Smoking Cessation and Lifestyle Changes

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I. Introduction

Several health behaviors affect longevity and quality of life: smoking, heavy use of alcohol, obesity, lack of exercise, stress, and other behaviors. While many studies have analyzed decisions to quit each one of these habits individually (e.g., Jones 1994; Douglas 1998; and Perreira and Sloan 2001), more realistically, all of these habits are jointly determined.

Smoking and high levels of alcohol consumption are positively correlated. Persons with drinking problems are two to three times more likely to smoke than are persons without such problems (Henningfield et al. 1990; Johnson and Jennison 1992; Rosengren 1993). Smokers consume twice the amount of alcohol per capita as do nonsmokers (Carmody et al. 1985).

Weight and smoking are negatively correlated (Wee et al. 2001). Also, smokers, especially women, report that weight gain is a major impediment to smoking cessation (U.S. Department of Health and Human Services 1990; Pirie et al. 1991; Rigotti 1999). Smoking appears to have a weight-suppressant effect, and weight gain frequently occurs following smoking cessation (Klesges et al. 1991; Moffat and Owens 1991; Williamson

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et al. 1991). However, the observed relationship is fragile, that is, is sensitive to model specification (Wee et al. 2001).

Various behaviors might be complements to smoking, such as heavy drinking, or substitutes (overeating). To economists, two goods are complements or substitutes depending on whether the consumption level of one of the goods affects the marginal utility of consuming the other good. Consumption of two goods may be positively or negatively associated for reasons other than being complements or substitutes. For example, an increase in income may cause an increase in consumption of large number of goods. Or a health shock may affect the marginal utility of many goods, positively or negatively. But then a change in consumption of one good would not *cause* a change in the consumption of another. Smoking advertisements may be common in bars, not because cigarettes and alcoholic beverages are complements but because of a preference structure not observed by the researcher, that regular or heavy drinkers happen to also like cigarettes.

A complementary relationship implies that smoking cessation efforts may also reduce heavy drinking. Thus, alcohol treatment and smoking cessation programs may be partial substitutes. The evidence on this relationship is not clear. Edwards et al. (1997, p. 118) suggested that when problem drinkers stop drinking, they may compensate by smoking more, implying that, at least for problem drinkers, alcohol and cigarettes may be substitutes, not complements.

If smoking and overeating are substitutes, as some evidence suggests (see e.g., Flegal et al. 1995), and many smokers, especially women, apparently believe to be the case (U.S. Department of Health and Human Services 2001), concerns about weight gain may be a barrier to smoking cessation. To the extent that such concerns are quantitatively important, it may be fruitful to incorporate successful methods for weight gain avoidance in interventions designed to promote smoking cessation. Quitting smoking may lead people to consume higher caloric meals. The 1990 report of the Surgeon General on the *Health Benefits of Smoking Cessation* concluded that, on average, quitting smoking leads to a weight gain of five pounds (U.S. Department of Health and Human Services 1990), but, nevertheless, the health benefits from smoking cessation far exceed the negative health effects associated with higher weight.

Knowing substitution/complementarity relationships is useful for public policy for at least three reasons. One is for gaining a more complete assessment of the full health impacts of programs aimed at promoting cessation. For example, the relative risk of being obese on survival and disability seems to be far lower than the relative risk of smoking on these outcomes (see e.g., Calle et al. 1999; Taylor and Ostbye 2001; Taylor et al. 2002). But not accounting for the effect of smoking cessation on weight gain will lead to an overestimate of the health benefits of smoking cessation. On the other hand, if there are positive spillovers for alcohol use, the health benefits from smoking cessation would be underestimated.

Second, the results may be useful for the design of treatment interventions. Smoking cessation prior to formal treatment of alcoholism may improve subsequent drinking outcomes (Miller et al. 1983) and conversely for smoking cessation programs (Burling et al. 1982).

A third use, related to the second, is for the design of specific information treatments to encourage reductions in each of these bad habits. More truthful messages would incorporate information about the side effects of interventions. Also, to the extent that habits are complements or substitutes, it may be advantageous to design interventions that address more than one habit at once.

Public policies, no matter how well intentioned, are subject to unintended consequences. For example, in the context of tobacco control, one purpose of imposing excise taxes is to reduce consumption of a harmful substance. However, faced with higher cigarette prices, smokers have adopted compensatory behaviors.

Evans and Farrelly (1998) found that smokers respond to increases in price by reducing the number of cigarettes consumed; they also engage in several compensating behaviors like switching to brands higher in tar and nicotine. But unintended consequences can be favorable as well. In an analysis of smoking initiation, Dee (1999) found that laws that increased the minimum age to consume alcohol also reduce smoking participation among teenagers.

In this study, we used the first five waves of the Health and Retirement Study (HRS) to study three distinct but possibly interrelated phenomena: smoking cessation, changes in alcohol consumption, and changes in weight. The HRS does not collect information on food consumption, but it does ask about heavy exercise, which we analyze in addition to the body mass index (BMI). The BMI reflects weight relative to height. Weight gain reflects a combination of food intake and exercise, as well as factors that are exogenous to the individual (metabolism). Of these, only exercise is directly observed, although some factors determining rate of metabolism are likely to be time-invariant, which, using panel data, can be measured with fixed effects.

Having panel data is highly advantageous for empirical analysis of smoking cessation and concomitant behaviors. Smoking cessation is inherently longitudinal. With a panel, one can gauge the effects of a behavioral change, such as in smoking. Also, one can distinguish between exogenous events, such as health shocks, affecting a number of decisions simultaneously from changes in other behaviors due to a change in a behavior, such as in cigarette consumption. Using fixed effects, one can isolate the effects of time invariant factors that influence consumption of commodities from effects of time-varying changes, such as in tobacco use. Finally, with a panel, one can assess the time path of responses of other decisions to a decision, such as a decision to stop smoking.

Although panel data have many advantages over single and repeated cross-sectional data, results from panels may be subject to bias because of respondent attrition or non-response. Attrition bias can result if the propensity to drop out is correlated with the outcome of interest. In our context, a health shock, such as a heart attack, may have cause an individual to quit smoking and drink less, but at the same time it will increase his/her probability of death and dropping out of the sample. Our econometric strategy took account of potential selectivity bias by estimating a probit model of surviving each wave and using Mills ratios as additional explanatory variables.

Section II discusses conceptual issues underlying research on addictive behavior. Section III develops the econometric strategy. Sections IV-VI in turn discuss data, the empirical specification, and results. Section VII concludes the paper.

II. Conceptual Issues

A large literature has analyzed the consumption of addictive and harmful goods like cigarettes and alcohol. Although the consumption of these goods may seem irrational and outside the scope of economics, today the most accepted economic framework to explain this kind of behavior assumes that individuals are rational and forward-looking, as formulated in Becker and Murphy (1988)'s rational addiction model. In this framework, fully rational forward-looking individuals chose whether or not to become addicted to a substance. A body of economic research finds empirical support for this model (see Chaloupka and Warner 2000). But, as Gruber and Köszegi (2002) have argued, the empirical evidence is consistent with other models of addictive behavior in which people are forward-looking but time-inconsistent.[2]

In the original rational addiction model, smokers quit "cold turkey," due to exogenous shocks, such as from changes in the relative price of the good or health shocks. In a recent article, Goldbaum (2000) extended the rational addiction model, showing that forward-looking rational addicts may quit gradually because as the individual ages he places a higher weight on the health consequences of smoking. Using data from HRS, Sloan et al. (2003) also found that many smokers in late middle age quit gradually.

The theoretical literature on rational addiction models has been concerned only with the consumption of a single good, such as smoking. Very few studies have investigated consumption of two addictive goods jointly; one exception is a recent paper by Arcidiacono et al. (2001), who used a structural model to explain decisions of male HRS respondents to smoke and engage in heavy drinking. Their framework allowed for a

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[2] Intuitively, time inconsistency means the following: As a shopper, I may eschew purchase of peach ice cream, knowing that at around 10 p.m., I will raid the icebox if the ice cream is there. Thus, there is the rational self who eschews the purchase and the more short-sighted self who figures that a little ice cream won't do that much harm and tastes so good. In the context of smoking and/or heavy drinking, a person may know that these behaviors are bad, but at a particular instance, taking that extra puff or extra drink is enjoyable and in itself does not seem to have much of an adverse impact on health.

comparison between fully rational, forward-looking behavior as hypothesized in the rational addiction model with an alternative model in which people do not take account of the future consequences of their present actions. On balance, they found, if anything, observed patterns of smoking and heavy drinking were more consistent with a myopic than with a fully rational model. Testing the rational addiction model and gauging the empirical importance of time inconsistency are beyond the scope of this study. Instead our goal is to empirically analyze changes in health lifestyles after an individual quits smoking.

III. Econometric Strategy

We estimate the following basic equation:

$$y_{it} = \delta_1^y q_{it}^1 + \delta_2^y q_{it}^2 + \delta_3^y pq_{it}^1 + \delta_4^y pq_{it}^2 + \beta_1^y H_{it} + \beta_2^y X_{it} + \beta_5^y d_t + \beta_6^y pd_t + \mu_i + \varepsilon_{it}^y \qquad (1)$$

where y is the dependent variable: the number of drinks per day, the BMI, or whether the individual engages in heavy exercise (defined below), among other health habits. The variable q^1 is a binary that equals 1 if the individual quit smoking between periods t and $t-1$ and q^2 equals 1 if the individual quit anytime before period t-1. The variable pq^1 is a binary that equals 1 if a problem drinker (defined below) quit smoking between periods t and t-1 and pq^2 equals 1 if a problem drinker quits before period t-1. Interacting a time-invariant measure of problem drinking with q_1 and q_2 generates these binaries. As noted above, the effects of smoking cessation may be different for this subgroup of individuals. The vector H stands for health variables and accounts for health shocks that have simultaneously caused smoking cessation and lifestyle changes. Exogenous variables, including prices and income, are included in X; d_t is a set of time dummies; and pd_t is a set of dummy variables obtained by interacting d_t with problem drinking. The variable pd_t

accounts for plausible differential trends in lifestyle behavior between problem drinkers and non-problem drinker. The individual fixed effect is μ_I; ε is an independent and identically distributed error term.

The coefficients δ_1 and δ_2 correspond to changes in y (e.g., drinking behavior) after the individual quit smoking as contrasted with those who did not quit. The first coefficient measures the effects during the period that the individual quit smoking, and the second measure, the change in future periods. It is possible that the lifestyle changes were not permanent. Coefficients δ_3 and δ_4 measure the additional effects for problem drinkers who quit smoking.

Because the same health shocks that affect the individual decision to quit smoking and change his lifestyle also plausibly increase the probability of death, attrition in our panel might not be random. Ignoring sample attrition will yield inconsistent parameter estimates if sample continuation is correlated with the unobserved variables.[3]

To control for this potential bias, we followed a two-step procedure (see Zilliak and Kniesner 2001). In the first step, we estimated the probabilities of survival between any two waves using probit methods. We then used these estimates to construct the sample selection Mills ratio λ_t. In the second step, we estimated the following attrition-corrected first-differences model:

$$\begin{aligned}\Delta y_{it} = {} & \delta_1^y \Delta q_{it}^1 + \delta_2{}^y \Delta q_{it}^2 + \delta_3{}^y \Delta pq_{it}^1 + \delta_4{}^y \Delta pq_{it}^2 + \beta_1^y \Delta H_{it} + \beta_2{}^y \Delta X_{it} + \beta_5{}^y \Delta d_t \\ & + \beta_6{}^y \Delta pd_t + \beta_7{}^y \lambda_{it} + \Delta \varepsilon_{it}^y \end{aligned} \qquad (2)$$

This first-differences model allowed us to control for individual fixed effects and sample attrition; it can be estimated using traditional regression methods.

[3] See Moffit et al. (1999) for a discussion of the literature on panel attrition.

We also analyzed the correlation between smoking cessation and lifestyle changes by assessing the effects of changes in heavy drinking on the probability of smoking cessation. Specifically, we estimated the following smoking cessation equation:

$$q_{it}^{*} = \gamma_1 qhd_{it} + \gamma_2 shd_{it} + \gamma_3 hd_i + X_{it}\alpha_1 + H_{it}\alpha_2 + d_t\alpha_3 + \lambda_{it}\alpha_4 + \varepsilon_{it} \qquad (3).$$

If $q^{*} > 0$, the individual quits smoking between periods t and t-1. The variables qhd_{it} and shd_{it} are binaries indicating whether the individual quitted or started heavy drinking between periods *t* and *t-1*. Because individuals who do not smoke cannot quit again, we could not use first-differences as in our previous model. Instead, we controlled for time-invariant heavy-drinking dummy hd_i, which equals one if the individual was a heavy drinker in any wave. We estimated this equation as a linear probability model.

IV. Data

We used data from the first five waves of the HRS, which was a survey conducted in 1992, 1994, 1996, 1998, and 2000. The original HRS sample consists of persons who were born between 1931 and 1941 (hence were aged 51-61 in 1992) and their spouses, who could be of any age.[4] Baseline interviews were conducted in respondents' homes, with subsequent interviews by telephone. A response rate of approximately 80 percent was obtained in each year. At baseline 12,652 persons (7,608 households) were sampled (Juster and Suzman 1995).

The HRS is well suited for our study in that it contains measures of smoking and drinking behavior; weight; and detailed financial, demographic, and health data; and both health conditions existing at baseline and those newly occurring. Formats differed somewhat among the waves. For purposes of this study's empirical analysis, we limited

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[4] A younger age cohort was added in 1998. We did not include these individuals in our analysis.

the sample to persons between the ages of 51 and 61 at wave 1. Because we were concerned with the effects of smoking cessation on other health habits, we further limited our sample to current smoker at wave 1. A total of 2,664 male and female respondents were included in our sample at wave 1. However, because of death or attrition by wave 5, our sample included 1,875 individuals—a 30 percent attrition in eight years.

In our analysis of the determinants of smoking cessation we further restricted our sample to individuals who were smokers at the wave immediately before to the decision. For example, if an individual quit smoking in wave 2, the person was dropped from the sample. However, if he restarts smoking in wave 4 he rejoins the sample.

V. Empirical Specification

Dependent Variables: Our main dependent variables were drinking behavior and the BMI. We measured drinking behavior by the number of drinks a day that the person reported consuming on average. In waves 1 and 2, HRS asked respondents if they ever drink alcoholic beverages, and for those who consumed alcoholic beverages, if usually consumed less than one, one-two, three-four, or five or more drinks per day. In subsequent waves, the HRS asked the number of days a week the person drinks and how much, allowing us to determine how many drinks are consumed on average. To compare alcohol consumption across waves, we did the following. First, we calculated the mean number of drinks for each respondent in waves 3 and 4 and assigned this number to the categories used in waves 1 and 2. Second, for individuals who reported consuming less than one drink daily, we assigned the value of 0.5 drinks per day, 1.5 for one-two, 3.5 for three-four, and six for five+ drinks per day. For men, we define current heavy drinking as consuming three or more drinks daily, and, for women, two or more drinks daily.

In each wave, the HRS asked the respondent a question about weight (height was asked at baseline). Responses for these questions were used to calculate the respondent's BMI at each wave. A person with a BMI above 30 is considered obese, and someone with a BMI of 25-29 is considered overweight.

In addition, we assessed variation in two other variables: heavy exercise and religiosity. As explained above, weight reflects food intake and exercise, but the HRS only provides information on the latter. An increase in religiosity may affect a person's consumption patterns, particularly alcohol use, but may affect cigarette consumption as well. Unfortunately, the HRS made a major change in question content between waves 2 and 3. Therefore, we limited our analysis of heavy exercise to waves 3-5. The HRS asked respondents whether they engaged in vigorous physical activity three or more times weekly. Included in such activity is both recreational activity, such as jogging, and activity related to work. The HRS did not ask about the duration of heavy exercise for the times that individuals participated in such activity.

On religion, at each wave, the HRS asked respondents how important religion is to the individual. Possible responses were: 1, not too important; 2, somewhat important; 3, very important. We assessed this variable as a continuous variable.

Finally, in our analysis of the determinants of smoking cessation, the dependent variable was a binary variable indicating whether the individual had quit smoking between waves.

Explanatory Variables: Our main explanatory variables were a binary variable indicating whether the individual had quit smoking in the last two years and another binary variable indicating whether the individual had quit smoking before the last two years. By making this distinction, we could assess if smoking cessation leads to temporary or more lasting changes in the other behaviors.

We measured problem drinking with a binary variable based on the CAGE instrument for clinical assessment of alcohol disorders. The instrument asks four questions: Have you ever felt that you should *cut down* (C) on your drinking? Have people *annoyed* (A) you by criticizing your drinking? Have you ever felt bad or *guilty* (G) about drinking? Have you ever had a drink first thing in the morning? (*eye opener* (E)) We set the binary variable for "problem drinker" to one if the respondent gave affirmative answers to two or more of these questions. The CAGE instrument has been found to be a valid indicator of alcohol problems. It picks up extreme rather than early cases (Edwards et al. 1997, p. 197). The HRS asked the CAGE questions only at the baseline interview. The survey did not ask when the person had experienced problems with alcohol use. We interacted problem drinker with binary variables for smoking cessation to determine whether problem drinkers who quit smoking reduce alcohol consumption by more or less than persons without drinking problems.

Other explanatory variables included annual household income and the following life events occurring since the last interview (two years previously): loss of job due to retirement or to unemployment, divorce, and death of spouse. Decreases in income should lead to decreased consumption of alcohol and food if they are normal goods. Losing a job and/or spouse may also lead an individual to increase his consumption of alcohol and food to the extent that this event is stressful.

We also controlled for a number of health shocks between waves that may have affected the individual drinking behavior and weights, specified as binary variables:

hospitalization for any cause, cancer, stroke, lung problems, diabetes, and heart attack. Two sets of the disease variables were included as explanatory variables: binary variables for onset of the disease since the last HRS interview and for onset prior to the previous interview—that is, preexisting illness at any time before the past two years. Health shocks may lead to decreased consumption of a variety of substances and cause individuals to update subjective probabilities of achieving a particular age (Smith et al. 2001). Also, substances such as alcohol interact with certain medications. Patients undergoing chemotherapy for cancer often lose appetite; diabetics are advised to limit their intake of certain foods and to exercise more frequently. In all of these cases, a third variable, the health shock, potentially affects consumption of cigarettes, alcoholic beverages, or food. It is important to account for these shocks to allow us to isolate complementary or substitutive relationships.

In the drinking behavior equations, we also included a binary variable indicating whether the individual lived in a state that enacted a reduced the blood alcohol content (BAC) standard for driving under the influence of alcohol as well as a variable for the state-level beer tax in cents at the time of the interview and the tax two years before interview date. Several states reduced the BAC from 10 to eight percent during the observational period.[5] A reduction in the maximum BAC a person can have to drive legally should decrease social drinking. In real terms, state beer taxes declined considerably between 1990 and 2000 (Wagenaar 2000). An increase in the alcohol tax is likely to increase the price and reduce consumption.

All of the models included individual fixed effects, time binary variables and time binaries interacted with problem drinking. Time dummies were included to control for

[5] Dee (2001) provides a summary of the implementation of these laws and its effects on saving lives.

natural trends in the consumption of alcohol and weight through time. The time-problem-drinking interaction was included to account for differential trends that may have existed for problem drinkers in the absence of smoking cessation. Individual fixed effects were included to control for time-invariant individual characteristics, such as unmeasured individual preferences and genes that may affect the smoking cessation decision, the drinking behavior, and the person's weight.

Finally, we included a smoking ban index, the percentage state tax on cigarettes at the time of the interview and a two-year lagged cigarette tax as additional explanatory variables in our analysis of the determinants of smoking cessation. The smoking ban index was created as follows: First, we constructed eight binary variables indicating if, at the time of the interview, the state had implemented restrictions on cigarette smoking. Restrictions on smoking were in: private worksites, restaurants, bars, health care facilities, government worksites, grocery stores, malls, and hotels. Second, we created a smoking ban index giving double weight to restrictions in bars and private worksites and assigning a weight of one to the other restrictions.[6] A higher smoking ban index should increase the time and inconvenience of smoking and thus increase the likelihood of cessation.

There was appreciable between-state and within-state variation in cigarette taxes during our study period. Under a variety of assumptions, increases in the price of cigarette will lead some smokers to quit (Gruber and Köszegi 2002).

All of our specifications included a Mills ratio for survival between waves, obtained using probit equations. In this analysis, the sample was the number of

[6] Data on smoking restrictions were obtained from the U.S. Centers for Disease Control Web site, http://www.cdc.gov.

individuals who were alive at the time of the interview, and the dependent variable was a binary indicating if the individuals were alive in the next interview. Explanatory variables in this analysis included the health variables described above, time-invariant demographic characteristics, and the self-assessed probability of living to age 75. These variables were found to be a good predictor of an individual's own mortality (Smith et al. 2001) and probably include genetic information about the individual not contained in the health measures. We did not control for attrition that was not due to death, but this source of attrition is likely to be control by the individual fixed effects (see Zilliak and Kniesner 1998).

VI. Results

Alcohol consumption and smoking are positively correlated for both males and females (Table 1). At wave 1, current male smokers consumed 1.2 drinks daily in contrast to never smokers, who consumed half as much. Current female smokers consumed 0.5 drinks daily while the mean for never smokers was 0.3. Heavy drinking was almost three times more prevalent among current smokers than among never smokers for both males and females. Current smokers had slightly lower BMIs than others. Male never smokers were more likely to have engaged in heavy exercise than current smokers.[7] Differences for females by smoking status were small. In general, smokers were less religious than nonsmokers. Problem drinkers had higher levels of alcohol consumption and were much more likely to be heavy drinkers. In the remaining tables and figures, we limited the sample to persons who smoked at wave 1.

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[7] The measure used here for heavy exercise comes from wave 1. The definition differs somewhat from the definition used in waves 3-5 and in our multivariate analysis.

As individuals age, they consume less alcohol. For males, the decline was from 1.2 at wave 1 to slightly less than 0.8 drinks daily by wave 5 (Fig. 1). For women, the decline was from slightly under 0.6 drinks to about 0.3 drinks daily. With the exception of wave 4 to 5 rate, smoking cessation rates were higher for men than for women (Fig. 2). For all two-year time intervals and both genders, two-year smoking cessation rates varied between 10 and 20 percent.

Weight, on the other hand, did not appear to vary with age (Table 2). Mean BMI was about 26 in all waves and for both genders. Common life events were loss of job and hospitalization within the past two years. By wave 5, about a quarter of the sample had been hospitalized within the previous two years. Health shocks were much more unlikely at wave 5 than at wave 1.

Men who quit smoking within two years before the interview reduced daily alcohol consumption by about 0.1 to 0.15 (Table 3). The coefficients on quit smoking within the past two years are statistically significant at better than the 10 percent level in regressions that do not contain covariates other than for smoking and drinking behavior (regression (1)) and contain covariates except for the health shocks (regression (2)). With the health shocks included, the coefficient remains negative but is no longer statistically significant even at the 10 percent level. The effect on alcohol consumption is temporary and appears to be due to health shocks that affect drinking and smoking at the same time. Several health shock variables (not shown) have statistically significant impacts on alcohol consumption, and the coefficient for smoking cessation is no longer significant at even the 10 percent level. [8]

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[8] The full specification will be presented in a longer, forthcoming paper.

For women, smoking cessation did not affect alcohol consumption; unlike for men, for whom there was no interaction between smoking cessation and problem drinking, problem drinkers who quit smoking during the last two years reduced daily alcohol consumption by about 0.3 to 0.4 drinks per day on average, but the effect was only temporary. Problem drinkers who quit smoking earlier than the previous two years did not reduce daily alcohol consumption. The problem-drinker-recent-quit interaction also is statistically significant when heavy drinking is the dependent variable; like alcohol consumption, this effect applies to female but not male problem drinkers.

Quitting or starting heavy drinking had no effect on smoking cessation for either gender (Table 4). Not surprisingly, people who quit smoking before were more likely to quit again, thus demonstrating a pattern of repeated attempts at quitting prior to succeeded. This pattern is evident even though smoking was measured only at two-year intervals.

Smoking cessation led to an increase in BMI, both for men and for women (Table 5). Furthermore, the effect appears to increase with duration of smoking cessation. For men, with covariates, BMI increased by 0.28 in the first two years after smoking cessation, but by almost 0.7 among male smokers who quit more than two years previously. For females, the short-run effect of smoking cessation was larger, but the longer-run effect was about the same as for men. A 0.7 increase in BMI is equivalent to about a five-pound increase in weight for a person who is five feet, 11 inches tall.[9]

For women, but not men, problem drinkers who quit smoking experienced a decrease in weight, but as with alcohol consumption, the effect was only temporary. For

[9] This figure appears to be at the low end of the literature. See U.S. Department of Health and Human Services (2001), pp. 15, 309-310.

both genders, the weight gain is limited to people who quit smoking who are not obese (BMI over 30). For obese persons, especially women, smoking cessation led to weight loss.

To determine whether smoking cessation was associated with an overall lifestyle change, we studied the impact of smoking cessation and other factors on heavy exercise and religiosity (Table 6). Heavy exercise for men did not change following smoking cessation. For women, smoking cessation led to an increase in the probability of engaging in heavy exercise. The long-run impact was about twice the short-run impact.

In the analysis of religiosity, only one coefficient is statistically significant at even the 10 percent level. Without covariates, female smokers who quit over two years before the interview became *less* religious. Thus, based on these two indicators, we found no evidence of a general lifestyle change, except for women, who did exercise more.

The statistically insignificant coefficients on the Mills ratio imply that sample attrition was not an important source of bias. Results tend to be similar between specifications that account for the Mills ratio and those that do not.

VII. Discussion and Conclusions

A large epidemiological literature documents the complementarity of bad health habits (Taylor and Taylor 1984, and Kandel 1975). For example, current smokers drink twice as much alcohol as compared to non-smokers (Carmody et al. 1985); 85 percent of current alcoholics smoke daily (DiFranza and Guerrera 1990). The reasons for these correlations are not well understood; they could be due to unmeasured individual preferences or because these goods have reinforcing effects (increased consumption of good A increase preferences for good B). An important health policy question is whether or not policies designed to encourage the cessation of a bad habit have spillovers to other bad habits.

On September 25, 1990, *The Health Benefits of Smoking Cessation: A Report of the Surgeon General* (U.S. Department of Health and Human Services 1990) was released. The major conclusion of the report was that smoking cessation has major and immediate health benefits for persons of all ages. The report also acknowledged that short-term consequences of smoking cessation include anxiety, irritability, difficulty concentrating, and increased appetite. With the exception of increased appetite, these effects disappear in the long run. Increase appetite leads to an average five-pound (2.3-kilogram) weight gain. However, in the short run, the psychological stress caused by smoking cessation may lead to increased alcohol consumption.

Using longitudinal data from the HRS our analysis shows that smoking cessation is negatively correlated with alcohol consumption and positively correlated with weight gain. These conclusions were not altered after we accounted for the endogeneity of smoking cessation. The negative association between smoking cessation and alcohol consumption can be seen as evidence of a change in lifestyle associated with quitting smoking. The mechanisms of the weight gain associated with quitting are not fully understood (U.S. Department of Health and Human Services 2001). Fortunately, the effect appears to be limited to persons who were not obese prior to smoking cessation. These results suggest that policies that encourage smoking cessation may have unintended positive externalities in terms of reduced alcohol consumption and the negative impact on weight gain is limited.

An econometric caveat is that we may not have completely controlled for health shocks that jointly affected drinking, body mass index, and smoking cessation. With incomplete adjustment, smoking cessation may be correlated with the error terms, causing our estimated effects of smoking cessation to be biased. We did not include lagged and forward levels of alcohol consumption, as a rational addiction model requires. In an extension to this study, we are estimating a more structural model, which includes lagged values of alcohol consumption and allows for the endogeneity of the smoking cessation binaries using the Generalized Methods of Moments developed by Arellano and Bond (1991). Preliminary results indicate that the conclusions of this study are not altered.

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Table 1: Means of Explanatory Variables by Smoking Status in Wave 1

	Males				
				Current	
Variable	Current	Former	Never	P.D.*	Not P.D.
No. drinks per day	1.183	0.7934	0.551	1.75	0.927
	(1.619)	(1.149)	(0.872)	(2.078)	(1.282)
Heavy drinking	0.165	0.0798	0.034	0.295	0.106
	(0.371)	(0.271)	(0.183)	(0.456)	(0.309)
Body mass index	26.28	27.63	27.55	25.85	26.48
	(4.278)	(4.089)	(4.177)	-4.503	(4.159)
Heavy exercise	0.163	0.209	0.219	0.1575	0.1661
	(0.369)	(0.406)	(0.414)	(0.364)	(0.372)
Religiosity	2.01	2.26	2.43	1.934	2.044
	(0.835)	(0.822)	(0.762)	(0.820)	(0.840)
N	1,347	2,029	1,176	420	927

	Females				
				Current	
Variable	Current	Former	Never	P.D.	Not P.D.
No. drinks per day	0.545	0.449	0.287	1.130	0.459
	(0.863))	(0.589)	(0.455)	(1.507)	(0.683)
Heavy drinking	0.148	0.1051	0.044	0.357	0.118
	(0.356)	(0.306)	(0.206)	(0.480)	(0.323)
Body mass index	25.81	27.69	27.33	25.05	25.92
	(5.242)	(5.688)	(5.424)	(5.420)	(5.209)
Heavy Exercise	0.184	0.204	0.194	0.155	0.189
	(0.388)	(0.403)	(0.396)	(0.363)	(0.391)
Religiosity	2.164	2.482	2.599	2.074	2.176
	(0.832)	(0.734)	(0.687)	(0.817)	(0.834)
N	1,317	1,484	2,388	168	1,149

Numbers in parentheses are standard deviations.

*Problem Drinker

Figure 1: Drinks per Day

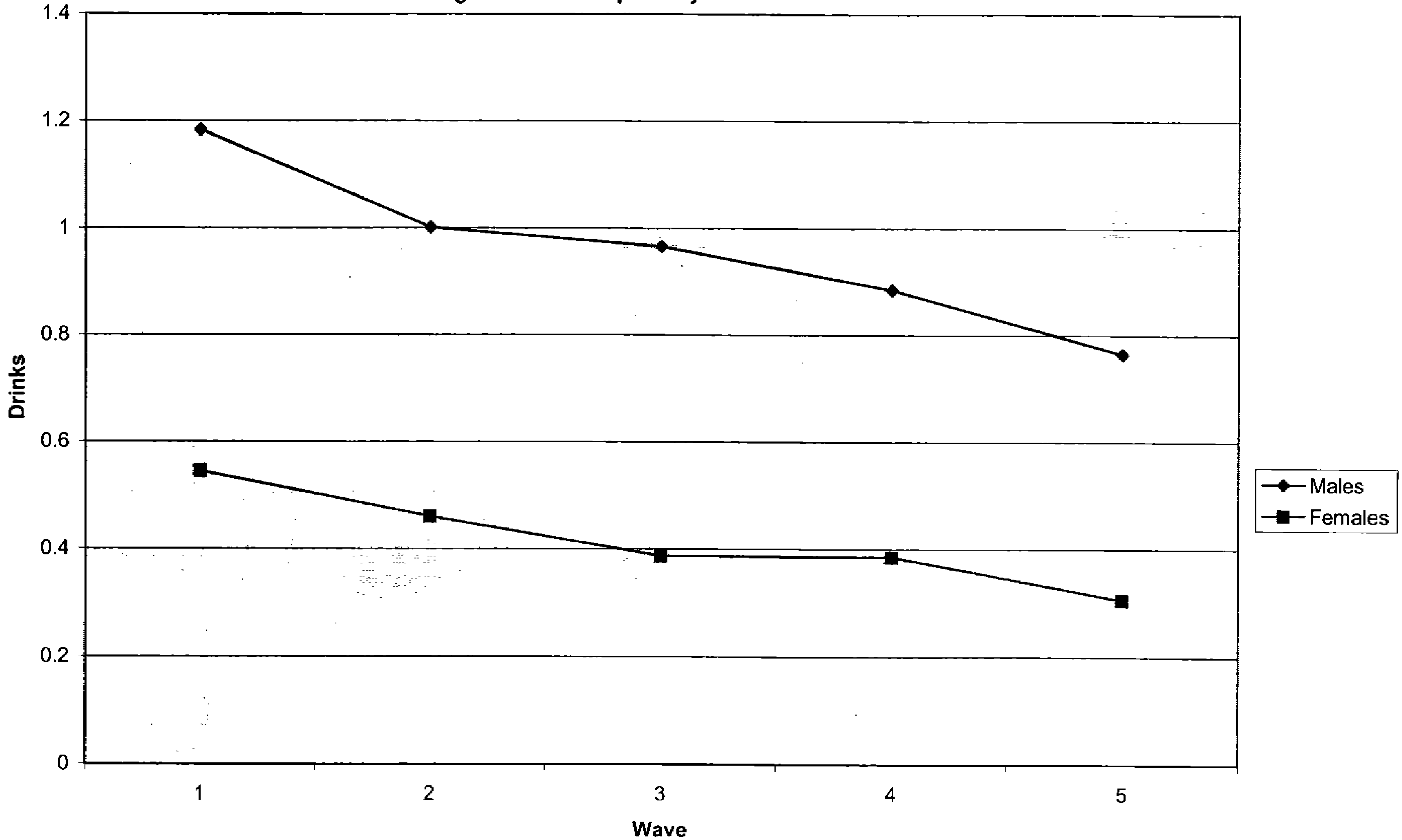

Figure 2: Smoking Cessation
Hazard Rates

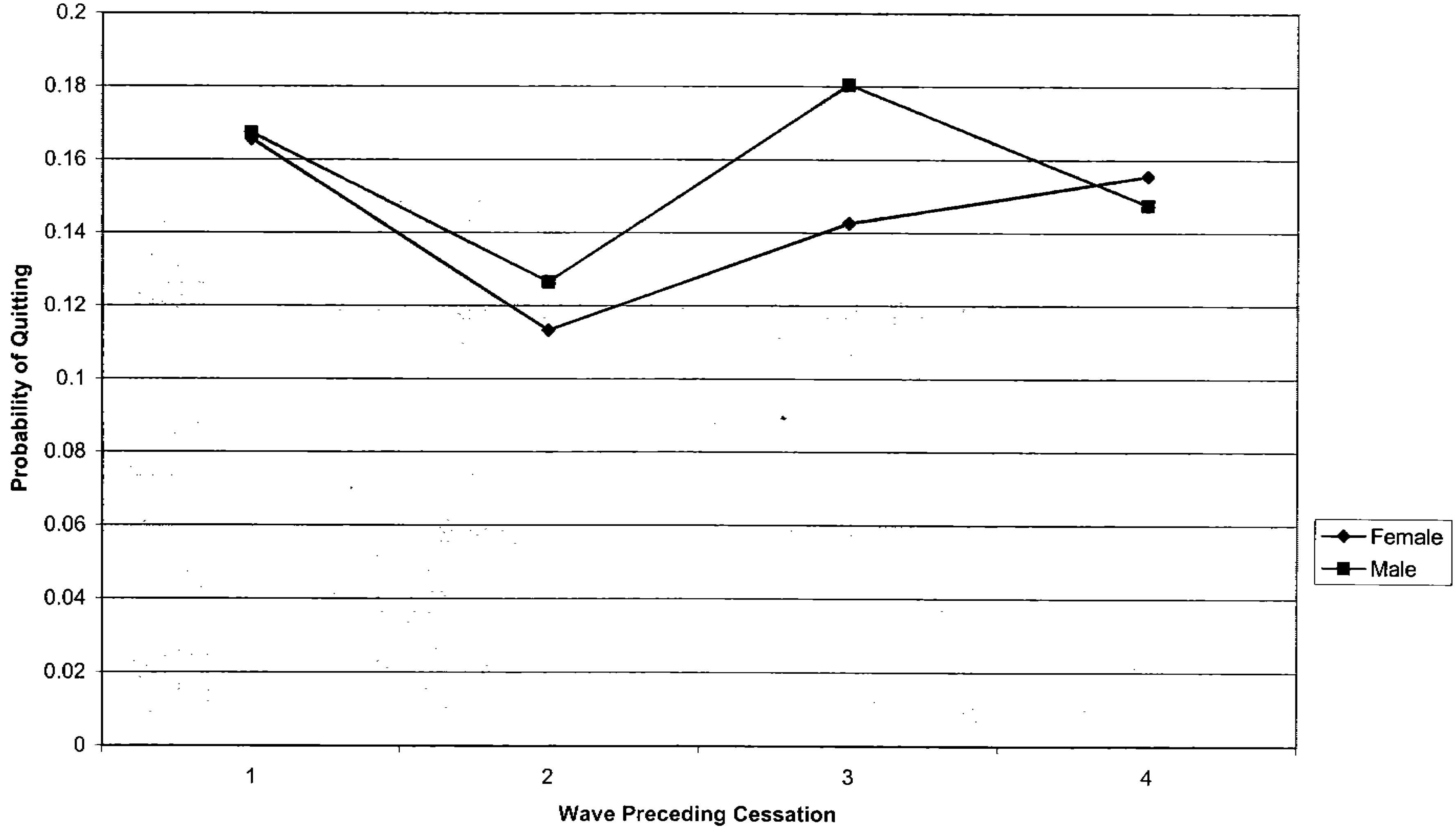

Table 2: Descriptive Statistics

Variable	Males		Females	
	Wave1	Wave 5	Wave1	Wave 5
Smoker	1.00	0.651	1.00	0.653
	(0.00)	(0.476)	(0.00)	(0.476)
Smoking cessation*	-	0.102	-	0.108
	(-)	(0.303)	(-)	(0.311)
Lag former smoker**	-	0.248	-	0.238
	(-)	(0.432)	(-)	(0.426)
Smoking cessation and problem drinker	-	0.031	-	0.007
	(-)	(0.173)	(-)	(0.084)
Lag former smoker and problem drinker	-	0.0625	-	0.0205
	(-)	(0.242)	(-)	(0.142)
Body mass index	26.28	26.68	25.81	26.27
	(4.278)	(4.635)	(5.242)	(5.369)
Number of drinks per day	1.183	0.765	0.545	0.305
	(1.616)	(1.339)	(0.863)	(0.758)
Heavy drinking	0.165	0.094		
	(0.371)	(0.293)	(0.371)	(0.293)
Heavy exercise	0.165*	0.407	0.184*	0.374
	(0.369)	(0.491)	(0.388)	(0.484)
Religiosity	2.011	2.317	2.164	2.608
	(0.835)	(0.763)	(0.832)	(0.601)
Family income (in $10,000s)	4.081	4.751	3.299	3.301
	(4.266)	(6.064)	(3.830)	(6.435)
Loss of job	0.167	0.089	0.110	0.078
	(0.373)	(0.286)	(0.313)	(0.269)
Retired	0.102	0.442	0.066	0.322
	(0.303)	(0.496)	(0.249)	(0.467)
Unemployed	0.0677	0.015	0.044	0.010
	(0.251)	(0.123)	(0.205)	(0.100)
Newly widowed	-	0.007	-	0.016
	(-)	(0.085)	(-)	(0.125)
Newly divorced	-	0.006	-	0.002
	(-)	(0.076)	(-)	(0.038)
Recent hospitalization	0.118	0.261	0.102	0.244
	(0.322)	(0.439)	(0.303)	(0.429)
Onset of cancer	0.013	0.033	0.014	0.034
	(0.114)	(0.180)	(0.119)	(0.182)
Lag cancer	0.021	0.091	0.069	0.122
	(0.145)	(0.288)	(0.253)	(0.328)
Onset of stroke	0.009	0.033	0.007	0.021
	(0.094))	(0.178)	(0.082)	(0.144)
Lag stroke	0.032	0.062	0.021	0.056
	(0.175)	(0.241)	(0.144)	(0.229)
Onset of diabetes	0.018	0.032	0.018	0.035
	(0.135)	(0.175)	(0.133)	(0.184)
Lag diabetes	0.089	0.160	0.068	0.141
	(0.284)	(0.367)	(0.252)	(0.348)
Onset of heart attack	0.023	0.037	0.013	0.020

	(0.150)	(0.191)	(0.113)	(0.141)
Lag heart attack	0.066	0.161	0.029	0.092
	(0.248)	(0.367)	(0.167)	(0.289)
Lung problem	0.128	0.173	0.141	0.186
	(0.334)	(0.378)	(0.348)	(0.389)
Depression index	2.295	1.571	2.709	2.126
	(2.053)	(1.888)	(2.148)	(2.272)
Self-reported health	2.845	3.085	2.832	2.979
	(1.250)	(1.152)	(1.198)	(1.137)
Alcohol tax	2.956	2.606	2.812	2.529
	(2.136)	(1.896)	(2.066)	(1.895)
BAC 0.08%	0.067	0.305	0.070	0.326
	(0.249)	(0.460)	(0.256)	(0.469)
Cigarette tax	26.43	42.86	26.27	43.52
	(11.29)	(27.04)	(11.48)	(27.99)
Smoking ban index	4.609	5.771	4.637	5.908
	(3.296)	(3.460)	(3.292)	(3.457)
N	1,347	900	1,317	975
N died		231		141

Numbers in parentheses are standard deviations.

* Change variables (e.g., cessation, "newly," "recent," "onset") refer to change within last two years.
** "Lag" variables refer to change prior to last two years.
*** The question for heavy exercise changed in wave 3. In our analysis we used waves 3 to 5 for the analysis of heavy exercise.

Table 3: Effects of Smoking Cessation on Drinking and Heavy Drinking: First-Difference Estimates.

	Number of drinks per day					
	Males			Females		
Variable*	(1)	(2)	(3)	(1)	(2)	(3)
Smoking cessation	-0.1365[c]	-0.1483[c]	-0.1113	-0.0241	-0.0256	-0.0196
	(0.0698)	(0.0787)	(0.0801)	(0.0313)	(0.0333)	(0.0332)
Lag former smoker	-0.1132	-0.1685	-0.1321	-0.0317	-0.0406	-0.0314
	(0.1206)	(0.1418)	(0.1414)	(0.0584)	(0.0650)	(0.0642)
Smoking cessation and problem	-0.1010	0.0012	0.0186	-0.3080[a]	-0.4196[a]	-0.3785[a]
drinker	(0.1275)	(0.1442)	(0.1453)	(0.0982)	(0.1080)	(0.1075)
Lag former smoker and problem	-0.4028[c]	-0.3162	-0.3073	0.0514	-0.2057	-0.1562
drinker	(0.2230)	(0.2628)	(0.2613)	(0.1761)	(0.1953)	(0.1916)
Mills ratio		-0.0188	0.0124		0.0020	-0.0044
		(0.0561)	(0.0629)		(0.0219)	(0.0226)

	Heavy drinking					
	Males			Females		
Variable*	(1)	(2)	(3)	(1)	(2)	(3)
Smoking cessation	-0.0308[c]	-0.0388[c]	-0.0305	0.0029	-0.0021	-0.0014
	(0.0179)	(0.0207)	(0.0213)	(0.0133)	(0.0153)	(0.0158)
Lag former smoker	-0.0374	-0.0514	-0.0418	-0.0135	-0.0290	-0.0279
	(0.0310)	(0.0373)	(0.0376)	(0.0249)	(0.0299)	(0.0305)
Smoking cessation and problem	0.0065	0.0289	0.0393	-0.1358[a]	-0.1915[a]	-0.1765[a]
drinker	(0.0328)	(0.0379)	(0.0386)	(0.0418)	(0.0498)	(0.0511)
Lag former smoker and problem	-0.0747	-0.0413	-0.0413	0.0166	-0.0316	-0.0152
drinker	(0.0573)	(0.0691)	(0.0695)	(0.0750)	(0.0901)	(0.0910)
Mills ratio		-0.0039	-0.0002		-0.0046	-0.0043
		(0.0147)	(0.0167)		(0.0101)	(0.0107)

(1) Also include time fixed effects.
(2) Also include income, changes in employment status, changes in marital status and time fixed effects.
(3) Also include income, changes in employment status, changes in marital status, hospitalized, onset cancer, lag cancer, onset stroke, lag stroke, onset diabetes, lag diabetes, onset heart attack, lag heart attack, lung problems, depression index, self-reported health, alcohol tax, BAC 0.08%, and time fixed effects.

[a] significant at the 1% level two-tail test
[b] significant at the 5% level two-tail test
[c] significant at the 10% level two-tail test

Numbers in parentheses are standard deviations.

* Variables refer to change within last two years, except for "lag" variables, which refer to change prior to last two years.

Table 4: Difference-in-Difference Linear Probability Estimates of Changes in Heavy Drinking on Smoking Cessation

Variable*	Males		Females	
	(1)	(2)	(1)	(2)
Quit heavy drinking	0.0595	0.0379	-0.0108	0.0058
	(0.0405)	(0.0463)	(0.0368)	(0.0414)
Start heavy drinking	-0.0006	0.0008	-0.0158	-0.0226
	(0.0433)	(0.0497)	(0.0736)	(0.0463)
Quit heavy drinking and problem drinker	0.0027	-0.0014	0.1088	0.1819[b]
	(0.0589)	(0.0698)	(0.0736)	(0.0854)
Start heavy drinking and problem drinker	0.0061	0.0116	-0.0811	-0.0320
	(0.0685)	(0.0821)	(0.0878)	(0.0978)
Quit smoking before last 2 years		0.0927[b]		0.1848[a]
		(0.0407)		(0.0407)
Mills ratio		0.0029		0.0177
		(0.0232)		(0.0156)

(1) Also include time fixed effects.
(2) Also include income, changes in employment status, changes in marital status, hospitalization, onset cancer, lag cancer, onset stroke, lag stroke, onset diabetes, lag diabetes, onset heart attack, lag heart attack, lung problems, depression index, self-reported health, cigarette tax, smoking ban index, and time fixed effects.

[a] significant at the 1% level two-tail test
[b] significant at the 5% level two-tail test
[c] significant at the 10% level two-tail test

Numbers in parentheses are standard deviations.

*Variables refer to change within last two years except where noted.

Table 5: Effects of Smoking Cessation on Weight: First-Difference Estimates.

Variable *	Males (1)	Males (2)	Females (1)	Females (2)
Smoking cessation	0.3398[a]	0.2800[a]	0.3913[a]	0.4651[a]
	(0.0924)	(0.1062)	(0.0967)	(0.1085)
Lag former smoker	0.5921[a]	0.6933[a]	0.6122[a]	0.7367[a]
	(0.1597)	(0.1887)	(0.1729)	(0.2001)
Smoking cessation and problem drinker	0.0506	0.1327	-0.6221[b]	-0.8699[a]
	(0.1623)	(0.1683)	(0.2832)	(0.3249)
Lag former smoker and problem drinker	-0.0254	-0.0678	-1.0311[b]	-1.5286[b]
	(0.2779)	(0.3263)	(0.5097)	(0.6020)
Smoking cessation and obese	-0.0833	0.0164	0.2132	-0.2519
	(0.1956)	(0.2195)	(0.2016)	(0.2340)
Lag former smoker and obese	-0.6614[b]	-0.4557	-0.1734	-0.8547[b]
	(0.3152)	(0.3497)	(0.3569)	(0.4209)
Mills ratio		0.0425		0.0713[a]
		(0.0264)		(0.0228)

(1) Also include time fixed effects.
(2) Also include income, changes in employment status, changes in marital status, hospitalization, onset cancer, lag cancer, onset stroke, lag stroke, onset diabetes, lag diabetes, onset heart attack, lag heart attack, lung problems, depression index, self-reported health, alcohol tax, BAC 0.08%, and time fixed effects.

[a] significant at the 1% level two-tail test
[b] significant at the 5% level two-tail test
[c] significant at the 10% level two-tail test

Numbers in parentheses are standard deviations.

*Variables refer to change within last two years except for "lag" variables, which refer to change before last two years.

Table 6: Effects of Smoking Cessation on Heavy Exercise and Religiosity: First-Difference Estimates

	Heavy Exercise			
	Males		Females	
Variable*	(1)	(2)	(1)	(2)
Smoking cessation	-0.0567	-0.0681	0.0698[c]	0.0777[c]
	(0.0401)	(0.0519)	(0.0362)	(0.0440)
Lag former smoker	-0.0047	0.0295	0.1181[c]	0.1421[c]
	(0.0667)	(0.0913)	(0.0617)	(0.0774)
Smoking cessation and problem drinker	0.0821	0.0383	-0.1472	-0.0335
	(0.0751)	(0.0986)	(0.1352)	(0.1753)
Lag former smoker and problem drinker	0.0850	-0.0885	-0.2412	-0.0082
	(0.1232)	(0.1647)	(0.2245)	(0.2850)
Mills Ratio		0.0175		0.0096
		(0.0439)		(0.0389)

	Importance of Religion			
	Males		Females	
Variable*	(1)	(2)	(1)	(2)
Smoking cessation	0.0018	-0.0356	-0.0112	-0.0021
	(0.0311)	(0.0359)	(0.0250)	(0.0275)
Lag former smoker	-0.0501	-0.0202	-0.0723[c]	-0.0631
	(0.0518)	(0.0019)	(0.0434)	(0.0488)
Smoking cessation and problem drinker	-0.0152	0.0019	0.0243	0.0543
	(0.0606)	(0.0718)	(0.0822)	(0.0925)
Lag former smoker and problem drinker	0.0288	-0.0784	-0.1186	-0.0191
	(0.0998)	(0.1205)	(0.1429)	(0.1598)
Mills Ratio		-0.0006		0.0072
		(0.0103)		(0.0199)

(1) Also include time fixed effects.
(2) Also include income, changes in employment status, changes in marital status, hospitalization, onset cancer, lag cancer, onset stroke, lag stroke, onset diabetes, lag diabetes, onset heart attack, lag heart attack, lung problems, depression index, self-reported health, alcohol tax, BAC 0.08%, and time fixed effects.

[a] significant at the 1% level two tail test
[b] significant at the 5% level two tail test
[c] significant at the 10% level two tail test

Numbers in parentheses are standard deviations.

*Variables refer to change within last two years except for "lag" variables, which refer to change before last two years.