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Binge Drinking and Labor Market Success: A Longitudinal Study on Young People

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Abstract: This paper presents a two-equation model of joint outcomes on an individual's decision to binge drink and on his/her annual labor market earnings. The primary data source is the 1979 cohort of the National Longitudinal Survey of Youth (NLSY79), 1979-1994. We show that binge drinking behavior is quite alcohol-price responsive and is a rational addiction. A new result is that an individual's decision to binge drink has a statistically significant negative effect on his/her earnings. Furthermore, we conducted simulations of the short-run and long-run impacts of increasing the alcohol price. They showed that that the tendency for an individual to binge drink heavily is reduced significantly, and the reduction is greater in the long- than short-run simulation. Also, an individual's annual earnings were increased. However, in the structural model, an individual's earnings have no significant effect on his/her tendency to engage in binge drinking. Our results contradict earlier findings from cross-section evidence that showed increased alcohol consumption raised an individual's earnings or wages.

Key words: binge drinking, earnings, rational addiction, health, labor productivity, panel data.

JEL Classification: J10, J22, J24

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Introduction

Education, experience, and race have received attention in efforts to the explain labor-market success of young people, i.e., earnings and labor force participation (Welch 1999; Neal and Johnson 1996; Heckman 1993). However, health status and unhealthy habits like binge drinking also seem likely to be important factors in determining the earnings of young people. An individual's binge drinking behavior and health investments are choices made jointly with decisions to work and earn. Therefore, untangling the relationships between binge drinking, health, and earnings has significant policy implications.

Drinking is habit-forming—current consumption has a positive influence on an individual's tastes for future consumption. Grossman, Chalouplka, and Sirtalan (1995a) have shown that alcohol consumption by young people is addictive in the rational addiction sense, using panel data for individuals 17 to 27 years of age. U.S. per capita alcohol consumption rose rapidly in the late 1960s and early 1970s as many states lowered their minimum legal drinking age—generally from 21 to 18 or 19 years. Binge drinking among young people, especially teenagers and college students, increased dramatically until at least the early 1980s, and it has drawn public attention because of the associated negative individual and social outcomes.[1]

To the individual, binge drinking has the short-run consequences of impaired judgement and physical coordination resulting from intoxicants and hangovers, and long-run consequences associated with damage to an individual's reputation, liver, heart, and immune system. These outcomes suggest reduced earnings in the short- and long-run from binge drinking. Binge drinking also has negative externalities associated with increased risk of auto accidents (Zobeck et al.

1994), abusive behavior toward family members and others (Grossman and Markowitz, 1999), higher health care costs to family, higher unemployment insurance use (Mullahy and Sindelar, 1996) and higher disability insurance use (National Council of Alcoholism and Drug Dependence; U.S. Dept. of Health and Human Services, 1997).

Although the evidence for adverse impacts of problem drinking by an individual on his/ her human capital is abundant, the economic literature fails to reach a consensus on the effect of an individual's drinking behavior on his/her earnings. Berger and Leight (1988) show that drinkers (moderate and abusive combined) earned a higher wage than nondrinkers across different demographic and human capital groups. Mullahy and Sindelar (1993) explore the life-cycle effect of alcoholism on work and income for males aged 22 to 64. They find that alcoholism has significantly negative effects on income and labor force participation for males aged 30 to 59, but not for younger and older men. They also demonstrate that there is an indirect effect of alcoholism through educational attainment and marital status. Hamilton and Hamilton (1997) find a flatter age-earnings profile for heavy drinkers than for moderate drinkers or non-drinkers. In contrast, using the National Household Survey on Alcohol Abuse, Heien (1996) shows that weekly earnings and the number of drinks have a concave relationship. He concludes that moderate drinkers earn more than abstainers or abusive drinkers. French and Zarkin (1995) examine the data collected from four worksites and find that moderate drinkers (two drinks per day) have higher weekly wages than others. By excluding human capital from the wage equation, they also show that alcohol use is related to wages through human capital variables such as health status, education and job tenure. Kenkel and Ribar (1994) find a small negative effect of heavy drinking on annual earnings for men and no effect for women. Zarkin, French, Mroz, and Bray (1998) use the number of drinks in the past 30 days as the measure of alcohol consumption and find no evidence of an inverse U-shaped relationship between an individual's wage and intensity of alcohol use when other characteristics were held constant. However, moderate drinkers (1.5 to 2.5 drinks per day) have higher wages than non-drinkers and heavy drinkers. Barrett (2002) analyzes data from the Australian National Health Survey and control for the endogeneity of an individual's drinking status. He finds that moderate drinking leads to a significant earnings premium but drinking heavily leads to an earnings penalty.

The empirical relationship between binge drinking and earnings may be incorrectly identified in these cross-sectional studies where drinking behavior is taken as exogenous. One can easily imagine that those individuals who choose to work hard also tend to binge drink less. The *objective* of this study is to examine the causal relationship between binge drinking and the labor market earnings of young adults. Hence, the basic empirical model contains two structural equations—an individual's demand for binge drinking and his/her earnings. We test the hypothesis that the price of alcohol has no effect on the tendency for an individual to engage in binge drinking and that binge drinking behavior is not a rational addiction. Furthermore, we test the hypothesis that an individual's decision to binge drinking has no effect on his/her earnings. The primary data source is a large panel data set, the NLSY79, 1979-1994, with geo-codes, that permit us to incorporate area level information with individual records. Our two-equation structural econometric model also includes a sample selection variable for employment and is estimated by the instrumental variable method.[2] We conclude that an individual's decision to binge drink is quite price-responsive and is a rational addiction, and that heavy binge drinking significantly lowers an individual's annual earnings. We also simulate the short- and long-run impacts of an increase in the price of alcohol on an individual's binge drinking behavior and earnings.

The econometric model is presented in the next section. Then the data and empirical definitions of the variables are described. In the third section, empirical results are presented and discussed, including simulations. The final section presents conclusions.

The Econometric Model

The empirical model consists of an individual's structural demand equation for binge drinking and his/her market earnings from work. A rational individual has the incentive to invest in his/her health and obtain positive psychic and financial rewards, i.e. fewer sick days and higher earnings. At the same time, individuals also take into account the consequences of their future addiction when they make the decision on current alcohol consumption.

The distinction between the myopic and the rational addiction model is that the rational addiction model involves multi-period optimization, while the myopic model involves only one period decision-making. The rational addiction model has been tested empirically and the results (Becker and Murphy 1988; Becker, Grossman, and Murphy 1994; Chaloupka 1991; Grossman, Chaloupka, and Sirtalan 1995; Grossman, Chaloupka, and Brown 1995) support the hypothesis that addictions are rational and are consistent with forward-looking optimization.

By modeling an individual's decision to binge drink and earnings as a joint outcome, the optimal conditions for inter-temporal resource allocation require that marginal benefits are equal to marginal costs. The marginal cost to him/her includes the price of alcohol and the discounted monetary values of the loss of health capital, utility, and labor productivity resulting from binge drinking. The marginal benefit is the satisfaction derived from current binge drinking.

The binge drinking variable is defined as an ordered-response variable with three categories: “no binge drinking” ($\text{DRINKING}_t = 1$), “binge drinking” ($\text{DRINKING}_t = 2$), and “heavy binge drinking” ($\text{DRINKING}_t = 3$), and the individual’s binge drinking demand equation is:

$$\begin{aligned} \text{D}^*{}_t &= \beta_1 + \beta_2 \text{P}ALCOHOL + \beta_3 \text{DOCBED} + \beta_4 \text{EARNINGS} + \beta_5 \text{NONWAGE\_INC}_t \\ &\quad + \beta_6 \text{D}_{t\text{-}1} + \beta_7 D_{t+1} + \beta_8 H_t + \beta_9 C_{1t} + u_{1t} \\ &\beta_2 < 0, \beta_3 \geq 0, \beta_4 > 0, \beta_5 > 0, \beta_6 > 0, \beta_7 > 0, \beta_8 < 0. \end{aligned} \tag{1}$$

The individual’s demand for binge drinking is expected to respond negatively to the local price of alcohol ($\beta_2 < 0$). Because data are quite limited on the local price of medical and hospital services, we use a proxy variable for it which is the per capita availability of local medical doctors and hospital beds (DOCBED). We expect the coefficient of DOCBED to be negative in the binge drinking equation ($\beta_3 > 0$). If drinking is associated with on-the-job social activities, e.g., business lunches, dinners, parties, or “afterwork” social drinking, an increase in an individual’s earnings could increase his/ her demand for binge drinking, or $\beta_4 > 0$. If the work environment is “dry”, an increase in earnings might decrease binge drinking. Furthermore, if alcohol is a normal good, an increase in an individual’s household nonwage income will increase his or her demand for drinking, or $\beta_5 > 0$.

The inclusion of a variable for an individual's anticipated future binge drinking behavior in his/her demand function for binge drinking distinguishes the rational addiction model from the myopic model. An individual is potentially addicted to alcohol if an increase in his/her current binge drinking increases his/her future demand for binge drinking. This is equivalent to current and past alcohol consumption and current and future alcohol consumption being complements across adjacent time periods. If addiction is economically rational behavior, the coefficients of D_{t-1} and D_{t+1} (β_6 and β_7) are expected to be positive and statistically significant in equation (1). An increase in an individual's demand for health (H) is expected to reduce the demand for binge drinking because it increases the marginal cost of binge drinking ($\beta_8 < 0$).

C_{1t} includes a set of year and state dummy variables; time-invariant personal and family background attributes reflecting the tendency for an individual to engage in risky behavior (to have engaged in illegal activity before 1980 or to have participated in underage drinking), religious affiliation when young, and father's education; variables reflecting permanent health endowment and gender, which proxy the human physiological capacity to process alcohol; and racial-ethnic background that may reflect the relevant local alcohol culture and demand for binge drinking. It also includes time-varying variables that could affect an individual's decision to binge drink, i.e., rural versus urban residence and local labor market conditions that signal potential frustration or satisfaction with one's current employment situation.

The individual's earnings equation is:

$$\ln(\text{EARNINGS}) = \alpha_1 + \alpha_2 \text{NONWAGE\_INC}_t + \alpha_3 \text{D}_t + \alpha_4 H_t + \alpha_8 C_{2t} + u_{2t} \quad (2)$$
$$\alpha_2 < 0, \alpha_3 < 0, \alpha_4 > 0.$$

If leisure is a normal good, an increase in an individual's family nonwage income will reduce his/her labor supply and earnings ($\alpha_2 < 0$). An individual's increase in binge drinking is expected to reduce his or her earnings ($\alpha_3 < 0$). An improvement in an individual's current health status (H) is expected to increase his/her earnings because of less time lost due to illness and greater labor productivity ($\alpha_4 > 0$).

C_{3t} is a set of year and state dummy variables, time-invariant personal and family background characteristics that affect an individual's tendencies to work in the market (including permanent health endowment or height, gender, race, and father's education) and a vector of potentially time-varying variables that may affect an individual's labor supply decisions (an individual's marital status, number of children, and local labor market conditions).[3] Also, we include selected interaction terms between gender, marital status, and the presence of young children to capture the different impacts of marital status and the presence of young children on the men's and women's labor supply.

Estimation Strategies and Identification

The basic econometric model consists of two structural equations, with the endogenous variables of DRINKING, which is a qualitative response, and *ln*(EARNINGS), which is continuous. Also, under the forward-looking hypothesis, an individual's one-year lag and lead binge drinking behavior ($DRINKING_{t-1}$ and $DRINKING_{t+1}$) are treated as endogenous variables in our model. The empirical definition of each variable in the model is given in Table 1, along with summary statistics, and Table 3 gives the exact specification of the two equations. In particular, we argue that an individual's composite score for his/her Armed Forces Qualification Test

(AFTQ) should enter the EARNINGS equation, but not his/her DRINKING equation. Similarly, the minimum legal drinking age of a state where an individual resides (MLDA) should included in his/her DRINKING equation, but not in his/her EARNINGS equation. Given that the specification of the 2-equation model includes an allowance for proxies for individual heterogeneity, each equation is identified (Greene, 2003; Gujarati,1995).

We choose to estimate the equations by the instrumental-variables method proposed by Nelson and Olson (1978).[4,5] The estimation method is similar to the two-stage least squares method, and its procedures are as follows. In the first stage, each endogenous variable is regressed on a set of instrumental variables consisting of all exogenous variables in the structural model plus year and state dummy variables, a dummy variable for presence of alcoholic parents, father's and mother's years of schooling completed, a dummy variable indicating that he/she lived with biological parents up to age 14, and the one-year lead and one-year lag values of the following variables: state minimum legal drinking age, real state secondary education expenditure per capita, and an individual's real net family income and marital status. The first-stage equation for binge drinking was fitted only for years in which the NLSY79 asked about binge drinking behavior—1979, 1980, 1983, 1984, 1985, 1988, 1989, and 1992--using the instruments listed above.

In the second-stage, predicted values of endogenous variables are the instruments for DRINKING, *ln* EARNINGS, and one-year lag and lead DRINKING. The structural equation system is then estimated equation-by-equation using the ordinal probit method for the frequency of binge-drinking and least squares for the earnings equation. The predicted values of an individual's current binge-drinking behavior, one-year lead and lag of binge-drinking behavior are the predicted latent values, $X'\hat{\beta}$, rather than predicted probabilities. Nelson and Olson have shown that the estimates obtained by this procedure are consistent.

By 1994, the NLSY79 had 16 waves of data. Although alcohol-related questions were only asked in 7 years, the health, earnings, and other socioeconomic variables were collected in all 16 years. To fully utilize the advantage of panel data, we use all 16 panels in the first-stage estimation. In the second stage, we use 16 years of data to estimate the earnings equation, while using 7 years of data in which alcohol-related questions were asked for fitting the binge drinking equation.

We have included family background and early outcomes to control for time-invariant individual effects in each equation. The rational addiction hypothesis for drinking places heavy demands on our data set because of its one-year lag and one-year lead drinking intentions, and hence, our model does not lend itself to differencing-out time-invariant individual effects from each structural equation. Given that we have included important time-invariant regressors in each equation to proxy what might otherwise be an unmeasured individual effect, we have minimized this problem.

Sample selectivity might arise due to panel attrition or labor force participation decisions. We follow the approaches used by Heckman (1976), Zabel (1998), and Ziliak and Kniesner (1998) and add a variable to control for potential self-selection. We, however, find that attrition is not selective, but labor force participation is selective, and choose to include an inverse Mills ratio, associated with labor force participation, in our two structural equations.

The local price of alcohol is affected primarily by local licensing policies for retail beer, wine and liquor sales, state excise taxes on alcohol and transportation costs. If individuals do not change their residence due to the local price of alcohol, the measured price of alcohol will have desirable properties for a regressor (e.g., Grossman and Markowitz, 1999; Kenkel, 1996; and Rosenzweig and Schultz, 1991, also used the local price). However, two potential problems arise. First, measurement errors may exist in our empirical measure of the price of alcohol, and this could cause inconsistency in the estimator. Second, the licensing policies for local retail beer, wine and liquor establishments and a state's alcohol tax policy might reflect the underlying alcohol culture, which also affects the tendency for an individual's to binge drink. This effect leads to inconsistent estimators for coefficients in the structural model (Greene 2003).

To test for the sensitivity of our results to a stochastic alcohol price, we experimented with an instrument for the local real alcohol price. The instrument is obtained from the forecast of a least-squares fit of a reduced-form equation for the alcohol price. The real local alcohol price is regressed on year and state dummy variables, dummy variables for MSA and PMSA and census region dummy variables. State fixed (and year) effects are also included in the alcohol-price equation, and they have statistically significant effects.[6] Also, the estimated coefficients of PMSA and MSA are significantly different from zero, suggesting that alcohol prices are higher in inner cities and in non-metropolitan areas relative to the suburbs.

Given the final structure of our two-equation model, the error terms have unknown distributions and might be heteroskedastic. Hence, for standard errors we choose a bivariate bootstrap method that is robust to assumptions about the distribution and heteroscedasticit of disturbances in the structural model. We generate random samples by bootstrapping pairs. We bootstrap pairs by re-sampling a block of dependent and independent variables with simultaneous replacement from all possible contiguous blocks. The choice of the block length is conditional on the degree of autocorrelation. We choose three years because the estimation requires one-year lead and lag variables. Efron and Tibshirani (1993) show that the outcomes from bootstrapping pairs (i.e., endogenous variables and vectors of exogenous variables) are less sensitive to the distributional assumption for these variables than bootstrapping residuals. Most importantly, bootstrapping residuals violate the basic idea underlying nonparametric analysis or the bootstrap, because a distributional assumption must be made to compute the residuals of any limited dependent variable.

Data and Empirical Definitions of Variables

The data set for this study is NLSY79, 1979-1994. The NLSY79 is a nationally-representative sample of 12,686 young men and women who were 14 to 21 years of age when they were first surveyed in 1979. The NLSY79 mainly collects information on the labor market experiences of young American adults, and over-samples blacks, Hispanics, and economically-disadvantaged white youth.

The binge drinking variable in this study is defined as the number of occasions when an individual consumed six or more drinks in one drinking session during the past 30 days. We choose it as our measure of alcohol consumption because binge drinking has become an important social problem that is more closely related to addiction than other measures. Although the NLSY79 collects data in annual surveys, the data for on frequency of binge drinking were available only for 1982-1985, 1988, 1989, and 1994.

The distribution of the reported occasions of binge drinking is skewed toward zero and contains a thin upper tail (see Table 2). Thus, we regroup the responses into *three* ordinal categories. We reassign the respondent to the "no binge drinking" group if his/her original response is 0 occasions; the "binge drinking" group if his/her original response is between 1 and 3 occasions; and "heavy binge drinking" if his/her original response is 4 occasions or more.[7]

Individual earnings (EARNINGS) are defined as *annual income from wage, salary and tips in constant prices*. The data pertaining to an individual's current health status in the NLSY79 are his/her self-reported physical limitations to work. We define "good current health status" to be when an individual indicates he/she has "no limitation" on the *amount* or *kind* of work he/she can perform. Hence, current health status is a binary variable, that equals one if the respondent has no health limitation and zero otherwise.

Data for the price of alcohol were taken from the *Cost of Living Index,* which is published quarterly by the American Chamber of Commerce Researchers Association (ACCRA). The publication reports data on prices for beer, wine and liquor for more than 250 cities located in the MSAs and the PMSAs. These prices are the actual prices paid by consumers for alcohol in the surveyed cities, and when an NLSY79 member lives in one of these cities, we assume that he/she pays this price. For respondents who do not live in one of the surveyed cities, we use state average prices, which are the average prices of the surveyed cities in a state.[8, 9]

Our alcohol price is a weighted average local price per gallon of ethyl alcohol (ethanol) from beer, wine and liquor. The weights are the consumption share of alcohol per capita from beer, wine and liquor in an individual's state of residence, and these data are from the *Brewers Almanac*. We assume that the ethyl alcohol content is 4 percent, 15 percent, and 40 percent for beer, wine and liquor, respectively. We convert the prices of beer, wine and liquor to the prices per gallon of ethyl alcohol by dividing the reported prices of beer, wine, and liquor by 0.56, 0.396, and 0.198, respectively. The weighted average price of pure alcohol is in constant 1994 dollars.[10]

Individuals learn about alcohol not only from their peers, but from church leaders, popular media, advertising and courses on healthy living. The NLSY79 collects data on the religious affiliations of individuals during their childhood years. We choose to categorize religious affiliations into two groups: those with liberal perspectives on alcohol consumption and those with a conservative perspective. We define RELIGA as a dummy variable taking a value of 1 if an individual reported in 1980 that he/she was raised as a Roman Catholic, an Episcopalian, or with no religious affiliation, and zero otherwise, which includes the Baptist, Methodist, Church of Christ, and Mormon religions that have a long history of opposing alcohol consumption. Hence, when RELIGA takes a value of one, the religious beliefs are at least somewhat positive toward drinking.

The price of local medical care is approximated by an indicator of availability of local hospital and medical services. The number of hospital beds available in the individual's resident area and number of physicians *per 100,000 people in the local population* proxy the degree of scarcity of medical resources and provide indicators of the cost of medical care (see Currie 2000). To combine the information on beds and physicians per 100,000 people into one variable, we standardize these two variables by dividing each of them by its own mean and then adding the two standardized values together to create a single index variable, DOCBED.[11]

The two time-invariant human capital variables—permanent health endowment and ability—receive proxies. The permanent health endowment is approximated by an individual's height at maturity, given gender. An individual's height at physiological maturity is a result of his/her genetic potential or heredity, and nurturing during gestation and early life, which affects the extent to which genetic potential is realized (Steckel 1995; Strauss and Thomas 1998; Fogel 1994, 1999; Schultz and Tansel 1997; Fogel and Costa 1997; Currie 2000).[12] The ability proxy is the Armed Force Qualification Test (AFQT) percentile.

Because the binge drinking equation contains one-year lag and lead values for drinking behavior, the estimation requires that each respondent participate in at least three consecutive surveys. Hence, the following restrictions are placed on our sample: (1) respondents who missed three or more consecutive surveys are deleted, (2) respondents who reported working more than 75 hours of weekly work are deleted, (3) observations having a missing value for the real alcohol price are deleted, (4) individuals who were enrolled in school or are in the armed forces when surveyed were deleted, (5) self-employed individuals and those working on a family farm or in a family business are deleted, and (6) individuals not living in the continental United States are deleted. Consequently, there are 65,602 observations.

Empirical Results and Model Simulations

Two fitted econometric models are presented in Table 3. Each model contains two equations, one for DRINKING and one for *ln* EARNINGS. The estimated coefficients of the two structural equations for DRINKING and EARNINGS in both models are very similar, except for the effects of DRINKING and HEALTH on EARNINGS. When the actual value of HEALTH is included as the regressor in the EARNINGS equation of Model 1 (column 2), both DRINKING and HEALTH have positive effects on EARNINGS. However, after we also instrument HEALTH, the estimated coefficient of DRINKING in the EARNINGS equation (column 4) is negative and the impact of HEALTH is two times larger, and both are significantly different from zero at the 5 percent level.[13] Our results suggest that failing to treat health as an endogenous variable may result in a biased and inconsistent estimator for coefficients in the binge drinking and earnings equations.[14] The pseudo or actual R^2 is larger for the equations in Model 2 than for those in Model 1. We therefore focus our discussion on Model 2.

The Demand for Binge Drinking

The estimated coefficient for PALCOHOL is negative and significantly different from zero at the 1-percent level. Hence, an individual's binge drinking behavior is price responsive. A 10 dollar (about 5 percent) increase in the price of pure alcohol per gallon (PALCOHOL) *decreases* an individual's probability of "heavy binge drinking" by 0.22 (and increases the probabilities of "binge drinking" and "no binge drinking" by 0.13 and 0.09, respectively). This result is achieved with an instrumented price of alcohol, which *increases the size* of the estimated coefficient of the alcohol price in the binge drinking equation by a *factor of 2.1* relative to actual alcohol price, and thus, coefficient of the price of alcohol is statistically more significant.

A larger DOCBED, i.e., increased availability of local medical services and fall in the price, increases the demand for DRINKING and suggests that health and drinking are substitutes. The estimated coefficient of NONWAGE-INC is positive and suggests that binge drinking is a normal good. Neither of these coefficients, however, is significantly different from zero at the 5 percent level. HEALTH has a negative and significant effect on DRINKING, implying that an increase in demand for health reduces frequencies of binge drinking.

Turning to other variables, an increase in the state minimum legal drinking age (MLDA) significantly reduces an individual's demand for binge drinking when he/she is an underage youth. A one-year increase in the minimum legal drinking age decreases an individual's probability of "heavy binge drinking" by 0.08 (and increases both the probabilities of "binge drinking" and "no binge drinking" by 0.05 and 0.03, respectively). These results suggest the rise in the minimum legal drinking age by states during the 1980s was effective in reducing heavy binge-drinking behavior by teenagers.

The effect of an individual's age on his/her demand for binge drinking is concave and statistically significant at the 5-percent level, supporting the maturing-out hypothesis and the impact of finite life on drinking behavior. A five-year increase in the individual's age decreases his/her probability of "heavy binge drinking" by 0.09 (and increases the probabilities of "binge drinking" and "no binge drinking" by 0.05 and 0.04, respectively). An increased level of schooling also reduces significantly an individual's binge-drinking behavior. This is consistent with previous findings that college *graduates* have the fewest occasions of binge drinking, although college students sometimes make the news for drinking excessively. An additional year of schooling decreases an individual's probability of "heavy binge drinking" by 0.084 (and increases his/her probabilities of "binge drinking" and "no binge drinking" by 0.048 and 0.036, respectively).[15]

Although we must interpret time-invariant individual effects with caution, there is nothing puzzling about their effects on binge drinking, which are consistent with direct effects dominating possibly-opposing indirect effects. Other factor being equal, an individual being male, engaging in illegal activity before 1980 (DILL80), or engaging in underage drinking (DRINK18) increase the demand for binge drinking. Also, an individual who was raised with a religious affiliation that was less-conservative (or liberal) regarding alcohol consumption (RELIGA) is significantly more likely to engage in binge drinking behavior.

The Earnings Equation

We focus our attention on column (4) of Table 3. An increase in an individual's non-wage income directly increases his or her annual earnings, which is consistent with an individual's leisure being an inferior good. The effect, however, is not significantly different from zero. The direct effect of a one-unit increase in the latent binge-drinking variable is a decrease in the individual's annual earnings by 4.7 percent. Contrary to cross-sectional evidence presented in earlier studies, an individual engaging in binge drinking significantly lowers his or her earnings. Individuals with no health limitations, other things equal, earn 6 percent more than other individuals.

The earnings function is concave with respect to an individual's age, as expected, and the effect of age peaks at 32 years. Increasing an individual's schooling (SCHOOL) by one year raises his/her earnings, but by only one percent in Model 2. This is in contrast to Model 1, where the impact is 6 percent, and is similar to estimates reported in Card (1999, p. 1834-45). Since the impact of schooling on earnings changes greatly, depending on the exogeneity/endogeneity treatment of current health status, this suggests that the two factors are strongly interrelated. An individual's schooling affects his/her earnings largely indirectly through health rather than directly.

An individual living in an urban area has higher annual earnings. Also, earnings are significantly higher outside of the South: 16 percent higher in the Northeast, and, 27 and 39 percent higher in the North Central and West regions, respectively. A higher resident-state unemployment rate also reduces significantly the individual's earnings. Our results imply a black-white wage differential of only 5 percent, other things equal, which is small compared to cross-sectional evidence presented by Neal (1996) for men.

Marital status and the presence of young children have different impacts on the earnings of males and females. Married men earn 17 percent more unmarried men. Individuals who have young children earn less. One additional child under age 5 or between the ages of 5 and 12 decreases women's earnings by 12.6 and 9 percent, respectively. Women's earnings increase by 5.6 percent with the presence of one additional child in the household over age 12. On the other hand, one additional child under age 5 or above age 12 *increases* a male's earnings by only 0.007 (-12.6+0.133) and 1.3 (0.056-0.043) percent, respectively. A male's earnings decrease by 2.3 (-0.09+0.067) percent with the presence of one additional child in the household between age 5 and 12. Consistent with other studies, our results show that men's earnings are less affected by the presence of young children than are women's earnings.

Model Simulations and Discussion

In this section, the results from the fitted econometric model are used to simulate the impacts of changing public policy, as reflected in the local price of alcohol. The simulation is based on the results from Model 2. First, reduced-form equations for the two-equation structural model are obtained.[16] The details of the derivation are available upon request. They are then used to compute the short-run and long-run alcohol price elasticity of demand on binge drinking and earnings. In these simulations, we include only respondents who participated in every NLSY survey between 1979 and 1994. This is to minimize the effect of survey nonparticipation on the simulated results. Because the reduced-form solutions are functions of current, past and future values of exogenous variables and the time horizon of these exogenous variables goes forward and backward to infinity, it is necessary to make assumptions about the data outside of the sample years. In the simulations, values of exogenous variables for years before 1979 are arbitrarily set equal to their 1979 values and values of exogenous variables for years after 1994 are set equal to their 1994 values.[17]

We simulate the long-run and short-run elasticities of binge drinking and annual earnings due to an increase in the alcohol price. The results are reported in Table 4. The short-run elasticity measures the effect of an unanticipated permanent increase in the local alcohol price, starting from period t, on an endogenous variable in period t. The long-run price elasticity estimates the effect of an anticipated permanent change in the alcohol price in all future periods on an endogenous variable.

Because binge drinking behavior is represented as an ordinal variable, the price elasticity of demand for binge drinking requires special interpretation. The elasticity shows the effect of increasing alcohol prices on the probability of an individual engaging in heavy binge drinking, binge drinking, or no binge drinking, respectively. The own-price elasticity of demand for binge drinking is relatively large in the short- and long-run, and consistent with standard economic theory, i.e., the long-run price elasticity is larger than the short-run elasticity. Binge drinking is quite responsive to the price of alcohol: a 1-percent increase in the local alcohol price decreases the probability of an individual engaging in heavy binge drinking by 2.36 and 1.29 percent in the long-run and short-run, respectively. Hence, these results suggest that binge drinking by young people is highly responsive to state taxes on alcohol.

Because the summation of the elasticities of heavy binge drinking, binge drinking, and no binge drinking equals one, our results show that an increase in the local alcohol price effectively decreases the occasions of binge drinking, and that an individual is thus, much less likely to become a binge drinker. The elasticity of earnings with respect to the alcohol price is positive, suggesting that raising alcohol prices promotes human health and improves earnings. A 1-percent increase in the price of alcohol has a simulated short-run effect of raising annual earnings by 0.21 percent and a long-run impact of 0.45 percent (Table 4). The long-term impacts on earnings are two times larger than short-term effects, consistent with the long-run impact of a rise in alcohol prices on binge drinking.

Conclusions

This study has used a dynamic model to examine an individual's decision to binge drinking and the effect of binge drinking on earnings. The empirical results support the rational addiction model that an individual's binge drinking behavior is rational and that binge drinking, health status, and earnings are jointly determined. Failing to instrument an individual's current health status leads to inconsistent and biased estimates. Our findings also show that an individual's demand for binge drinking can be reduced significantly by a substantial increase in the local price of alcohol, e.g., more stringent licensing of local retail sales of beer, wine and liquor, and an increase in states excise taxes on alcohol. An increase in the alcohol price was shown to significantly reduce an individual's probability of "heavy binge drinking" and increase the probability of "no binge drinking" after controlling for early experiences with alcohol and early delinquent behavior. Although we find that the demand for binge drinking by underage youth is responsive to a state's minimum legal drinking age, the highest minimum legal drinking age is currently 21 years, and further increases seem unlikely.

Contrary to studies using cross-sectional data, our findings suggest that an individual's decision to binge drink *does* lower his earnings significantly. Although our definition of alcohol consumption, i.e., binge drinking, is different from those used in earlier studies, we believe that the main difference in the results is due to the panel nature of our data set and to the increased sophistication of the econometric model. Furthermore, the short-run and long-run effects on earnings of a simulated increase in the price of alcohol are positive.

Our analysis holds constant proxies for time-invariant individual-specific effects through mature height, ability, gender, religious affiliation when young, race/culture, and early tendencies to engage in illegal activity. When health is treated as exogenous, we obtain an implied return on schooling in the wage equation that is in the range of other studies. However, when we instrument for good health, the impact of schooling falls to one-sixth its previous value. Hence, there seem to be strong schooling-health linkages.

In conducting our econometric analysis we have made modeling decisions that seem justifiable, but that undoubtedly affect our results. For example, we have imposed a set of restrictions on our econometric model to simplify it and to achieve identification. These decisions must be made in order for us to have the potential for making new discoveries and progress. However, as with any empirical research, the quality of our results hinges on these decisions. In addition, the data we use are limited to individuals younger than 40. The negative effect of binge drinking on health and earnings may be even greater in older individuals. As the years pass and the NLSY79 cohort becomes older, new research can expect to find greater effects of binge drinking and other decisions, such as health investment, on earnings.

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Table 1. Symbols, Definitions, Means, and Standard Errors of Variables: NLSY79, 1979-1994

Symbols	Mean (Std. Deviation)	Definitions
Endogenous Variables:		
DRINKING	1.47 (0.71)	Ordinal response: no binge drinking (1), binge drinking (2), and heavy binge drinking (3) in the past 30 days
EARNINGS	24,981.99 (90,523)	Real annual earnings from wages, salaries and tips in dollars
Exogenous or Predetermined Personal and Family Background Characteristics:		
HEALTH	0.07(0.25)	Dichotomous variable equals 1 if individual has no health limitations on the amount or kind of work
NONWAGE_INC	20.05 (53.93)	Real family nonwage income (in thousands)
AGE	25.29 (4.27)	Age
AGE2	657.98 (218.14)	Age square
SCHOOLING	12.35 (2.29)	Highest grade completed
MARRIED	0.41 (0.49)	Dichotomous variable equals 1 if respondent is married
URBAN	0.80 (0.4)	Dichotomous variable equals 1 if respondent lives in urban area
WEST	0.19 (0.40)	Dichotomous variable equals 1 if respondent lives in the West region
NORTHEAST	0.18 (0.39)	Dichotomous variable equals 1 if respondent lives in the Northeast region
NORTHCENTRAL	0.24 (0.43)	Dichotomous variable equals 1 if respondent lives in the North Central region
MARRIED*MALE	0.17 (0.37)	Interaction term of MARRIED and MALE
KIDS5	0.47 (0.76)	Number of children who are younger than 5
KIDS12	0.07 (0.33)	Number of children who are older than 5, but younger than 12
KIDS18	0.04(0.24)	Number of children who are older than 12, but younger than 18
KIDS5*MALE	0.16 (0.49)	Interaction term of KIDS5 and MALE

Table 1, continued

KIDS12*MALE	0.07 (0.33)	Interaction term of KIDS12 and MALE
KIDS18*MALE	0.01 (0.12)	Interaction term of KIDS18*MALE
HEIGHT	5.58 (0.34)	Height at maturity (in feet)
MALE	0.47 (0.50)	Dichotomous variable equals 1 if respondent is male
BLACK	0.27 (0.44)	Dichotomous variable equals 1 if respondent is African American
HISPANIC	0.17 (0.38)	Dichotomous variable equals 1 if respondent is Hispanic
RELIGA	0.40 (0.49)	Dichotomous variable equals one if respondent was raised as a Roman Catholic, Episcopalian, or religious "none"
DILL80	0.10 (0.30)	Dichotomous variable equals 1 if respondent had delinquent record in 1980
DRINK18	0.44 (0.50)	Dichotomous variable equals 1 if started drinking before age 18
AFQT	38.71 (28.48)	AFQT test percentile
Exogenous Area Characteristics:		
DOCBED	2.00 (1.12)	Sum of the standardized values of physicians and hospital beds per 100,000 population in the area of residence[18]
PALCOHOL	175.36. (15.48)	Weighted average real local price of a gallon of pure alcohol in beer, wine, and liquor
MLDA*DMINIAGE	1.46 (5.24)	Interaction term between minimum legal drinking age and the indicator for a respondent being younger than the minimum legal drinking age[19]
UNEMPLY	3.10 (1.07)	Local unemployment rate

Table 2. Absolute Frequency, Percentage and Cumulative Percentage Distribution for Occasions of Binge Drinking: NLSY79, 1979-1994

Occasions of Binge Drinking	Frequency	Percentage	Cumulative Percentage
0 Occasion	33,780	66.0	66.0
1 Occasion	4,883	9.5	75.6
2-3 Occasions	5,870	11.5	87.0
4-5 Occasions	2,951	5.8	92.8
6-7 Occasions	1,287	2.5	95.3
8-9 Occasions	652	1.3	96.6
10 or More Occasions	1,745	3.4	100.0
Total	51,168	100.0	100.0

Source: NLSY79

Table 3. IV Estimates of 2-Equation Model for an Individual's Demand for Binge Drinking and Earnings: NLSY79, 1979-1994 (Robust Multivariate-Bootstrap standard errors)[a/]

Variables	Model 1		Model 2[b/]	
	DRINKING (1)	ℓn EARNINGS (2)	DRINKING (3)	ℓn EARNINGS (4)
PALCOHOL	-0.098**		-0.099**	
	(0.037)		(0.036)	
DOCBED	0.005		0.005	
	(0.004)		(0.005)	
ℓn EARNINGS	-0.018		0.037	
	(0.025)		(0.103)	
NONWAGE-INC	0.0001	0.0005***	0.0001	0.00002
	(0.0001)	(0.00006)	(0.0001)	(0.00004)
DRINKING		0.364***		-0.047***
		(0.013)		(0.013)
DRINKING(-1)	0.180**		0.169**	
	(0.080)		(0.081)	
DRINKING(+1)	0.467***		0.485***	
	(0.071)		(0.075)	
HEALTH	0.0189***	0.287***	-0.045***	0.623***
	(0.043)	(0.016)	(0.007)	(0.002)
MLDA*DMINIAGE	-0.004**		-0.003*	
	(0.002)		(0.002)	
AGE	0.105**	0.223***	0.098**	0.371***
	(0.035)	(0.011)	(0.040)	(0.012)
AGE2	0.002**	-0.003***	-0.002**	-0.006***
	(0.0004)	(0.0001)	(0.0005)	(0.0004)
SCHOOLING	-0.038**	0.062***	-0.036***	0.010***
	(0.006)	(0.003)	(0.007)	(0.003)

Table 3 continued

MARRIED	-0.198***		-0.196***	
	(0.030)		(0.029)	
URBAN	0.027	0.038***	0.023	0.052***
	(0.023)	(0.009)	(0.022)	(0.007)
UNEMPLY		-0.055***		-0.030***
		(0.003)		(0.004)
WEST	0.458**	0.13	0.434**	0.394***
	(0.221)	(0.102)	(0.223)	(0.095)
NORTHEAST	0.386	0.144	0.375	0.165*
	(0.254)	(0.102)	(0.251)	(0.09)
NORTH CENTRAL	0.297	0.111	0.295	0.274**
	(0.237)	(0.122)	(0.234)	(0.113)
MARRIED*MALE		0.363***		0.175***
		(0.013)		(0.040)
KIDS5		-0.26***		-0.126***
		(0.007)		(0.009)
KIDS12		-0.052***		-0.09***
		(0.006)		(0.009)
KIDS18		0.018		0.056***
		(0.017)		(0.013)
KIDS5*MALE		0.096***		0.133***
		(0.01)		(0.009)
KIDS12*MALE		0.055***		0.067***
		(0.012)		(0.008)
KIDS18*MALE		-0.073**		-0.043*
		(0.041)		(0.024)
HEIGHT	0.066*	-0.058***	0.062*	0.053***
	(0.031)	(0.017)	(0.029)	(0.014)

Table 3 continued.

MALE	0.154**		0.155**	
	(0.036)		(0.035)	
BLACK	-0.121***	0.071***	-0.122***	-0.054***
	(0.026)	(0.013)	(0.079)	(0.002)
HISPANIC	-0.036	0.062***	-0.037	-0.011
	(0.026)	(0.02)	(0.024)	(0.006)
RELIGA	0.049***	-0.015**	0.051***	-0.009
	(0.015)	(0.005)	(0.017)	(0.007)
DILL80	0.142***	-0.161***	0.134***	0.026**
	(0.032)	(0.014)	(0.029)	(0.009)
DRINK18	0.187***	-0.199**	0.186***	-0.002
	(0.035)	(0.007)	(0.036)	(0.007)
FATHER's ED	0.005**	-0.003**	0.004**	0.001***
	(0.001)	(0.001)	(0.002)	(0.0005)
AFQT		0.005***		0.0012***
		(0.0003)		(0.0003)
LAMBDA	-0.149*	-0.364***	-0.178*	-0.407***
	(0.084)	(0.042)	(0.101)	(0.036)
Sample χ^2 [c]	7,380.53	373.35	7,360.74	599.68
Degree of freedom	77	86	77	86
R^2 or pseudo R^2	0.122	0.328	0.122	0.439
No. of observations	33,501	65,602	33,501	65,602

[a] State, year dummies and intercept terms are included in each equation, but estimates for them are not reported here.

[b] Health is also treated as an endogenous variable and instrumented in this model.

[c] Test of null hypothesis that the equation has no explanatory power.

***Statistically significant at the 1 percent level.

** Statistically significant at the 5 percent level.

* Statistically significant at the 10 percent level.

Table 4. Simulated Short-Run and Long-Run Effects of an Increase in the Local Alcohol Price on Binge Drinking Behavior and Earnings

Dependent Variables		**Price Elasticity**
DRINKING:		
(a) Probability of being a heavy binge drinker	Short Run	-1.28
	Long Run	-2.36
(b) Probability of being a binge drinker	Short Run	0.07
	Long Run	0.08
(c) Probability of not being a binge drinker	Short Run	1.21
	Long Run	2.28
ℓn (EARNINGS)	Short Run	0.21
	Long run	0.45

Endnotes:

[1] U.S. per capita consumption of alcohol peaked in 1980-81 and in 1984, the federal government imposed transportation legislation requiring that states wanting federal highway aid must raise their legal minimum drinking age to 21 years.

[2] The NLSY79 asked binge drinking questions only in 1979, 1980, 1983, 1984, 1985, 1988, 1989, and 1992, one half of the years in the 1979-1994 period. Hence, a differences-in-difference model would require discarding a large amount of the available binge drinking data and would preclude testing the rational addiction hypothesis. With a structural model, we can bring all of this data to bear on the parameters in the binge drinking equation, including the hypothesis of rational addiction.

[3] The labor economics literature is mixed in its treatment of the number of children as predetermined and endogenous. Since family size is not the primary focus of this study and the panel data are annual, an individual's number of children by age group is treated as predetermined.

[4] A good review of the estimation methods for simultaneous equations with limited dependent variables can be found in Amemiya (1974, 1978, and 1979), Lee (1982), and Maddala (1983). We also instrument the lead and lag values of binge drinking because they are endogenous.

[5] The instrumental variable estimation method is similar to the two-stage least square estimation method and the estimation in the first stage is statistically significant. The chi-square statistics for the demand for health, current binge drinking, lag binge drinking, and lead binge drinking in the first stage are 4,838, 9,561, 9,481, and 10,071 respectively. The F statistics for labor supply and the wage equations are 344 and 977 respectively.

[6] The R-squared for the local real alcohol price equation is high (0.75), and hence, we do not have a weak correlation between the instrument and the endogenous/stochastic explanatory variable (see Bound, Jaeger, and Baker 1995). The regression results are available upon request.

[7] The number of groups and boundaries on the categories are, of course, somewhat arbitrary. Compared to binge drinking measures that are continuous, our measure has two advantages. First, we do not force a linear incremental relationship on the severity of binge drinking. Having no occurrences of binge drinking (being in group 1) is much different than binge drinking with 1, 2, or 3 occassions per month, but more frequent binge drinking (i.e., 3 or more times per month) may be very different than lesser values. Second, our measure of binge drinking minimizes the problems of memory lapses—and measurement errors—in those individuals who have a high frequency of binge drinking, e.g., our binge drinking measure treats individuals who report 3 or more occurrence of binge drinking in the past 30 days equally, rather than needing to accurately distinguish between, for example, 4 or 6 or 10 occurrences.

[8] Before 1982, the *Cost of Living Index* only surveyed prices of liquor. Regression analysis is applied to obtain the predicted prices of beer and wine for 1979-1982. We regressed state prices for beer and wine between 1982 and 1996 on state excise tax rates, indicators for geographical regions, and a time trend. The data on state excise tax rates come from the *Brewers Almanac*.

[9] If the respondents did not live in the same state or the same city in consecutive years, the lead and lag alcohol prices are simply calculated as the average of the pure alcohol prices in the two different cities or states.

[10] The derivation of the price of ethyl alcohol per gallon is as follows: [(beer price per gallon / alcohol content)* consumption share of beer per capita] + [(wine price per gallon / alcohol content) * consumption share of wine per capita] + [(liquor price per gallon / alcohol content) * consumption share of liquor per capita].

[11]This procedure was suggested to us by Wayne Fuller.

[12] Human growth seems to have functional consequences for physical and mental development, health, personality, and personal appearance that have been shown to affect labor productivity and (or) hours of work (Steckel 1995; Fogel 1994; Strauss and Thomas 1998; Biddle and Hamermesh 1998). Also, height (and weight) at early ages have predictive power for the on set of chronic diseases and premature mortality in middle and late ages (Fogel 1999; Fogel and Costa 1997). Steckel (1995) shows that the average height of U.S. adult, native-born, white males rose steadily for the 75 years before the birth cohort of 1955, but then peaked and declined to 1965, being about 1 percent below trend in 1965, before starting to increase again.

[13] First stage estimates are available from the authors for all variables that are instrumented.

[14] Some other differences are as follows. In Model 1, the estimated coefficients for HEIGHT and FATHERs ED in the *ln* EARNINGS equation are negative and significant, but they are positive and significant in Model 2. The latter results seem most plausible. Also, in Model 1, the estimated coefficient of SCHOOL in the *ln* EARNINGS equation is 0.06, but is 0.01 in Model 2.

[15] If an individual is living in an urban area, this increases his/her demand for binge drinking, holding the price of alcohol constant, perhaps due to a "wetter" local alcohol culture in urban than rural areas. Also, when an individual is married, his/her demand for binge drinking is reduced, which is consistent with greater personal responsibilities than when he/she is not married.

[16] The details of the derivation are available upon request.

[17] The computations also depend on how quickly the effects of the past and anticipated future values of variables diminish in their impact on the current value of the endogenous variables. The unstable root, 1.93, implies that the effects of anticipated future values of variables are approximately zero after 18 years. The stable root, 0.4, suggests that the effects from past values of variables will approach zero in 10 years. Therefore, the calculation in each year uses the actual values of lead variables for 18 years in the future and the values of lagged variables for 10 years in the past. We impose a stability condition to derive the long-run price elasticities.

[18] The means of the number of physicians and hospital beds per 100,000 population are 1811.92 (1285.18) and 6266.08 (4624.65), respectively. The standard errors are in parentheses.

[19] MLDA is the state minimum legal drinking age. Its mean and standard error are 20.23 and 1.17, respectively. DMINAGE is a dichotomous variable that equals 1 if the respondent is younger than minimum legal drinking age. Its mean and standard error are 0.07 and 0.26, respectively.

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