent with the hypothesis that alcohol consumers are myopic. Still, the estimates are not fully consistent with rational addiction because the estimates of the discount factor (β)—given by the ratio of the coefficient of future consumption to the coefficient of past consumption—are implausibly high. The implied discount factor is 2.58 in the first regression, 1.26 in the second regression, 1.37 in the third regression, and 1.34 in the fourth regression. These discount factors correspond to negative interest rates of –61%, –20%, –27%, and –26%, respectively.

We imposed a discount factor of 0.95 (interest rate of 5%) a priori and reestimated the four regressions in Panel B of Table I. The price and legal drinking age coefficients in these models are extremely close to their unconstrained counterparts. These results, combined with the detailed analysis in Becker, Grossman, and Murphy [1994], suggest that data on alcohol consumption or cigarette smoking are not rich enough to pin down the discount factor with precision even if the rational addiction model is accepted.

At the weighted sample means of consumption and price, the long-run price elasticity of demand ranges from –0.26 to –1.26 (average equals –0.65) in Panel B. The short-run elasticity ranges from –0.18 to –0.86 (average equals –0.41). The ratio of the long-run elasticity to the corresponding short-run elasticity is more stable. It varies from 1.44 to 1.77 (average equals 1.60). This ratio should be compared to a ratio of approximately 1.91 in the case of rational addiction demand functions for cigarettes reported by Chaloupka [1991] and by Becker, Grossman, and Murphy [1994]. Becker, Grossman, and Murphy [1991] show that the ratio of the long-run price elasticity to the short-run price elasticity rises as the degree of addiction, measured by the coefficient of past consumption, rises. Thus, our results suggest that alcohol consumption is somewhat less addictive than cigarette smoking.

Nevertheless, the long-run elasticity of demand for the number of drinks of alcohol in the past year is substantially larger than the short-run elasticity. The average long-run price elasticity of –0.65 also is more than twice as large as the benchmark price elasticity of –0.29 that emerges from the demand functions in Panel A that ignore addiction. Indeed, the average short-run elasticity is almost 40% larger than the benchmark elasticity.

Our results bear on efforts to reduce youth alcohol abuse by raising the legal drinking age or by raising the Federal excise tax rate on beer. The former policy was actively pursued by the Federal government and state governments in the late 1970s and the 1980s. It resulted in a uniform minimum drinking age of 21 in all states as of July 1988. Increased taxation of beer—the alcoholic beverage of choice among youth and young adults—has been virtually ignored in the anti-drinking campaign. Between November 1951 and January 1991, the Federal excise tax rate on beer was fixed in nominal terms at 16 cents per six-pack. Moreover, despite the popularity of beer, the alcohol in distilled spirits currently is taxed twice as heavily as the alcohol in beer, and the alcohol in spirits was taxed three times as heavily as the alcohol in beer prior to October 1985.[3] Due in part to the stability of the Federal beer tax and the modest increases in state beer taxes, the real price of beer declined by 20% between 1975 and 1990.

We use the four regression models in Panel B of Table I to simulate the effects of drinking age changes and Federal beer tax excise tax hikes on the annual number of drinks of alcohol consumed by 19 year olds in the mid years of our sample—1982 and 1983. This age group consumed 62 drinks per year in the period at issue (this is the weighted mean). The average legal drinking age was 19.6, and 19% of the sample lived within 25 miles of a state with a lower drinking age.

If the drinking age had been 21 in all states in 1982 and 1983 (which means that the border age indicator would have been zero for all youth), 19 year olds would have consumed approximately 11 fewer drinks of alcohol in the long run. This is an average of the four

3. Prior to October 1, 1985, the Federal excise tax on distilled spirits amounted to $10.50 per gallon of spirits (50% alcohol by volume) or $21.00 per gallon of alcohol in spirits. The beer tax of 16 cents per six-pack is equivalent to a tax of $.29 per gallon. Since one gallon of beer contains 4.5% alcohol by volume, this amounts to a tax of $6.44 on one gallon of alcohol in beer. Between October 1, 1985 and January 1, 1991, the Federal tax rate on spirits was $12.50 per gallon or $25.00 per gallon of alcohol in spirits. On January 1, 1991, the Federal beer tax rate doubled to $.58 per gallon, and the spirits tax rose by 8% to $13.50 per gallon.

long-run declines predicted by the regression models in Panel B and amounts to an 18% reduction relative to the mean of 62. If the Federal beer tax had been indexed to the rate of inflation in the Consumer Price Index since 1951, consumption would have declined by six drinks or by 10%. If the beer tax were raised to equalize the rates at which the alcohol in beer and liquor are taxed and if beer and liquor taxes both were indexed to the inflation rate, consumption would have fallen by 26 drinks per year or by more than 40%.

The impact of the combined tax policy is more than twice as large as the impact of the drinking age policy. In part, this is because a number of states had raised the drinking age to 21 by 1982 or 1983. Therefore, to put these two policies in perspective, suppose that the drinking age had been 18 (the historical minimum in any state) in all states in the years at issue. Then consumption would have risen by eight drinks per year. Put differently, the effect of going from a minimum legal drinking age of 18 to one of 21 amounts to a reduction of 19 drinks per year or slightly more than 30% relative to the mean of 62. Thus, the reduction in consumption associated with the combined tax policy exceeds that associated with the maximum increase in the drinking age by approximately 37%. These computations agree with conclusions reached by Grossman, Coate, and Arluck [1987]; Coate and Grossman [1988]; Kenkel [1993]; and Grossman, Chaloupka, Saffer, and Laixuthai [1994] with regard to the effectiveness of beer tax hikes. The absolute magnitudes of the effects in these studies differ from those in our study because the outcomes differ and because our estimates are obtained in the context of a model of rational addiction.

Our evaluations of policies that would increase the Federal excise tax on beer in order to curtail teenage and young adult alcohol abuse extend previous evaluations in two important ways. First, we find that the long-run price elasticity of consumption with respect to the price of beer is approximately 60% larger than the short-run elasticity and twice as large as the elasticity that ignores addiction. Thus, forecasts of reductions in consumption in this age group would be considerably understated if they were not based on the long-run elasticity. Put differently, a tax hike to curtail abuse may have an unfavorable cost-benefit ratio based on the short-run price elasticity or the price elasticity that ignores addiction, while the same policy may have a very favorable cost-benefit ratio based on the long-run price elasticity.

Second, we find evidence that alcohol consumption decisions made by teenagers and young adults exhibit rational or farsighted behavior in the sense that current consumption is positively related to future consumption. This suggests that at least some of the internal effects or costs of alcohol abuse are not ignored costs that can be used to justify government intervention. If consumers take into account the future costs that they impose upon themselves by abusing alcohol, then the case for higher taxes or other policies to curtail abuse must be based solely on the harm that abusers do to third parties. This conclusion is tentative because we have focused on a measure of alcohol use rather than on a measure of abuse and because certain aspects of moderate current alcohol consumption may raise future utility by lowering the risk of heart disease or by improving social interactions at bars, clubs, and parties. Future research could clarify these issues by directly considering measures of abuse in the context of rational addiction.

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