Journal of Wine Economics, Volume 11, Number 3, 2016, Pages 436–464
doi:10.1017/jwe.2016.19

Beer-Purchasing Behavior, Dietary Quality, and Health Outcomes among U.S. Adults*

Richard Volpe [a], Michael McCullough [b], Michael K. Adjemian [c] and Timothy Park [d]

Abstract

We use rich IRI household- and individual-level data sets to examine the relationships between heart disease and type 2 diabetes with alcohol consumption. We control for a wide variety of potential confounders, including diet quality and lifestyle choices. Beer has long been studied in related literature to ambiguous outcomes. We explore the role of beer consumption in detail by separating craft beer from macrobeer and imported beer. The results indicate that most alcohol types could have protective effects against heart disease and diabetes, with the strongest effects occurring for craft beer and wine. Treating beer as a single, homogenous category in health studies likely leads to measurement error. (JEL Classifications: D12, I12, R20, L66, P36)

Keywords: alcohol purchases, dietary quality, heart disease, scanner data, type 2 diabetes.

* We are thankful to participants at the 2015 Beeronomics Conference in Seattle and the 2016 American Association of Wine Economists Conference in Bordeaux for helpful feedback and suggestions on this manuscript. We are grateful to Abigail Okrent, Jessica Todd, and Annemarie Kuhns at the U.S. Department of Agriculture, Economic Research Service (USDA-ERS) for their work in organizing foods in the Information Resources Incorporated (IRI) data to enable the calculation of dietary scores. We also thank an anonymous referee for a number of helpful comments and suggestions on the manuscript. The views expressed in this paper are those of the authors and may not be attributed to the USDA or the ERS. This research was conducted using a third-party agreement with IRI.
[a] Agribusiness Department, College of Agricultural, Food and Environmental Sciences, California Polytechnic State University, San Luis Obispo, 1 Grand Ave., San Luis Obispo, CA 93407; e-mail: rvolpe@calpoly.edu (corresponding author).
[b] Agribusiness Department, College of Agricultural, Food and Environmental Sciences, California Polytechnic State University, San Luis Obispo, 1 Grand Avenue, San Luis Obispo, CA 93407; e-mail: mpmccull@calpoly.edu.
[c] Markets and Trade Division, Economic Research Service, U.S. Department of Agriculture, 1400 Independence Ave. SW, Mail Stop 1800, Washington, DC 20250-1800; e-mail: madjemian@ers.usda.gov.
[d] Food Economics Division, Economic Research Service, U.S. Department of Agriculture, 1400 Independence Ave. SW, Mail Stop 1800, Washington, DC 20250-1800; e-mail: tapark@ers.usda.gov.

I. Introduction

Research in health, epidemiology, and nutrition has long suggested a link between moderate alcohol consumption and health. Early studies (Klatsky et al., 1977; Marmot et al., 1981) established a "U-shaped" relationship between alcohol consumption and health outcomes and mortality. That is, alcohol confers health-protective benefits up to a point, but excessive consumption leads to adverse health effects. Renaud and de Lorgeril (1992) were among the first to highlight wine as having specific health benefits beyond those attainable through beer or spirits consumption.

However, two lines of research in recent decades have raised questions regarding the exceptionalism of wine as an alcoholic beverage with potential protective effects. In one, studies have found a robust inverse relationship between mortality or the incidence of adverse health effects with beer or alcohol, broadly defined. For example, Brenner et al. (2001) found evidence for a strong protective effect against coronary heart disease (CHD) of alcohol among beer drinkers in Germany. The other line of research (e.g., Johansen et al., 2006) has shown that wine drinkers tend to have healthier diets and lifestyle choices, as compared with beer drinkers and spirits drinkers. Therefore, perhaps some of the protective benefits of wine may have been overestimated due to confounding effects.

Although specific linkages and mechanisms still need to be identified, evidence is growing to support the notion that beer may confer specific health-protective benefits. Much as the antioxidants specific to wine, including resveratrol, have been found to support health and reduce mortality, beer is likely to contain its own protective agents. There is reason to believe that, in this regard, not all beers are the same. Craft beer differs fundamentally from the typical American adjunct lager macrobeer (e.g., Budweiser), in that it typically features significantly more hops per gallon, higher alcohol content, and silicone and other minerals from malted barley, and it is generally nonpasteurized allowing for the digestive aid of brewer's yeast, among other factors. Although not all of these factors are necessarily health protective in nature, the brewing process and content of craft beer differ substantially from those of macrobeer, and hence there is reason to expect that the health effects of consuming these beverages may differ.

We use household-level scanner data on food and beverage purchases, merged with self-reported health outcomes, to investigate relationships between alcohol-purchasing behavior and CHD and type 2 diabetes (T2D). We measure alcohol-purchasing behavior by using annual expenditures. We are thus able to measure the associations between the incidence of CHD and T2D with shifts in expenditures among beer, wine, and spirits. Additionally, we quantify the associations between alcohol purchases, by type, and health outcomes, relative to nondrinkers. We differentiate between craft beer, macrobeer, and additional categories of beer purchases in an effort to identify the various health impacts.

Our results provide further evidence for the potential health-protective benefits of moderate alcohol consumption. Craft beer, macrobeer, and wine expenditures are all significantly associated with the decreased likelihood of CHD and T2D, after controlling for a large number of demographics, lifestyle choices, and other potential confounders. In many cases, the estimated craft beer effect is at least as strong as that found for either wine or macrobeer.

II. Background and Literature Review

Researchers throughout many disciplines have long sought to identify the factors associated with mortality and adverse health outcomes. Empirical findings in this respect have informed audiences including the medical profession, policy makers, and the general public. Likewise, alcohol use has been a subject of health-related research for readily apparent reasons. According to the National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health (2016), in 2014 71% of American adults reported that they had consumed alcohol within the past year. Alcohol abuse in the United States is estimated to be responsible for $249 billion in costs annually, and approximately 88,000 American adults die each year from alcohol-related causes.

Early on, researchers in health and epidemiology established that alcohol use shares a U-shaped, or parabolic, relationship with morbidity and a number of other prominent ailments (Klatsky et al., 1977; Marmot et al., 1981). Moderate alcohol use is more associated with good health than is abstinence. This finding has proved robust across the years and a wide range of methods, data sets, ailments, and countries. Roerecke and Rehm (2014) conduct a review of meta-analyses, citing more than 100 scholarly articles, and determine that alcohol consumption shares a clear parabolic relationship with heart disease.

Wine has been the subject of many studies on alcohol and health. Renaud and de Lorgeril (1992) authored one of the earliest influential studies in this vein, investigating the so-called French paradox, whereby French adults consume more saturated fats yet experience less CHD than many other comparable populations. The authors identified red wine intake as a key factor in resolving this apparent contradiction. It is widely understood that resveratrol, a compound found in grapes and wine but not in other alcoholic beverages, is partially responsible for the perceived health benefits of wine. Resveratrol has a number of anti-inflammatory, anticarcinogenic effects and serves as an antioxidant (Gehm et al., 1997). A handful of studies have compared estimated impacts across alcohol types and found wine to have the strongest protective impacts, including Criqui and Ringel (1994) with respect to CHD, Arranz et al. (2012) with respect to cardiovascular disease and cancer, and Klatsky et al. (2003) with respect to adult mortality.

Beer has its own health-protective attributes, unique among alcoholic beverages. Both Keil et al. (1997) and Brenner et al. (2001) found the familiar U-shaped relationships between alcohol consumption and health outcomes, based on samples of predominantly beer-drinking German adults. Via hops, a key input to the beer-brewing process, beer contains the flavonoid xanthohumol, which has been the subject of a number of health studies. Stevens and Page (2004) found it has the potential to impart cancer-preventive properties through beer drinking. In laboratory tests, Vanhoecke et al. (2005) showed xanthohumol to inhibit the growth and spread of cancer cells. Magalhães et al. (2009) note that although questions remain regarding the specific mechanisms, the evidence to date suggests broad protective effects through beer consumption. Kaplan, Palmer, and Denke (2000) and Bamforth (2002) reviewed the extensive literature on beer and health and synthesized a body of research demonstrating that beer is similarly effective to wine in preventing CHD and that beer features a greater composition of B vitamins, minerals, and fiber than does wine. Gerhäuser et al. (2002) conducted a series of laboratory analyses to show that beer is a source of several potential anticancer agents, including but not limited to xanthohumol.

Additionally, a wealth of research over the past 30 years has shown that there is a robust and significant impact of moderate alcohol consumption, defined generally, on health and longevity.[1] This includes Djouseé and Gaziano (2007) studying the incidence of heart failure, Brien et al. (2011) examining levels of high-density cholesterol and the risk of CHD, Valmadrid et al. (1999) studying CHD among people with older-onset diabetes, Ronksley et al. (2011) on the risk levels for multiple cardiovascular outcomes, Williams et al. (2005) on bone mineral density in women, and Wang et al. (2010) comparing moderate drinking with not drinking in the study of weight loss and overweight status among women. In studies particularly relevant to our own, Koppes et al. (2005) and Joosten et al. (2010) showed that moderate alcohol intake is associated with reduced risk of T2D, compared with nondrinkers.

In contrast to those studies cited previously demonstrating the greatest health benefits from wine among all alcoholic beverages, a number of studies have reached comparable conclusions for beer. Rimm et al. (1996) conducted a review of studies analyzing both beer and wine impacts. The reviewed case-control studies collectively do not suggest that wine is more protective than beer, and prospective cohort studies are evenly split in finding stronger health effects for beer or wine. Renaud et al. (1999) conducted a prospective cohort study and found that wine was more strongly associated with reduced mortality, but that beer and wine have comparable effects in reducing CHD. Costanzo et al. (2011) found that beer

[1] The scientific consensus on this relationship is not uniform. To our knowledge, no study has demonstrated significance, adverse health effects of moderate alcohol consumption. However, research has raised questions about these findings. For example, Fillmore et al. (2006) showed that in a number of studies comparing moderate drinkers with abstainers, those in the latter category were often adults who had quit drinking, thereby overstating the health effects of moderate alcohol use. An additional line of inquiry, which we discuss subsequently, examines how diet may be a confounder in studies on alcohol and health.

and wine had essentially identical overall impacts on cardiovascular health. Using the same data as our own, Adjemian, Volpe, and Adjemian (2015) found that wine-purchasing behavior was most strongly, negatively associated with heart disease, but that beer and wine were equally associated with the reduction in T2D. Data limitations are likely a factor behind this ambiguity, as robust dietary data, including alcoholic intake differentiated by type, are rarely seen in alcohol-health studies.

We study the health impacts of beer and wine separately due to the possibility that diet and lifestyle have potentially confounded previous studies. Research on alcohol and diet have reached a consensus that wine drinkers, on average, consume healthier foods than do other drinkers and nondrinkers. Tjønneland et al. (1999) evaluated diet quality according to alcohol preferences and found that, among Danish adults, wine drinkers eat significantly healthier diets. Mortensen et al. (2001) and Barefoot et al. (2002) argued that differences in diet and lifestyle explain much of the perceived differences between beer and wine impacts, as wine drinkers eat more fruits and vegetables, fewer saturated fats, and are less likely to smoke. The former study also found that wine drinkers also have higher average incomes and IQs. Breslow, Guenther, and Smothers (2006) examined alcohol intake and diet with the National Health and Nutrition Examination Survey (NHANES). They found that adults consuming at least three alcoholic beverages per day ate significantly healthier diets, on average, than those consuming fewer than one drink per day.

To measure health impacts, our study focuses on CHD and T2D. These ailments were chosen due to data availability, but also because they are among the most studied phenomena in the literature cited previously. Both ailments have been linked to alcohol preferences for decades, are prevalent in the United States, and are responsible for substantial health care expenditures. High cholesterol and high blood pressure are associated with a number of heart ailments, notably CHD, that are estimated to be responsible for more than $300 billion in health care costs (Centers for Disease Control and Prevention [CDC], 2011). An estimated 29 million U.S. adults have diabetes, causing an estimated $176 billion in direct medical costs in 2012 (CDC, 2014).

III. Data and Statistics

To measure purchasing behavior, we use the Information Resources Incorporated (IRI) Household Panel, 2008–2012, which includes comprehensive point-of-sale records for all UPC-coded food and beverage purchases. Participants use handheld scanners to scan the bar codes for all purchases made for at-home consumption, and purchase records include prices, quantities, detailed product descriptors, any promotional activity, and the retailers. The household data are reported by purchase frequency, meaning each shopping trip yields observations, coded by date. We aggregate food and beverage purchases annually.

This data set affords a number of advantages, relative to dietary recall data (e.g., NHANES). The IRI purchase records are comprehensive, providing longitudinal data and precluding the need to infer diet quality based on periodic survey responses. With purchase records at the UPC level, we are able to distinguish alcoholic beverages at a granular level, separating out wine, beer, spirits, and subcategories within. The same is true for food, allowing researchers to examine dietary choices in conjunction with multiple measures of diet quality, food groups, or consumption recommendations. The disadvantages of the IRI household data are that we observe purchase only, not consumption, and that we have no records of food or beverage purchases for consumption away from home (e.g., restaurants). Our analysis assumes parity between purchase and consumption at the household level, and that consumers engage in relatable behavior at home and away from home.

To measure health outcomes, we use the 2010–2012 IRI MedProfiler data. This includes an array of self-reported ailments and health concerns at the individual level. Participants in MedProfiler are asked to respond to questions regarding common ailments with one of five possible responses: suffer but do not treat, suffer and treat with a prescription, suffer and treat with over-the-counter medication, suffer and treat with both prescription and over-the-counter medications, or do not suffer. For both CHD and T2D, we created annual binaries equal to 1 if the respondent indicated that he or she suffers at all. MedProfiler also includes responses to a number of questions that provide insight into lifestyle choices and overall healthiness. These include the frequency of exercise, eating dessert, eating fast food, eating organic foods, or experiencing stress. Approximately 30,000 households participated in both the Household Panel and the MedProfiler data.

The IRI data sets provide rich information on demographics and other important descriptors, providing us with key controls, as suggested by past studies on alcohol and health. The Household data include household-level characteristics, including annual income, the education level and occupation of the household head(s), race, geographic location, marital status, and the age and number of children. The MedProfiler data include individual descriptors, including height and weight (with which we can calculate body mass index [BMI]), age, and gender.

To control for diet quality, we calculate the annual USDAScore, by household. The USDAScore was devised by Volpe and Okrent (2012) and measures the extent to which shopping baskets conform to the Dietary Guidelines for Americans (DGA). The U.S. Department of Agriculture (USDA) Center for Nutrition Policy and Promotion (CNPP) Thrifty Food Plan is intended to inform households on any budget how to best apportion food dollars in order to meet the DGA. The CNPP organized all foods and nonalcoholic beverages into 24 comprehensive categories and assigned recommended expenditure shares, by category and by age and gender. The USDAScore is calculated by comparing observed expenditure shares with household-specific recommendations, and higher scores reflect greater adherence to the DGA. The full details of the variable construction are available from Volpe and Okrent (2012).

Our alcohol preference variables are based on expenditure shares. For each household and year, we calculate total alcohol expenditures and the share of alcohol expenditures attributed to beer, wine, and spirits. We also use total alcohol expenditures, by year, to classify all households as light, medium, heavy, or nondrinkers. Due to potential health effects of hops and alcohol, two beer ingredients that can vary depending on the brewing process, we further distinguish beer as either macrobeer, craft beer, imported beer, or malt beverages and cider.[2] To enrich further our understanding of the associations between alcohol and health, we also create subcategories for wine. Much as the concentration of fiber or B vitamins is likely to differ across beer varieties, production methods and inputs vary with the quality of wine. Moreover, wine demand can change substantially based on price points (Cuellar and Huffman, 2008; Nelson, 2013). Hence, we use price per liter to categorize all wine purchases in our data as jug, table, premium, or ultrapremium.[3]

Given that our data set pairs household-level expenditures with individual health outcomes, care must be taken in interpreting the results. With our data set, we are able to provide insights into the associations between residing in households exhibiting alcohol expenditures and the likelihood of reporting T2D and CHD. Nevertheless, it remains the case that our data set and preferred estimation approach are subject to measurement error due to the merger of household and individual characteristics. We take care to examine and discuss this point with robustness checks.

We also calculate the annual ratio of total alcohol expenditures to total food expenditures. This variable, AlcFoodRatio, serves two purposes. First, it is an additional lifestyle control, intended to capture households' overall preferences toward alcohol consumption. Second, it allows us to identify potentially problematic

[2] We categorized beers largely according to the brewery type definitions provided by the Brewers Association (https://www.brewersassociation.org/). The Brewers Association offers a lookup service called Find-A-Brewery based on brewery name, which we match to UPC parent company names. The categories are as follows: microbreweries produce less than 15,000 barrels per year with at least 75% of sales off-site; brewpubs produce less than 15,000 barrels annually with 25% or more sold on-site; regional breweries produce between 15,000 and 6,000,000 barrels per year; contract beer is beer produced, marketed, and sold by an independent firm; and macrobreweries produce greater than 6,000,000 barrels per year. Craft beer consists of microbreweries, brewpubs, regionals, and contract beer. IRI categorizes malt beverages and ciders by UPC; we group these together due to a limited number of observations for each category. Finally, imports are all beers produced outside the United States.

[3] We adopt the price cutoffs of Silverman et al. (2002), which have in turn been used in a number of published wine studies. By this scheme, if the price per liter is under $3, wine is classified as jug; between $3 and $7, table; between $7 and $14, premium; and $14 and above, ultrapremium. Silverman et al. include a fifth category, luxury, but as the IRI data grow very thin at these price points, we combine ultrapremium and luxury in our analysis.

outliers, such as households that considerably underreport food purchases, overreport alcohol expenditures, or have made disproportionately large alcohol purchases for hosting or entertaining purposes. Table 1 reports definitions and summary statistics for the variables used in our analysis.

Relative to the general population, the IRI households sampled for our study are older, have higher incomes, and are better educated. The average age in our sample is 53, and the average annual household income is $63,663. Approximately 18% of respondents completed some graduate school. Our data set is also 84% white. These aspects of our sample should be kept in mind while interpreting the results and considering further research.

With respect to health, approximately 10% of respondents have CHD and T2D, respectively. Over a third suffer from high cholesterol and hypertension, respectively. The average BMI is nearly 29, indicating that the average respondent is nearly clinically obese. Almost 72% of respondents indicated that they experienced stress throughout the time series. Hence, we have a range of health risks and indicators within the sample.

Among alcoholic beverages, wine dominates slightly, with an average expenditure share of 23%. Thus, households in our sample spend the most on wine among all alcoholic beverages. Macrobeer is second, with an average 18% expenditure. Spirits are third with 13%, followed by craft beer with 3%, malt beverages/cider with 2%, and imported beer with 1%, on average.

IV. Methodology and Results

We employ a two-pronged approach to estimate potential health impacts from alcohol consumption, as proxied by expenditures. First, following Adjemian, Volpe, and Adjemian (2015), who also used IRI data and similarly controlled for overall diet quality, we estimate logistic regressions to identify the impacts of alcohol preference on the prevalence of CHD and T2D. Our indicators for CHD and T2D are binaries, reporting 1 for sufferers and 0 for nonsufferers; therefore, limited dependent variable regression is appropriate for our purposes. The likelihood of suffering from the ailment of interest (CHD or T2D) for individual *i* in household *h* at time *t* is modeled as follows:

$$\begin{aligned}\text{Ailment}_{iht} = \theta_1 + \theta_2\text{USDAScore}_{ht} + \theta_A\mathbf{AlcoholShares}_{ht} + \theta_H\mathbf{HealthIndicators}_{it} \\ + \theta_D\mathbf{Demographics}_{ht} + \theta_L\mathbf{Lifestyle}_{it} + \mathbf{e}_{iht}.\end{aligned} \tag{1}$$

Thus, the determinants of the incidence of these ailments are dietary quality and a series of vectors. **AlcoholShares** is the vector of alcohol preference variables, given by the expenditure shares by alcohol type. In this setting, we are restricted to

Table 1
Variable Definitions and Summary Statistics

Variable	*Definition*	*Mean*	*Standard deviation*
Cholesterol	Binary = 1 if respondent indicates suffering from high cholesterol in 2012	0.346	
Hypertension	Binary = 1 if respondent indicates suffering from hypertension in 2012	0.340	
HeartDisease	Binary = 1 if respondent indicates suffering from heart disease in 2012	0.099	
T2D	Binary = 1 if respondent indicates suffering from type 2 diabetes (T2D) in 2012	0.104	
Obese	Binary = 1 if respondent has a body mass index (BMI) >30[a]	0.341	
Overweight	Binary = 1 if respondent has a BMI between 25 and 30	0.346	
Underweight	Binary = 1 if respondent has a BMI <18.5		
Female	Binary = 1 if respondent is female	0.539	
Age	Age of respondent, in years	54.126	14.257
White	Binary = 1 if respondent is white, including Hispanic	0.847	
Black	Binary = 1 if respondent is black	0.081	
Asian	Binary = 1 if respondent is Asian	0.033	
Married	Binary = 1 if respondent is married	0.752	
YoungChildren	Binary = 1 if respondent has children under the age of 13	0.086	
OlderChildren	Binary = 1 if respondent has children over the age of 13	0.119	
Rural	Binary = 1 if respondent resides in a rural area, defined as being outside of the IRI metropolitan markets	0.263	
South	Binary = 1 if respondent resides in the southern states	0.363	
West	Binary = 1 if respondent resides in the western states	0.190	
Midwest	Binary = 1 if respondent resides in the midwestern states	0.176	
BMI	BMI of respondent	28.770	6.882
Exercise	Binary = 1 if respondent indicates that he or she exercises most days or some days	0.726	
Dessert	Binary = 1 if respondent indicates that he or she eats dessert most days or some days	0.757	
FastFood	Binary = 1 if respondent indicates that he or she eats fast food most days or some days	0.489	
Organic	Binary = 1 if respondent indicates that he or she eats organic food most days or some days	0.362	
USDAScore	Score measuring the adherence of the household's cumulative food purchases to the Dietary Guidelines for Americans, full details available from Volpe and Okrent (2012)	6.596	1.642

Continued

Table 1
Continued

Variable	*Definition*	*Mean*	*Standard deviation*
Stress	Binary = 1 if respondent indicates that he or she experiences stress	0.711	
HHIncome	Annual household income, in U.S. dollars	\$63,752	\$35,758
GradSchool	Binary = 1 if respondent attended graduate school	0.185	
College	Binary = 1 if respondent attended college but not graduate school	0.369	
HighSchool	Binary = 1 if respondent attended high school but not college	0.436	
WineShare	Share of cumulative alcohol expenditures attributable to wine	0.232	0.296
AlcFood Ratio	Ratio of cumulative alcohol expenditures to food expenditures	0.075	0.175
JugWineShare	Share of cumulative alcohol expenditures attributable to jug wine (less than \$3 per liter)	0.017	0.083
TableWineShare	Share of cumulative alcohol expenditures attributable to table wine (between \$3 and \$7 per liter)	0.090	0.174
PremWineShare	Share of cumulative alcohol expenditures attributable to premium wine (between \$7 and \$14 per liter)	0.090	0.162
UltraPremWineShare	Share of cumulative alcohol expenditures attributable to premium wine (more than \$14 per liter)	0.036	0.102
SpiritsShare	Share of cumulative alcohol expenditures attributable to spirits	0.127	0.218
CiderMaltShare	Share of cumulative alcohol expenditures attributable to cider and malt beverages	0.022	0.088
CraftBeerShare	Share of cumulative alcohol expenditures attributable to craft beer	0.031	0.102
ImportBeerShare	Share of cumulative alcohol expenditures attributable to imported beer	0.008	0.044
MacroBeerShare	Share of cumulative alcohol expenditures attributable to macrobeer	0.178	0.272

Note: [a] The classifications based on BMI are taken from the Centers for Disease Control and Prevention.

estimating potential health impacts among broad categories of drinking behavior. **HealthIndicators** is the vector of measures of health and well-being, as drawn from the MedProfiler data, including age, BMI, stress, hypertension, and high cholesterol. **Demographics** is the vector of household-level descriptors drawn from the Household Panel, including income, education levels, marital status, the presence of children, race, and a vector of geographic variables including urban versus rural and regional dummies. Consumption craft versus macro beer has been shown to be geographically dependent (Elzinga et al., 2015). **Lifestyle** is a vector of variables measuring an individual's stated lifestyle and preferences, in our effort to account for the unobservable demand for health that is likely correlated with health outcomes. These include exercise frequency and consumption of fast foods, organic foods, and dessert.

The second component of our approach seeks to identify potential health impacts of alcohol consumption, based on intensity and relative to not drinking. The likelihood of suffering from the ailment of interest (CHD or T2D) for individual i in household h at time t is modeled as follows:

$$\begin{aligned}\text{Ailment}_{iht} = {} & \theta_1 + \theta_2\text{USDAScore}_{ht} + \theta_{\text{AL}}\text{AlcoholSharesLight}_{ht} \\ & + \theta_{\text{AM}}\mathbf{AlcoholSharesModerate}_{ht} + \theta_{\text{AH}}\mathbf{AlcoholSharesHigh}_{ht} \\ & + \theta_{\text{H}}\mathbf{HealthIndicators}_{it} + \theta_{\text{D}}\mathbf{Demographics}_{ht} + \theta_{\text{L}}\mathbf{Lifestyle}_{it} + \mathbf{e}_{iht}.\end{aligned} \tag{2}$$

The setup is comparable to equation (1), though the households have now been classified as nondrinkers (the reference category), light, medium, or heavy. We calculated total alcohol expenditures, by household and year, and created three equal quantiles to create the categories. An example of an alcohol variable is CraftBeerShareLight, which is the share of alcohol expenditures among households in the lowest quantile for alcohol expenditures. In estimating equation (2), we also expand our classification of wine into the four subcategories, based on price per liter. This has the advantages of providing a more nuanced understanding of alcohol/health associations. However, the samples of households within the subcategories included in the model may grow small, potentially yielding imprecise coefficient estimates.

Given the size of the data set and the work required by respondents to record and input responses, we expect that the sample contains errors and outliers. We removed all households with total food expenditures, 2008–2012, less than \$100, to eliminate households that significantly underreport food purchases. We also removed households with total alcohol expenditures at least twice the value of total food expenditures. Finally, we removed households with individuals who demonstrate likely errors in inputting their health outcome data. Any household with individuals who changed their ailment status twice between 2010 and 2012 was removed from the sample. We also removed all possible and probable outliers for any of the continuous variables, including BMI and dietary scores.

In settings such as these, endogeneity and dual causality are persistent concerns. It is easy to imagine that less healthful preferences for alcohol and food, as well as the proclivity toward CHD or T2D, are both determined by underlying preferences for health that cannot be captured by the model. To circumvent this and to establish a degree of causality, we treat alcohol preferences and diet as stock variables. Additional, this decision was made in light of Williams's (2005) finding that alcohol use is partially due to habit formation and therefore longer-term decisions. In our baseline estimation, we model health outcomes in 2012 as a function of each household's overall alcohol expenditure shares and USDAScore for the entire time period during which they participated in the Household Panel. In many cases, this constitutes 5 years of data. To increase the sample size, we also relax this restriction and estimate equations (1) and (2) such that health outcomes for 2010–2012 are functions of aggregate purchasing behavior for all years leading up to and including the year of the outcome. The results for CHD are reported in Table 2.

Unless otherwise noted, we restrict our discussion to the 2012-only results, our preferred specification for both equations (1) and (2). With few exceptions, the results are closely comparable across our two specifications of equation (1), lending robustness to the results. The coefficient estimates are odds ratios. A value below 1 indicates factors associated with decreased risk, whereas a value above 1 indicates heightened risk for the ailment of interest. In our preferred estimation of equation (1), among alcohol variables only the coefficient on wine share is statistically different from 0, and it indicates the expected protective effect. However, the coefficient on craft beer share is the smallest in magnitude and is very near being statistically significant at the 0.10 level, providing evidence for a potential protective effect for CHD. Although insignificant, the coefficients on spirits, macrobeer, and import beer are all below 1, whereas the coefficient for cider and malt beverages indicates a potential harmful effect, though we stress more data are needed to study this category.

As expected, our estimates for equation (2) are less precise, as there are fewer households in each drinking category. Here we find that light craft beer drinking, relative to not drinking, is associated with the decreased incidence of CHD. We also find significant protective effects for heavy macrobeer expenditures and heavy jug and premium wines. The results to this point are beginning to flesh out the narrative that wine and beer exhibit the strongest protective effects with respect to CHD, a finding consistent with much of the research to date on alcohol and health.

The results of estimating equations (1) and (2) on T2D are reported in Table 3. Wine, spirits, craft beer, and macrobeer are all associated with decreased risk, among drinkers, according to the estimation results for equation (1). Among these four, there are no coefficient estimates statistically different from any others. Comparing drinkers with nondrinkers via the results for equation (2), we find consistent evidence of the protective effects of wine consumption. The estimated impacts of medium and heavy jug wine consumption, heavy table wine consumption, all degrees of premium wine consumption, and light ultrapremium wine consumption are statistically significant. Light and heavy spirits consumption demonstrate protective effects, and again we find no significant impacts for the relatively thin cider/malt beverage category. Among beer, heavy consumption of craft beer and the medium and heavy consumption of macrobeer are all associated with protective effects. Import beer consumption demonstrates no effect overall, but we caution that more data on import beer purchases are needed to better study the potential role of these beverages.

Broadly, the results support the long-standing contention that alcohol consumption (as proxied by purchase behavior in our study) has health-protective effects. Craft beer, wine, and macrobeer are all associated with the decreased likelihood of CHD and T2D. Moreover, spirits are also associated with decreased T2D risk.

Table 2
Logit Regression Results for Coronary Heart Disease

	Baseline model		*Alcohol expenditures by quantile*	
Variable	*2012*	*2010–2012*	*2012*	*2010–2012*
AlcFood Ratio			1.118	1.046
			(0.347)	(0.613)
Cholesterol	2.273***	2.370***	2.281***	2.378***
	(0.083)	(0.056)	(0.090)	(0.093)
Hypertension	2.742***	2.863***	2.769***	2.889***
	(0.104)	(0.074)	(0.117)	(0.082)
T2D	1.396***	1.431***	1.410***	1.439***
	(0.063)	(0.042)	(0.067)	(0.045)
Female	0.580***	0.596***	0.580***	0.594***
	(0.018)	(0.065)	(0.019)	(0.015)
Age	1.013	1.005	1.014	1.006
	(0.259)	(0.569)	(0.225)	(0.458)
Age2	1.000**	1.000***	1.000**	1.000***
	(0.011)	(0.000)	(0.018)	(0.000)
White	0.844	0.699	0.847	0.699
	(0.698)	(0.215)	(0.703)	(0.216)
Black	2.930**	1.611	2.948**	1.618
	(0.0480)	(0.184)	(0.047)	(0.180)
Asian	0.617	0.249***	0.607	0.250***
	(0.490)	(0.003)	(0.475)	(0.003)
Married	0.822	0.716**	0.806	0.707**
	(0.357)	(0.022)	(0.310)	(0.017)
YoungChildren	0.989	1.119*	0.987	1.121*
	(0.905)	(0.081)	(0.893)	(0.07)
OlderChildren	0.964	1.057	0.962	1.053
	(0.632)	(0.304)	(0.616)	(0.334)
Rural	0.982	1.023	0.982	1.025
	(0.657)	(0.441)	(0.651)	(0.417)
Midwest	0.990	0.995	0.987	0.992
	(0.861)	(0.895)	(0.818)	(0.848)
South	1.028	1.012	1.018	1.008
	(0.544)	(0.727)	(0.684)	(0.820)
West	0.902*	0.884***	0.907*	0.888***
	(0.057)	(0.002)	(0.0731)	(0.003)
Underweight			1.100	1.342***
			(0.550)	(0.003)
Overweight			0.999	0.977
			(0.979)	(0.447)
Obese			1.098**	1.071**
			(0.048)	(0.042)
Exercise	0.855***	0.854***	0.848***	0.852***
	(0.000)	(0.000)	(0.000)	(0.000)
Stress	1.215***	1.267***	1.214***	1.268***
	(0.043)	(0.029)	(0.045)	(0.031)
HHIncome	0.951***	0.955***	0.951***	0.954***
	(0.043)	(0.004)	(0.006)	(0.004)

Continued

Table 2
Continued

Variable	*Baseline model* 2012	*Baseline model* 2010–2012	*Alcohol expenditures by quantile* 2012	*Alcohol expenditures by quantile* 2010–2012
GradSchool	1.106	0.909	1.096	0.902
	(0.562)	(0.420)	(0.597)	(0.381)
College	1.112	0.979	1.108	0.977
	(0.532)	(0.856)	(0.544)	(0.840)
HighSchool	1.039	0.948	1.034	0.945
	(0.818)	(0.636)	(0.844)	(0.617)
USDAScore	0.984	0.982**	0.985	0.983*
	(0.196)	(0.048)	(0.215)	(0.052)
SpiritsLight			1.044	1.015
			(0.102)	(0.298)
SpiritsMedium			1.008	0.999
			(0.589)	(0.929)
SpiritsHeavy			0.990	0.992
			(0.339)	(0.292)
CiderMaltLight			1.024	1.034*
			(0.523)	(0.074)
CiderMaltMedium			1.012	0.996
			(0.745)	(0.857)
CiderMaltHeavy			1.034	0.986
			(0.499)	(0.751)
CraftBeerLight			0.905*	0.953
			(0.070)	(0.124)
CraftBeerMedium			0.964	0.992
			(0.263)	(0.704)
CraftBeerHeavy			0.991	0.995
			(0.776)	(0.832)
ImportBeerLight			1.006	0.939
			(0.948)	(0.235)
ImportBeerMedium			0.925	0.982
			(0.374)	(0.743)
ImportBeerHeavy			1.040	1.008
			(0.573)	(0.906)
MacroBeerLight			1.026	1.006
			(0.182)	(0.533)
MacroBeerMedium			0.994	0.992
			(0.599)	(0.284)
MacroBeerHeavy			0.984*	0.984**
			(0.095)	(0.021)
JugWineLight			0.926	0.987
			(0.349)	(0.783)
JugWineMedium			1.010	0.989
			(0.812)	(0.692)
JugWineHeavy			0.938**	0.940***
			(0.016)	(0.001)
TableWineLight			0.996	0.991
			(0.863)	(0.466)

Continued

Table 2
Continued

	Baseline model		Alcohol expenditures by quantile	
Variable	*2012*	*2010–2012*	*2012*	*2010–2012*
TableWineMedium			0.991	0.993
			(0.578)	(0.536)
TableWineHeavy			1.007	0.998
			(0.637)	(0.863)
PremWineLight			0.995	0.974*
			(0.842)	(0.069)
PremWineMedium			0.974	0.986
			(0.179)	(0.267)
PremWineHeavy			0.957**	0.972*
			(0.022)	(0.054)
UPremWineLight			1.019	0.997
			(0.710)	(0.915)
UPremWineMedium			1.025	0.989
			(0.425)	(0.601)
UPremWineHeavy			1.017	1.020
			(0.604)	(0.384)
Dessert	0.935*	0.961	0.935*	0.959
	(0.0965)	(0.130)	(0.098)	(0.118)
FastFood	1.004	1.005	1.004	1.005
	(0.923)	(0.846)	(0.922)	(0.830)
Organic	1.017	1.043	1.012	1.039
	(0.677)	(0.107)	(0.773)	(0.145)
Age × white	1.004	1.006	1.004	1.006
	(0.562)	(0.259)	(0.548)	(0.254)
Age × black	0.976***	0.985**	0.976***	0.985**
	(0.007)	(0.014)	(0.008)	(0.014)
Age × Asian	1.007	1.020**	1.007	1.020**
	(0.544)	(0.0116)	(0.536)	(0.0131)
Age × married	1.004	1.006**	1.004	1.006***
	(0.220)	(0.0138)	(0.179)	(0.009)
BMI	1.010***	1.007***		
	(0.000)	(0.001)		
WineShare	0.986**	0.986***		
	(0.037)	(0.002)		
SpiritsShare	0.998	0.996		
	(0.812)	(0.539)		
CiderMaltShare	1.019	1.013		
	(0.432)	(0.383)		
CraftBeerShare	0.966	0.984		
	(0.107)	(0.288)		
ImportBeerShare	0.992	0.974		
	(0.860)	(0.442)		
MacroBeerShare	0.992	0.991*		
	(0.260)	(0.062)		
N	48,488	169,849	48,488	169,849
Pseudo R^2	0.179	0.186	0.177	0.185

Notes: Asterisks (***, **, and *) indicate estimated odds ratio is statistically different from 1 at the 0.01, 0.05, and 0.10 levels, respectively. *P* values in parentheses. BMI, body mass index; T2D, type 2 diabetes.

Table 3
Logit Regression Results for Type 2 Diabetes

	Baseline model		*Alcohol expenditures by quantile*	
Variable	*2012*	*2010–2012*	*2012*	*2010–2012*
Cholesterol	2.806***	2.857***	2.760***	2.780***
	(0.111)	(0.074)	(0.082)	(0.076)
Hypertension	2.142***	2.131***	2.213***	2.218***
	(0.083)	(0.056)	(0.090)	(0.062)
CHD	1.418***	1.410***	1.433***	1.423***
	(0.063)	(0.042)	(0.067)	(0.045)
Female	0.724***	0.740***	0.766***	0.785***
	(0.023)	(0.018)	(0.026)	(0.020)
Age	1.116***	1.125***	1.107***	1.113***
	(0.014)	(0.010)	(0.014)	(0.010)
Age2	0.999***	0.999***	0.999***	0.999***
	(0.000)	(0.000)	(0.000)	(0.000)
White	0.664	0.657	0.721	0.666
	(0.375)	(0.182)	(0.483)	(0.194)
Black	0.608	0.871	0.689	0.887
	(0.381)	(0.714)	(0.510)	(0.748)
Asian	1.298	0.829	1.162	0.695
	(0.683)	(0.680)	(0.815)	(0.425)
Married	0.723	0.851	0.569***	0.684**
	(0.144)	(0.296)	(0.009)	(0.012)
YoungChildren	0.862	0.900	0.838*	0.876*
	(0.127)	(0.129)	(0.065)	(0.052)
OlderChildren	0.841**	0.906*	0.824**	0.882**
	(0.023)	(0.057)	(0.010)	(0.014)
Age × white	0.999	1.000	0.998	1.000
	(0.862)	(0.959)	(0.815)	(0.973)
Age × black	1.005	1.001	1.003	1.001
	(0.621)	(0.895)	(0.749)	(0.907)
Age × Asian	0.999	1.006	1.001	1.009
	(0.909)	(0.473)	(0.893)	(0.259)
Age × married	1.006*	1.003	1.010***	1.006**
	(0.080)	(0.250)	(0.005)	(0.013)
Rural	1.022	1.053*	1.022	1.057*
	(0.601)	(0.091)	(0.600)	(0.072)
Midwest	0.925	0.963	0.910*	0.955
	(0.176)	(0.387)	(0.096)	(0.285)
South	0.996	0.989	0.988	0.987
	(0.937)	(0.737)	(0.784)	(0.708)
West	0.930	0.959	0.940	0.972
	(0.191)	(0.311)	(0.266)	(0.492)
BMI	1.077***	1.081***		
	(0.002)	(0.002)		
Exercise	0.887***	0.853***	0.832***	0.800***
	(0.032)	(0.019)	(0.030)	(0.019)
Stress	0.997	1.030	0.996	1.029
	(0.934)	(0.237)	(0.915)	(0.252)

Continued

Table 3
Continued

	Baseline model		*Alcohol expenditures by quantile*	
Variable	*2012*	*2010–2012*	*2012*	*2010–2012*
HHIncome	0.969***	0.963***	0.965***	0.961***
	(0.006)	(0.004)	(0.006)	(0.005)
GradSchool	1.173	1.017	1.220	1.027
	(0.401)	(0.899)	(0.288)	(0.838)
College	1.293	1.119	1.342	1.120
	(0.167)	(0.383)	(0.108)	(0.365)
HighSchool	1.347	1.113	1.369*	1.100
	(0.107)	(0.398)	(0.083)	(0.442)
USDAScore	0.961***	0.983*	0.958***	0.984*
	(0.002)	(0.057)	(0.001)	(0.075)
WineShare	0.948***	0.955***		
	(0.005)	(0.004)		
SpiritsShare	0.958***	0.964***		
	(0.000)	(0.000)		
CiderMaltShare	0.996	0.996		
	(0.847)	(0.778)		
CraftBeerShare	0.945***	0.951***		
	(0.007)	(0.001)		
ImportBeerShare	1.012	1.010		
	(0.776)	(0.724)		
MacroBeerShare	0.955***	0.963***		
	(0.006)	(0.004)		
Dessert	0.738***	0.729***	0.715***	0.707***
	(0.028)	(0.018)	(0.029)	(0.018)
FastFood	1.196***	1.186***	1.184***	1.175***
	(0.041)	(0.027)	(0.044)	(0.028)
Organic	0.924*	0.936**	0.922**	0.936**
	(0.051)	(0.012)	(0.045)	(0.012)
AlcFood Ratio			0.447***	0.526***
			(0.082)	(0.070)
Underweight			0.610*	0.768*
			(0.071)	(0.097)
Overweight			1.589***	1.660***
			(0.089)	(0.063)
Obese			3.494***	3.742***
			(0.187)	(0.142)
SpiritsLight			0.951*	0.991
			(0.0633)	(0.476)
SpiritsMedium			0.981	0.983*
			(0.220)	(0.078)
SpiritsHeavy			0.980*	0.977***
			(0.082)	(0.009)
CiderMaltLight			0.963	0.980
			(0.291)	(0.319)
CiderMaltMedium			0.988	0.985
			(0.699)	(0.478)

Continued

Table 3
Continued

	Baseline model		Alcohol expenditures by quantile	
Variable	*2012*	*2010–2012*	*2012*	*2010–2012*
CiderMaltHeavy			1.058	1.046
			(0.264)	(0.242)
CraftBeerLight			1.036	0.987
			(0.467)	(0.619)
CraftBeerMedium			0.947	0.952**
			(0.103)	(0.031)
CraftBeerHeavy			0.926**	0.934***
			(0.015)	(0.004)
ImportBeerLight			1.113	1.033
			(0.108)	(0.439)
ImportBeerMedium			1.003	1.007
			(0.970)	(0.894)
ImportBeerHeavy			0.922	0.981
			(0.371)	(0.757)
MacroBeerLight			1.007	0.989
			(0.692)	(0.221)
MacroBeerMedium			0.960***	0.970***
			(0.001)	(0.000)
MacroBeerHeavy			0.958***	0.961***
			(0.000)	(0.000)
JugWineLight			1.087	1.024
			(0.273)	(0.525)
JugWineMedium			0.893**	0.912***
			(0.041)	(0.007)
JugWineHeavy			0.904***	0.938***
			(0.001)	(0.005)
TableWineLight			0.980	0.975**
			(0.321)	(0.028)
TableWineMedium			0.990	0.991
			(0.575)	(0.493)
TableWineHeavy			0.967*	0.960***
			(0.054)	(0.002)
PremWineLight			0.954*	0.985
			(0.066)	(0.283)
PremWineMedium			0.938***	0.943***
			(0.002)	(0.000)
PremWineHeavy			0.910***	0.905***
			(0.000)	(0.000)
UPremWineLight			0.881**	0.932**
			(0.020)	(0.010)
UPremWineMedium			1.013	1.015
			(0.677)	(0.473)
UPremWineHeavy			1.019	0.986
			(0.604)	(0.613)
N	48,822	170,851	48,822	170,851
Pseudo R^2	0.202	0.208	0.196	0.201

Notes: Asterisks (***, **, and *) indicate estimated odds ratio is statistically different from 1 at the 0.01, 0.05, and 0.10 levels, respectively. *P* values in parentheses. BMI, body mass index; CHD, coronary heart disease.

Among statistically significant associations, we find that beer and wine are comparable in their health-protective effects.[4] In most estimations, the coefficient for craft beer is the lowest among all beer types and is among the lowest among all alcohol variables. However, these differences among coefficients are not statistically significant.

Most of our controls have the expected signs and are, for the most part, significant. All of the health factors are positively and significant associated with CHD, and all but stress are significant determinants of T2D. Females are significantly less at risk for both ailments. Age is a significant risk factor for T2D, married couples are less at risk for CHD, and households with children present are somewhat less as risk for T2D. Income and dietary quality are negatively and significantly associated with both ailments.

The lifestyle measurements are jointly important as determinants. Exercise significantly decreases the risk factor for both CHD and T2D. Fast-food consumption, as expected, is positively associated with T2D incidence, and the opposite is true for organic foods. One somewhat counterintuitive finding is that dessert is shown to have a protective effect for T2D. However, there are multiple potential explanations for this. Dietary quality is in the model, and so sugars and sweets purchased to constitute desserts are already controlled for, meaning that this variable could be capturing, in part, the tendency to eat dinners as a family. Additionally, the IRI question on dessert does not specify the type of dessert, meaning this includes individuals eating fruit or cheese for dessert.

To aid in the interpretation of the odds ratios for our key alcohol variables, we calculated the marginal effects on the incidences of the ailments based on 10 percentage point increases in the respective expenditure shares. These values are reported in Table 4. As with the estimated odds ratios, the majority of the estimated effects are not statistically different from one another.

Our findings suggest that, with respect to health-protective effects, beer consumption is comparable to wine and in some cases may be superior. Increasing the household craft beer expenditure share by 10 percentage points is associated with a 3.4% decrease in risk for CHD and a 5.5% decrease in the risk for T2D in our baseline estimations of equation (1). A similar adjustment for macrobeer is associated with

[4] One contention of the results is that medium to heavy consumption for some alcohol categories is associated with protective effects, whereas the body of evidence on alcohol and health stresses the benefits of moderate intake among adults. We emphasize that drinkers in our sample are classified according to expenditure quantiles within the data set. Therefore, adults in a household in the "heavy" quantile may not actually be heavy drinkers. It reflects that they are in the top third of total alcohol expenditures in the IRI panel. Thus, we caution interpreting our results in terms of drinks per day. To contextualize this, consider that the upper quantile consists of households spending $168.74 per year and up on alcohol. The threshold equates to $0.46 per day, which does not reflect a household purchasing or consuming multiple drinks per day.

Table 4
Marginal Impacts on the Incidence of Heart Disease and Type 2 Diabetes

	Coronary heart disease		*Type 2 diabetes*	
Variable	*Baseline model (1)*	*Alcohol expenditures by quantile (2)*	*Baseline model (1)*	*Alcohol expenditures by quantile (2)*
SpiritsLight		−4.4		4.9
SpiritsMedium		−0.8		1.9
SpiritsHeavy		1		2
CiderMaltLight		−2.4		3.7
CiderMaltMedium		−1.2		1.2
CiderMaltHeavy		−3.4		−5.8
CraftBeerLight		9.5		−3.6
CraftBeerMedium		3.6		5.3
CraftBeerHeavy		0.9		7.4
ImportBeerLight		−0.6		−11.3
ImportBeerMedium		7.5		−0.3
ImportBeerHeavy		−4		7.8
MacroBeerLight		−2.6		−0.7
MacroBeerMedium		0.6		4
MacroBeerHeavy		1.6		4.2
JugWineLight		7.4		−8.7
JugWineMedium		−1		10.7
JugWineHeavy		6.2		9.6
TableWineLight		0.4		2
TableWineMedium		0.9		1
TableWineHeavy		−0.7		3.3
PremWineLight		0.5		4.6

Continued

Table 4
Continued

	Coronary heart disease		*Type 2 diabetes*	
Variable	*Baseline model (1)*	*Alcohol expenditures by quantile (2)*	*Baseline model (1)*	*Alcohol expenditures by quantile (2)*
PremWineMedium		2.6		6.2
PremWineHeavy		4.3		9
UPremWineLight		−1.9		11.9
UPremWineMedium		−2.5		−1.3
UPremWineHeavy		−1.7		−1.9
WineShare	1.4		5.2	
SpiritsShare	0.2		4.2	
CiderMaltShare	−1.9		0.4	
CraftBeerShare	3.4		5.5	
ImportBeerShare	0.8		−1.2	
MacroBeerShare	0.8		4.5	
BMI	−1.0		−7.7	
Exercise	14.5	15.2	11.3	16.8
USDAScore	1.6	1.5	3.9	4.2
HHIncome	4.9	4.9	3.1	3.5

Notes: The marginal impacts are calculated using the estimated odds ratios from Table 2, the regression results. For the alcohol variables, they report the estimated effect of increasing the respective shares by 10% on the likelihood of suffering from the ailments. For example, a 10 percentage point increase in the craft beer share is associated with a 3.4% decrease in the likelihood of reporting coronary heart disease.

approximately a 0.8% decrease in risk for CHD and a 4.5% decrease in T2D risk. For wine, the estimated marginal effects are a bit more disparate, at 1.4% for CHD and 5.2% for T2D. There is no evidence that malt beverages and cider or imported beer have protective health effects, but these beverages had low average expenditure shares in the data.

We also provide the estimated marginal impacts relative to nondrinkers, as drawn from our estimation of equation (2). As before, care must be taken in using these numbers, as model (2) yielded less precise estimates. However, the magnitudes of the protective effects for craft beer stand out among beer types. The potential reduction in the incidence or likelihood of CHD is as high a 9% as a result of craft beer drinking, relative to not drinking at all. For T2D, the effect is as high as 7%. In some cases, the estimated protective effects due to wine consumption may be as high as 10% to 11%.

Finally, to help contextualize these marginal impacts, we also report the estimated effects for some of our key control variables. A 1-point increase in BMI is associated with a 1% increase in the likelihood of CHD and a 7% increase for T2D, at the mean. Increases in exercise frequency, as measured by the scale used in the IRI questionnaire, have substantial implications for health effects. Adults who exercise regularly are between 11% and 17% less likely to suffer from either of these ailments, as compared with nonexercisers. Dietary quality and household income are both associated with economically significant protective effects as well.

A. Robustness Check: The Panel of Individuals Only

Recognizing the potential measurement error that may result from using household behavior to model individual health outcomes, we also estimate equations (1) and (2) using the sample of households in the panel consisting of individuals only. We identified these households using the household size variable and restricting our attention to only those with values equal to 1. The selected results are reported in Table 5.

Our goal in conducting this robustness check is to investigate if the estimated effects, with respect to alcohol expenditures, are qualitatively comparable to those reported in Tables 2 and 3, using the full sample. There are two important reasons to expect that the magnitudes of the coefficients might differ considerably. The first is that the sample is very thin for this estimation, particularly for equation (2). The second is that people living alone in the sample differ, statistically, from the overall sample. They are considerably more likely to be either students or elderly and are more likely to live in urban areas, as examples.

Nevertheless, the results in Table 5 corroborate our findings from the general sample. Wine and craft beer stand out among alcohol types, exhibiting significant protective effects in four and three of the estimations of equation (1), respectively. Spirits and macrobeer demonstrate significant protective effects for T2D, whereas import beer and spirits show no significant effects. We therefore conclude that our full-sample results are not affected importantly by the merging of household and individual factors.

V. Conclusions

We investigate relationships between alcohol-purchasing behavior, dietary quality, and the incidence of CHD and T2D. Among U.S. adults who purchase alcohol, we find support for the contention that beer is comparable to wine in its protective

Table 5
Selected Logit Regression Results for Households of Size 1

	Coronary heart disease				*Type 2 diabetes*			
	Baseline model (1)		*Alcohol expenditures by quantile (2)*		*Baseline model (1)*		*Alcohol expenditures by quantile (2)*	
Variable	*2012*	*2010–2012*	*2012*	*2010–2012*	*2012*	*2010–2012*	*2012*	*2010–2012*
USDAScore	0.941**	0.967	0.940**	0.968	0.974	1.012	0.966	1.011
	(0.0302)	(0.120)	(0.0266)	(0.133)	(0.361)	(0.582)	(0.243)	(0.603)
SpiritsLight			0.985	1.031			0.902*	0.970
			(0.811)	(0.331)			(0.076)	(0.351)
SpiritsMedium			0.974	0.984			0.961	0.974
			(0.428)	(0.506)			(0.236)	(0.260)
SpiritsHeavy			0.984	0.978			1.001	0.982
			(0.492)	(0.225)			(0.985)	(0.392)
CiderMaltLight			1.012	0.937			1.059	1.030
			(0.910)	(0.308)			(0.413)	(0.517)
CiderMaltMedium			0.999	0.923			0.714***	0.875**
			(0.987)	(0.239)			(0.005)	(0.029)
CiderMaltHeavy			1.053	1.062			0.529*	0.800
			(0.537)	(0.501)			(0.055)	(0.281)
CraftBeerLight			0.617*	0.925			1.034	0.943
			(0.065)	(0.433)			(0.846)	(0.466)
CraftBeerMedium			0.956	0.974			0.931	0.930
			(0.618)	(0.727)			(0.415)	(0.294)
CraftBeerHeavy			0.910	0.969			0.901	0.934
			(0.222)	(0.591)			(0.199)	(0.240)
ImportBeerLight			1.051	0.991			1.271*	1.228*
			(0.758)	(0.947)			(0.092)	(0.067)
ImportBeerMedium			0.893	1.149			0.920	0.959
			(0.514)	(0.183)			(0.599)	(0.687)
ImportBeerHeavy			1.129	1.099			0.480	0.707
			(0.537)	(0.542)			(0.148)	(0.136)

MacroBeerLight			1.017	1.001			1.050	0.993
			(0.678)	(0.965)			(0.194)	(0.741)
MacroBeerMedium			0.997	1.005			0.966	0.971
			(0.927)	(0.803)			(0.253)	(0.142)
MacroBeerHeavy			0.967	0.975			0.972	0.956**
			(0.210)	(0.203)			(0.334)	(0.041)
JugWineLight			0.788	0.858			1.194	0.986
			(0.281)	(0.157)			(0.117)	(0.865)
JugWineMedium			0.958	0.868*			0.662***	0.916
			(0.715)	(0.060)			(0.008)	(0.156)
JugWineHeavy			0.862**	0.941			0.957	0.976
			(0.012)	(0.154)			(0.523)	(0.686)
TableWineLight			0.972	0.959			1.021	0.996
			(0.550)	(0.117)			(0.658)	(0.889)
TableWineMedium			0.974	0.991			1.024	1.005
			(0.446)	(0.703)			(0.492)	(0.843)
TableWineHeavy			0.959	0.940**			0.967	0.918**
			(0.279)	(0.047)			(0.464)	(0.013)
PremWineLight			1.036	1.051*			0.904*	0.948*
			(0.488)	(0.063)			(0.086)	(0.087)
PremWineMedium			0.983	0.987			0.978	0.959
			(0.689)	(0.643)			(0.598)	(0.151)
PremWineHeavy			0.908*	0.959			0.882*	0.898**
			(0.064)	(0.272)			(0.056)	(0.019)
UPremWineLight			1.003	0.991			0.656***	0.784***
			(0.978)	(0.875)			(0.009)	(0.007)
UPremWineMedium			1.063	1.034			0.982	0.966
			(0.327)	(0.465)			(0.764)	(0.449)
UPremWineHeavy			1.059	1.099*			1.053	0.971
			(0.385)	(0.0520)			(0.534)	(0.643)
WineShare	0.969**	0.981*			0.945***	0.949***		
	(0.025)	(0.063)			(0.000)	(0.000)		
SpiritsShare	0.980	0.988			0.937***	0.956***		

Continued

Table 5
Continued

	Coronary heart disease				*Type 2 diabetes*			
	Baseline model (1)		*Alcohol expenditures by quantile (2)*		*Baseline model (1)*		*Alcohol expenditures by quantile (2)*	
Variable	*2012*	*2010–2012*	*2012*	*2010–2012*	*2012*	*2010–2012*	*2012*	*2010–2012*
	(0.263)	(0.357)			(0.003)	(0.002)		
CiderMaltShare	1.018	0.955			0.900*	0.969		
	(0.759)	(0.317)			(0.081)	(0.401)		
CraftBeerShare	0.900*	0.958			0.896*	0.929*		
	(0.075)	(0.321)			(0.066)	(0.073)		
ImportBeerShare	1.016	1.082			1.019	1.068		
	(0.881)	(0.302)			(0.861)	(0.413)		
MacroBeerShare	0.987	0.992			0.964*	0.962***		
	(0.487)	(0.566)			(0.051)	(0.003)		
N	7,168	24,657	7,168	24,657	7,270	24,963	7,270	24,963
Pseudo R^2	0.1448	0.1517	0.1482	0.1547	0.1998	0.2017	0.201	0.1964

Notes: Asterisks (***, **, and *) indicate estimated odds ratio is statistically different from 1 at the 0.01, 0.05, and 0.10 levels, respectively. *P* values in parentheses.

effects for drinkers. We measure alcohol behavior based on expenditure shares and find that shifting alcohol expenditures to beer or wine has significant protective effects against both ailments. Moreover, we distinguish craft beer from other varieties of beer and find evidence that craft beer may have stronger protective effects than macrobeer or wine. We discuss a number of reasons as to why craft beer may be healthier than macrobeer, malt beverages/cider, or other choices.

Our findings also support the growing consensus in research across multiple disciplines that alcohol intake has health-protective effects, relative to not drinking at all. We find that beer, wine, and spirits are all associated with the decreased incidence of heart disease and diabetes, relative to nondrinkers. As was the case when we focused entirely on drinkers, the effects of beer and wine on health are closely comparable, lending weight to the notion that beer has its own health-protective attributes.

There are three avenues by which this research can readily and fruitfully be extended. One is to examine the impacts of alcohol-purchasing behavior on other health measures, including longevity and body weight. Examining shorter-term ailments, for example strokes, might also improve the identification strategy. Another is to examine consumption directly, in order to quantify adults according to the number of drinks consumed per day or per week. This would allow for consumers to be categorized according to their adherence to dietary recommendations with respect to alcohol intake, specific to gender and body weight. Related to this, it would improve our estimation considerably to observe alcohol consumption away from home. Finally, it would be worthwhile to investigate the prevalence of switching among alcohol types among U.S. consumers and to understand the determinants of this behavior among consumers. Research (Bray, Loomis, and Engelen, 2009; Empen, Glauben, and Loy, 2012) has demonstrated that brand loyalty can be an important factor in determining purchases, at least among beers. Future work can help inform on the mechanisms that might drive consumers toward more health-protective alcoholic beverages.

References

Adjemian, M.K., Volpe, R.J., and Adjemian, J. (2015). Relationships between diet, alcohol preference, and heart disease and type 2 diabetes among Americans. *PLoS ONE*, 10(5), e0124351. doi:10.1371/journal.pone.0124351.

Arranz, S., Chiva-Blanch, G., Valderas-Martínez, P., Medina-Remón, A., Lamuela-Raventós, R.M., and Estruch, R. (2012). Wine, beer, alcohol and polyphenols on cardiovascular disease and cancer. *Nutrients*, 4(7), 759–781.

Bamforth, C.W. (2002). Nutritional aspects of beer—a review. *Nutrition Research*, 22(1–2), 227–237.

Barefoot, J.C., Grønbæk, M., Feaganes, J.R., McPherson, R.S., Williams, R.B., and Siegler, I. C. (2002). Alcoholic beverage preference, diet, and health habits in the UNC Alumni Heart Study. *American Journal of Clinical Nutrition*, 76(2), 466–472.

Bray, J.W., Loomis, B.R., and Engelen, M. (2009). You save money when you buy in bulk: Does volume-based pricing cause people to buy more beer? *Health Economics*, 18(5), 607–618.

Brenner, H., Rothenbacher, D., Bode, G., März, W., Hoffmeister, A., and Koenig, W. (2001). Coronary heart disease risk reduction in a predominantly beer-drinking population. *Epidemiology*, 12(4), 390–395.

Breslow, R.A., Guenther, P.M., and Smothers, B.A. (2006). Alcohol drinking patterns and diet quality: The 1999–2000 National Health and Nutrition Examination Survey. *American Journal of Epidemiology*, 163(4), 359–366.

Brien, S.E., Ronksley, P.E., Turner, B.J., Mukamal, K.J., and Ghali, W.A. (2011). Effect of alcohol consumption on biological markers associated with risk of coronary heart disease: Systematic review and meta-analysis of interventional studies. *British Medical Journal*, 342, d636. doi:10.1136/bmj.d636.

Centers for Disease Control and Prevention. (2011). Most Americans with high blood pressure and high cholesterol at unnecessary risk for heart attack and stroke. Accessed July 20, 2016, at http://www.cdc.gov/media/releases/2011/p0201_vitalsigns.html.

Centers for Disease Control and Prevention. (2014). *National Diabetes Statistics Report: Estimates of Diabetes and Its Burden in the United States*, 2014. Atlanta, GA: U.S. Department of Health and Human Services. Accessed October 24, 2016, at http://www.cdc.gov/diabetes/pubs/statsreport14/national-diabetes-report-web.pdf.

Center for Disease Control and Prevention. (2016). "Overweight and Obesity Statistics." Accessed online on November 4, 2016. Available at https://www.niddk.nih.gov/health-information/health-statistics/Pages/overweight-obesity-statistics.aspx.

Costanzo, S., Di Castelnuovo, A., Donati, M.B., Iacoviello, L., and de Gaetano, G. (2011). Wine, beer or spirit drinking in relation to fatal and non-fatal cardiovascular events: A meta-analysis. *European Journal of Epidemiology*, 26(11), 833–850.

Criqui, M.H., and Ringel, B.L. (1994). Does diet or alcohol explain the French paradox? *Lancet*, 344(8939–8940), 1719–1723.

Cuellar, S.S., and Huffman, R. (2008). Estimating the demand for wine using instrumental variable techniques. *Journal of Wine Economics*, 3(2), 172–184.

Djouseé, L., and Gaziano, J.M. (2007). Alcohol consumption and risk of heart failure in the Physicians' Health Study I. *Circulation*, 115(1), 34–39.

Elzinga, K.G., Tremblay, C.H., and Tremblay, V.J. (2015). Craft Beer in the United States: History, numbers, and geography. *Journal of Wine Economics*, 10(3), 242–274.

Empen, J., Glauben, T., and Loy, J.-P. (2012). Spatial retail pricing strategies for beer in Germany. Paper presented at the German Association of Agricultural Economists (GEWISOLA) 52nd Annual Conference, Stuttgart, Germany.

Fillmore, K.M., Kerr, W.C., Stockwell, T., Chikritzhs, T., and Bostrom, A. (2006). Moderate alcohol use and reduced mortality risk: Systematic error in prospective studies. *Addiction Research & Theory*, 14(2), 101–132.

Gehm, B.D., McAndrews, J.M., Chien, P.-Y., and Jameson, J.L. (1997). Resveratrol, a polyphenolic compound found in grapes and wine, is an agonist for the estrogen receptor. *Proceedings of the National Academy of Sciences of the United States of America*, 94 (25), 14138–14143.

Gerhäuser, C., Alt, A.P., Klimo, K., Knauft, J., Frank, N., and Becker, H. (2002). Isolation and potential cancer chemopreventive activities of phenolic compounds of beer. *Phytochemistry Reviews*, 1(3), 369–377.

Johansen, D., Friis, K., Skovenborg, E., and Grønbæk, M. (2006). Food buying habits of people who buy wine or beer: Cross sectional study. *British Medical Journal*, 332(7540), 519–521.

Joosten, M.M., Grobbee, D.E., van der A, D.L., Verschuren, W.M.M., Hendriks, H.F.J., and Beulens, J.W.J. (2010). Combined effect of alcohol consumption and lifestyle behaviors on risk of type 2 diabetes. *American Journal of Clinical Nutrition*, 91(6), 1777–1783.

Kaplan, N.M., Palmer, B.F., and Denke, M.A. (2000). Nutritional and health benefits of beer. *American Journal of the Medical Sciences*, 320(5), 320–326.

Keil, U., Chambless, L.E., Döring, A., Filipiak, B., and Stieber, J. (1997). The relation of alcohol intake to coronary heart disease and all-cause mortality in a beer-drinking population. *Epidemiology*, 8(2), 150–156.

Klatsky, A.L., Friedman, G.D., Armstrong, M.A., and Kipp, H. (2003). Wine, liquor, beer, and mortality. *American Journal of Epidemiology*, 158(6), 585–595.

Klatsky, A.L., Friedman, G.D., Siegelaub, A.B., and Gérard, M.J. (1977). Alcohol consumption and blood pressure—Kaiser Permanente multiphasic health examination data. *New England Journal of Medicine*, 296(21), 1194–1200.

Koppes, L.L.J., Dekker, J.M., Hendriks, H.F.J., Bouter, L.M., and Heine, R.J. (2005). Moderate alcohol consumption lowers the risk of type 2 diabetes: A meta-analysis of prospective observational studies. *Diabetes Care*, 28(3), 719–725.

Magalhães, P.J., Carvalho, D.O., Cruz, J.M., and Barros, A.A. (2009). Fundamentals and health benefits of xanthohumol, a natural product derived from hops and beer. *Natural Product Communications*, 4(5), 591–610.

Marmot, M.G., Shipley, M.J., Rose, G., and Thomas, B.J. (1981). Alcohol and mortality: A U-shaped curve. *Lancet*, 317(8220), 580–583.

Mortensen, E.L., Jensen, H.H., Sanders, S.A., and Reinisch, J.M. (2001). Better psychological functioning and higher social status may largely explain the apparent health benefits of wine: A study of wine and beer drinking in young Danish adults. *Archives of Internal Medicine*, 161(15), 1844–1848.

National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health. (2016). Alcohol facts and statistics. Accessed October 24, 2016, at http://www.niaaa.nih.gov/alcohol-health/overview-alcohol-consumption/alcohol-facts-and-statistics.

Nelson, J.P. (2013). Robust demand elasticities for wine and distilled spirits: Meta-analysis with corrections for outliers and publication bias. *Journal of Wine Economics*, 8(3), 294–317.

Renaud, S., and de Lorgeril, M.. (1992). Wine, alcohol, platelets, and the French paradox for coronary heart disease. *Lancet*, 339(8808), 1523–1526.

Renaud, S.C., Guéguen, R., Siest, G., and Salamon, R. (1999). Wine, beer, and mortality in middle-aged men from eastern France. *Archives of Internal Medicine*, 159(16), 1865–1870.

Rimm, E.B., Klatsky, A., Grobbee, D., and Stampfer, M.J. (1996). Review of moderate alcohol consumption and reduced risk of coronary heart disease: Is the effect due to beer, wine, or spirits? *British Medical Journal*, 312(7033), 731–736.

Roerecke, M., and Rehm, J. (2014). Alcohol consumption, drinking patterns, and ischemic heart disease: A narrative review of meta-analyses and a systematic review and meta-analysis of the impact of heavy drinking occasions on risk for moderate drinkers. *BMC Medicine*, 12, 182. doi:10.1186/s12916-014-0182-6.

Ronksley, P.E., Brien, S.E., Turner, B.J., Mukamal, K.J., and Ghali, W.A. (2011). Association of alcohol consumption with selected cardiovascular disease outcomes: A systematic review and meta-analysis. *British Medical Journal*, 342, d671. doi:10.1136/bmj.d671.

Silverman, M., Castaldi, R., Baack, S., and Sorlien, G. (2002). Competition in the global wine industry: A U.S. perspective. In Thompson, A., and Strickland, A.J. (Eds.), *Strategic Management: Concepts and Cases*. New York: McGraw-Hill Irwin. Available at http://online.sfsu.edu/castaldi/bie/globcase.htm

Stevens, J.F., and Page, J.E. (2004). Xanthohumol and related prenylflavonoids from hops and beer: To your good health! *Phytochemistry*, 65(10), 1317–1330.

Tjønneland, A., Grønbæk, M., Stripp, C., and Overvad, K. (1999). Wine intake and diet in a random sample of 48763 Danish men and women. *American Journal of Clinical Nutrition*, 69(1), 49–54.

Valmadrid, C.T., Klein, R., Moss, S.E., Klein, B.E.K., and Cruickshanks, K.J. (1999). Alcohol intake and the risk of coronary heart disease mortality in persons with older-onset diabetes mellitus. *JAMA*, 282(3), 239–246.

Vanhoecke, B., Derycke, L., Van Marck, V., Depypere, H., De Keukeleire, D., and Bracke, M. (2005). Antiinvasive effect of xanthohumol, a prenylated chalcone present in hops (*Humulus lupulus* L.) and beer. *International Journal of Cancer*, 117(6), 889–895.

Volpe, R.J., and Okrent, A. (2012). *Assessing the Healthfulness of Consumers' Grocery Purchases*. Washington, DC: U.S. Department of Agriculture, Economic Research Service, Economic Information Bulletin No. 102.

Wang, L., Lee, I.-M., Manson, J.E., Buring, J.E., and Sesso, H.D. (2010). Alcohol consumption, weight gain, and risk of becoming overweight in middle-aged and older women. *Archives of Internal Medicine*, 170(5), 453–461.

Williams, F.M.K., Cherkas, L.F., Spector, T.D., and MacGregor, A.J. (2005). The effect of moderate alcohol consumption on bone mineral density: A study of female twins. *Annals of the Rheumatic Diseases*, 64(2), 309–310.

Williams, J. (2005). Habit formation and college students' demand for alcohol. *Health Economics*, 14(2), 119–134.