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PRICE SENSTIVITY OF ALCOHOLIC BEVERAGES: THE DIFFERENTIAL RESPONSE TO PRICE AMONG DIFFERENT RACIAL/ETHNIC POPULATIONS

by

Shin Ta Tung

A dissertation submitted to the Graduate Faculty in Economics in partial fulfillment of the requirement for the degree of Doctor of Philosophy, The City University of New York

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1/25/99
Date

Michael Grossman
Chair of Examining Committee

1/25/99
Date

Michael Grossman
Executive Officer

Michael Grossman

Theodore Joyce

Robert Kaestner

Supervisory Committee

The City University of New York

Abstract

PRICE SENSTIVITY OF ALCOHOLIC BEVERAGES: THE DIFFERENTIAL RESPONSE TO PRICE AMONG DIFFERENT RACIAL/ETHNIC POPULATIONS

by

Shin Ta Tung

Advisor: Professor Michael Grossman

The goal of this study is to explore whether various racial/ethnic populations differ significantly in alcohol price sensitivity in the relationship between gender and age and alcohol drinking patterns. The Second Health and Nutrition Survey (NHANES II) was used as data in order to take advantage of the large sample size with the characteristics of alcohol consumption in each subsample. The ordered logit model is the method to analyze the data because it captures the ordinal and preferential nature of alcohol consumption, and the determinants of drinking participation are assumed to be the same as those of drinking frequencies. In general, the study finds males drink more than females and females are more price responsive than males; drinking measure rises sharply in youth and falls gradually with advancing age; youths are more price sensitive than adults. Raising alcohol prices can reduce the probability of people becoming heavy drinkers, who are responsible for a large percentage of alcohol problems. In addition, in the more detailed results real beer price is an effective policy tool to curb beer consumption of white non-Hispanics and Hispanics, while real liquor price has a significant and negative impact on liquor consumption of black non-Hispanics. Governments should realize the differential responses to alcohol prices among various racial/ethnic, age, and gender subgroups in order to effectively reduce the alcohol-related problems.

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To my parents, who missed me so much when I was in the U.S., and to my dear wife Judy, who has sacrificed so much to be here with me, this dissertation is dedicated to you, and I know no way I can repay your love for the rest of my life.

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1. INTRODUCTION

1.1. Introduction and Background

For many years, it has been known that alcohol use, especially alcohol abuse, is a major underlying cause of death. Fatality and mortality rates generally believed to be alcohol related are caused by the following: chronic alcohol liver disease, other specific chronic liver disease, unspecified chronic liver disease, alcohol dependence syndrome, non-dependent abuse of alcohol, alcohol psychosis, alcohol poisoning, motor vehicle traffic accidents, suicide, homicide, falls, drowning, fires and burns, and other accidents. Motor vehicle accident fatalities are the leading cause of injury deaths in the U.S., accounting for over 45,000 deaths annually, and are the leading cause of death for persons under 35. Approximately half are attributable to alcohol abuse, with the percentage much higher for people under 25, according to National Highway Traffic Safety Administration. Motor vehicle accident fatalities are particularly important in some race and ethnic populations. For example, the overall motor vehicle accident fatality rate among American Natives is 2.3 times as high as it is in the rest of population (May, 1988). Likewise, arrest rate data for drinking and driving are higher among both Blacks and Hispanics than they are in the rest of the population. These data suggest that drunk driving is a particularly important problem in various racial and ethnic populations.

Chronic liver disease, such as cirrhosis, is the main chronic health hazard associated with alcohol abuse and was the ninth leading cause of death in 1986. Furthermore, cirrhosis rates among non-whites have persistently exceeded rates among whites since the early 1960s. This is the result of migration by blacks from the rural South to the urban North during the 1960s and the accompanying social and demographic changes, which led to increased alcohol consumption.

Alcohol also plays a major role in violent crimes, such as homicide and assault. According to the Bureau of Justice Statistics, in 1988 about half of those imprisoned after conviction for a violent crime used alcohol just prior to committing the crime. Similarly, among

victims, about half of all homicide victims were found to have been drinking just prior to their murder (Combs-Orme et al., 1983). Young black males, for whom homicide is the leading cause of death, are at extremely high risk.

Since the mid-1970s, the federal government of the United States and various state and local governments have been involved in a campaign to reduce deaths from motor vehicle accidents by discouraging alcohol abuse. Alcohol related policies to be emphasized included law related to driving under the influence of alcohol (for example, open container laws), restriction on availability of alcohol (for example, minimum legal drinking ages), and limits on alcohol advertising. One major effect of this campaign has been the upward trend in state minimum legal drinking ages for the purchase and consumption of alcoholic beverages. This trend began with the increase in the legal drinking age in Minnesota from eighteen to nineteen years of age in 1976. An additional twenty-seven states had increased legal drinking ages by the time Congress passed the Federal Uniform Drinking Age Act of July 1984. This legislation allows the federal government, through its control of federal highway funds, to intercede in a legislative area traditionally reserved for states. Five percent of a state's federal highway construction fund allocation for the fiscal year 1987 was withheld if that state's minimum legal drinking age was below twenty-one on October 1, 1986, and ten percent will be withheld from each future fiscal year allocation if that state's drinking age remains below twenty-one. A second major element of the anti-drinking campaign is reflected by more severe penalties for conviction of drunk driving, the allocation of additional resources to apprehend drunk drivers, and the easing in the standards required for conviction.

One policy that has been virtually ignored by the federal and state governments in the anti-drinking campaign is increased taxation of alcohol beverages which, by raising prices, would lower alcohol beverage consumption and motor vehicle mortality. Instead, the federal excise tax rates on liquor (distilled spirits), beer, and wine remained constant in nominal terms between November 1, 1951, and the end of fiscal year 1985. During this period, the federal government

taxed liquor at the rate of $10.50 per proof gallon (one gallon of 100-proof liquor, which is the equivalent of 50 percent alcohol by volume), beer at the rate of $0.29 per gallon (approximately 4.5 percent alcohol by volume), and wine at the rate of $0.17 per gallon (between 11.6 percent and 21 percent alcohol by volume).

Partly as a result of the stability of the federal excise tax rates and modest increases in state and local excise taxes, the real price of alcoholic beverages (the nominal price divided by the Consumer Price Index) has declined substantially over time. Between 1960 and 1980, the real price of liquor fell by 48 percent, the real price of beer by 27 percent, and the real price of wine fell by 20 percent. While twenty-nine states raised the legal drinking age from 1976 through 1984, real alcoholic beverage prices continued to fall: 27 percent for liquor, 12 percent for beer, and 19 percent for wine. Federal taxes on alcohol beverages were increased on January 1, 1991 as part of a budget deficit reduction package. The beer tax doubled to 32 cents per six pack and wine tax increased almost eight-fold to 24 cents/750ml bottle. These were the first increases in these taxes since 1951. Spirits taxes, raised from $10.50 to $12.50 per proof gallon in 1985, further increased to $13.70. However, these increases do little to correct the erosion in the real prices of alcohol beverages since 1951. Manning et al. (1989,1991) suggest that current taxes are not sufficient to cover the heavy social costs that alcohol abusers impose on others – in terms of driving fatalities and higher collectively financed costs (e.g., medical care). The interest in high excise taxes stem partly from a concern that we are providing inappropriate signals about drinking. Thus, if alcohol abuse is sensitive to price, a government policy of declining real excise tax levels actually may be exacerbating this problem (Cook and Tauchen, 1982).

As the economics literature suggests, increasing the price of alcoholic beverages decreases alcohol consumption, encourages some to abstain, discourages initiations among youths, and reduces various alcohol related problems, including drunk driving and liver cirrhosis mortality. Policymakers can increase alcohol prices by raising excise taxes on alcohol and/or by raising the markup charged in monopoly states. While a large body of research describes the

effects of tax-increasing policy on overall alcohol consumption and related problems, very little is known about how various public policy measures influence drinking behaviors among different racial and ethnic groups. Differences in the impacts of the policies among these groups will be helpful in developing appropriate public policies for reducing the specific alcohol related problems within these racial and ethnic groups.

This dissertation examines the demand for alcohol beverages among various racial and ethnic populations. Some specific questions to be addressed: Is alcohol use and abuse in various racial and ethnic populations sensitive to the price of alcohol or to the minimum legal drinking age? Are certain racial and ethnic populations more sensitive to prices and legal drinking ages than the other? Are some subgroups within a specific racial or ethnic population, particularly those at high risk (i.e. youths), more responsive to prices and policy than other segments of that population? The large survey data, the second National Health and Nutrition survey (NHANES II), used in this study contain beverage-specific consumption and frequency of consumption. These data allow a detailed examination of alcohol use and abuse in the following populations: non-Hispanic whites, non-Hispanic blacks, and Hispanics.[1] Age and sex specific subgroups will also be examined.

1.2. Literature Review

Although little has been done about different race/ethnic groups' demand functions of alcohol beverages, a good deal of econometric work has appeared for the alcohol consumption of the entire general population. A main focus of economic studies of alcohol is to examine the price sensitivity of the demand for alcohol beverages. Similar to other empirical analyses, most of the studies center around the estimation of elasticities. Estimates of the price elasticity of demand for alcohol can be useful for tax questions. If the goal of the government is to raise revenue in the

least welfare-distorting manner, then the optimal tax is inversely related the price elasticity of demand. All other things equal, the less elastic the demand is for a good, the greater should be the tax on that good (Ramsey, 1927). All the literature can be divided into two broad categories: aggregate data studies and individual data studies. Such a distinction is useful because each category of work addresses different issues and employs different estimation methods.

1.2.1. Review of Aggregate-Demand Studies

There have been a number of studies of the effects of alcohol taxes on alcohol consumption and various results of drinking behaviors, such as motor vehicle fatality rates and liver cirrhosis mortality rates. Many of them have relied on panel or time-series analysis of state or national data to infer the price elasticities for overall consumption of beer, wine, and spirits separately, or of total alcohol consumption. The most extensive surveys of the literature are those by Ornstein (1980) and Ornstein and Levy (1983). They found that the estimates of the price elasticity of demand range from –1.39 to +0.01 for beer, from –3.65 to +0.02 for distilled spirits, and from –3.28 to –0.06 for wine. The estimates for the cross-price elasticity of demand range from –0.01 (spirit price on wine consumption) to +2.55 (beer price on wine consumption). All the econometric studies reviewed in the Ornstein and Ornstein and Levy surveys were based on aggregate data. Different forms of aggregate data have been used: time series for specific countries, countrywide time-series and cross-sections, state cross-sections in the United States, and province cross-section in Canada.

Leung and Phelps (1993) reviewed the aggregate data studies since the Ornstein and Ornstein and Levy surveys. They summarized, in general, that the price of beer is found to be the most inelastic, and that the price elasticity range from –0.56 to –3.9 for distilled spirits, and from –0.09 to –2.05 for wine. The research techniques employed range from simple comparisons and

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[1] The Hispanics are treated as a single group consisting of the following subgroups: Puerto Rican, Cuban, Mexican, Latin American, and other Hispanics. Unfortunately, survey data with large Asian/Pacific

bivariate correlations to the estimation of beverage-specific alcohol demand functions by ordinary least squares multiple regression analysis and its modifications.

These studies on state or national data have a number of econometric problems. First, some are subject to simultaneous equations bias because they treat prices as exogenous, when in fact, prices and quantities are jointly determined by supply and demand.[2] Second, there may be a bias from omitting relevant and possibly important explanatory variables which could be confounded with price. Third, even if the biases were minor, there may still be a precision problem from a limited number of observations. Fourth, since state alcoholic beverage markets are not completely distinct or separable, consumption estimates across states may be biased due to the effects of border crossing to avoid higher local taxes or high minimum legal drinking ages for youths. Fifth, demand functions estimated with time-series data are highly unstable because of the high correlations among income, price, and time. Finally, and perhaps most important, using aggregate data one cannot distinguish the price response of light, moderate, and heavy drinkers, or the decision to drink at all, which may be of interest in their own right; nor can one separate the price sensitivity of the demand for alcoholic beverages among different racial and ethnic groups. Aggregate alcohol demand studies employ data on per capita consumption by all age groups as the dependent variable. Therefore, the estimated price elasticities primarily reflect adult drinking behavior and cannot be used to predict how youths would respond to excise tax and price changes. As pointed out above, it may be especially important to focus on youths, who are at high risk of initiation of alcohol consumption, in the context of anti-drinking campaign. Nevertheless, if one could obtain unbiased estimates of the aggregate demand response to price, those estimates could be used to assess the desirability of an increased alcohol tax.

American or Native American populations are unavailable.

[2] Some have argued that one could use the excise tax level as an instrument in the studies of aggregate data which used price measures. If taxes were exogenous, then such an argument would provide both a microeconomically instrument and one that has the right econometric properties. Unfortunately, tax levels are often set at the level of state or national government. Unless the tax setting process is independent of

1.2.2. Review of Micro Demand Studies

As an alternative to aggregate data, the proliferation of economic work based on individual data (micro-data) and the development of econometric techniques for these data (micro-econometrics) have begun to exert their influence on alcohol research. The availability and use of individual data can shed light on debates that cannot be resolved using aggregate data. One good example is the debate on whether heavy drinkers are responsive to price changes. Price elasticities estimated from aggregate data measure only the effect of price on the alcohol consumption of the population as a whole. Room (1984) contended that such a broad measure is not of central interest because what really matters is the effect of price on high-risk drinking patterns.

Ideally, we would like to tax the harmful aspects related to drinking, by taxing drunk driving or by charging abusive drinkers higher health insurance premiums. Practically, we must rely on excise taxes on all alcohol, not just alcohol consumed under certain circumstances. But a broad based excise tax on alcohol will discourage light and moderate drinking, as well as heavy drinking. This may not be desirable, because there is some evidence to suggest that low levels of drinking may be beneficial. A drinker who has only a beer or a glass of wine with dinner every day has a very different social impact than someone who drinks seven drinks every Saturday night, especially if the latter drives.

Some alcohol literature asserts that price will only affect moderate and trouble-free drinkers (Room, 1984) and that increases in prices on alcoholic beverages will have little or no effect on heavy drinkers and problem drinkers because they are either addicted to or physically dependent on alcohol (Pittman, 1980). Therefore, increases in taxes on alcoholic beverages will only affect light and moderate drinkers. To evaluate these claims, individual data are needed because there is no direct way to gauge from aggregate data the impact of price increases on the

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demand and supply conditions in the market for alcoholic beverages, then the tax is also endogenous and no longer a proper instrument.

alcohol consumption of heavy drinkers and problem drinkers.[3] Consequently, previous research on aggregate price elasticities of alcohol has not yet provided complete and direct support for the use of price as a public health policy instrument.

Atkinson et al. (1990), Grossman and his colleagues (Grossman et al., 1987; Coate and Grossman, 1988) and Heien and Pompelli (1989) have used data on individuals to look at individual demands. Using expenditure data on alcoholic beverages by British households, Atkinson et al. (1990) used a Gamma version of the Tobit model to estimate the demand for alcohol, finding a price elasticity of about –1.1. Using data from the Household Food Consumption Survey, Heien and Pompelli (1989) report price elasticities for beer of –0.8, for spirits of –0.5, and for wine of –0.7.

By far the most extensive studies on the demand for alcoholic beverages using U.S. individual data are Grossman et al. (1987) and Coate and Grossman (1988). Their main objectives were to study the price sensitivity of youth alcohol demand and the effectiveness of minimum legal drinking age laws. The two studies had the same objectives and used the same estimation method, and the analyses were similar in many respects. Both studies focused only on youths between the ages of 16 and 21. The only main difference is the source of data. For alcohol consumption data, Grossman et al. Used the first National Health and Nutrition Survey (NHANES I), whereas Coate and Grossman used the second one (NHANES II). NHANES I and NHANES II cover the periods 1971-74 and 1976-80, respectively, and they also differ in the survey questions on drinking behavior.

Grossman et al. created three measures of drinking from NHANES I: participation, frequency, and quantity (number of drinks on a typical drinking day). The explanatory variables are alcohol prices, minimum legal drinking age, and individual background variables such as sex

[3] By using some proxies for heavy drinking and problem drinking, aggregate data can nevertheless be used to offer a partial solution to the problem. For instance, there are studies which employ aggregate data to relate the adverse effects of heavy drinking and abusive drinking, such as liver cirrhosis mortality rates and automobile accidents, to the price of alcoholic beverages (Cook, 1981).

and family income. Participation is treated as a dichotomous variable, and three separate dichotomous logit models are estimated, one for each type of beverage participation. Both the frequency of drinking (which consists of five outcomes) and the quantity of drinking (which is converted into four categories from the original continuous variable) are estimated by multinomial logit models. They focused on beer and liquor, because the results of wine were not satisfactory. All of the cross-price effects were found to be insignificant.

For the participation logit models, the price effects are negative and statistically significant for beer and liquor. For the frequency and quantity multinomial logit models, the price effects of all the outcome categories are negative for beer, but a majority of the estimates are statistically insignificant. The price effects of most of the outcome categories for liquor are negative and significant. These results provide weak evidence that heavy drinkers, especially for beer, are more sensitive to price changes than are moderate drinkers among youths.

Coate and Grossman (1988) only report the estimates of a multinomial logit model for beer consumption frequency. Their results suggest that the frequency of the consumption of beer, the most popular alcoholic beverage among youths, is inversely related to the real price of beer and to the minimum legal drinking age for its purchase and consumption. In addition, the fraction of youths who consume beer fairly frequently (one to three times a week) and frequently (four to seven times a week) fall more in absolute or percentage terms than the fraction of infrequent drinkers when price or drinking age rises.

2. DATA

2.1. Subsample Selection

To examine the effects of alcohol prices on the alcohol use of different groups, I have used NHANES II to estimate demand functions for alcohol consumption by the race/ethnic, adult/youth, and gender groups. The NHANES II is a national probability sample of the civilian, noninstitutionalized population of the United States with some oversampling of low-income persons, preschool children, and the elderly. The survey was conducted by NCHS between February 1976 and February 1980 and contains approximately 28,000 persons between the ages of six months and seventy-four years. These persons were selected from sixty-four primary sample units, which consist of one or more counties. Each person in the survey was given a detailed physical examination. A variety of information on medical and health history, family socioeconomic characteristics, and diet patterns were also obtained. Data on alcohol use for the past three months were collected for persons from age twelve to seventy-four. These data were acquired on the date on which the physical examination was given as one component of a food frequency review.[4]

Alcohol beverage prices have been added to the NHANES II survey based on a given sampling person's place of residence (primary sample unit). Since alcohol prices for the state of Hawaii were not available, sample persons residing in Honolulu, Hawaii, were excluded. After deleting observations with missing data, I obtained a final sample of 13273 aged twelve through seventy-four living in sixty-three of the sixty-four NHANES II primary sampling units.[5] Among them, 6890 are females, 2959 are youths, 10981 are non-Hispanic whites, 1588 are non-Hispanic

[4] The NHANES II is described in detail in U.S. Department of Health and Human Services, National Center for Health Statistics, Plan and Operation of the Second Health and Nutrition Examination Survey, 1976-80 (1981).

[5] Of the variables employed in the demand functions, the ones with missing values are alcohol use, family income, and education variables. In each case the number of observations with missing values is very small.

blacks, and 704 are Hispanics. All the race and ethnic demand-function estimates pertain to this sample and its subsamples divided by adult/youth and/or gender.

One issue has to be addressed here is how to separate youth samples from adults. Regarding the topic of alcoholic usage in this study, twenty-one-year-olds and below are treated as youths due to the interest in the sensitivity of alcohol consumption of older youths to both price and legal drinking age. Twenty-one-year-olds were legal drinkers in all states, but they are included in the youth group because twenty-one-year-olds in states with a legal drinking age of eighteen will have legal drinkers for a longer period of time than youths in states with a legal drinking age of nineteen, twenty, or twenty-one. This may have an impact on their consumption of alcoholic beverages. Although the choice of twenty-one is somewhat arbitrary, demand functions of youths of slightly different age, such as twenty, yield results that are very similar to those presented in the fourth chapter of this article.

2.2. Dependent Variables: Measurement of Alcohol Use

The NHANES II alcohol use measures for the final sample of 13273 are summarized by the percentage distributions of beverage-specific drinking frequencies in the past three months in Table 1. These measures pertain to the number of drinking occasions per week in the past three months. Information about the number of drinks consumed in total or on a typical drinking occasion was not obtained. The figures in Table 1 highlight the popularity among various alcoholic beverages. Approximately 42 percent of full samples drank beer in the past three months, compared with 37 percent who drank liquor and 32 percent who drank wine. Beer is even more popular among youths, for about 39 percent of youths drank beer while only 25 percent drank liquor and only 23 percent drank wine. Moreover, in the category for the heavy alcohol users who are defined as those drinking four times or above per week in the study, the percentage of beer consumption is approximately at least twice as large as that of liquor or wine. The

Table 1

Percentage Distributions of Beverage Specific Frequencies

Full Samples				
Beverage	More Than 3 Times a Week	1-3 Times a Week	Less Than Once a Week	Never
Beer	9.52	16.03	16.21	58.24
Liquor	4.93	12.12	20.24	62.71
Wine	2.65	9.28	20.59	67.48
Adults				
Beverage	More Than 3 Times a Week	1-3 Times a Week	Less Than Once a Week	Never
Beer	10.38	15.42	16.66	57.74
Liquor	6.21	13.16	21.53	59.10
Wine	3.24	10.23	21.78	64.75
Youths				
Beverage	More Than 3 Times a Week	1-3 Times a Week	Less Than Once a Week	Never
Beer	6.52	18.15	14.67	60.66
Liquor	0.51	8.52	15.71	75.26
Wine	0.57	5.95	16.46	77.02
Non-Hispanic Whites				
Beverage	More Than 3 Times a Week	1-3 Times a Week	Less Than Once a Week	Never
Beer	9,56	15.84	16.55	58.05
Liquor	5.30	12.13	21.08	61.49
Wine	2.86	9.66	21.55	65.93
Non-Hispanic Blacks				
Beverage	More Than 3 Times a Week	1-3 Times a Week	Less Than Once a Week	Never
Beer	9.45	16.94	14.10	59.51
Liquor	3.34	12.72	15.93	68.01
Wine	1.70	7.81	14.80	75.69
Hispanics				
Beverage	More Than 3 Times a Week	1-3 Times a Week	Less Than Once a Week	Never
Beer	9.09	16.90	15.77	58.24
Liquor	2.84	10.65	16.76	69.75
wine	1.57	6.53	18.57	73.15

Note: The sample size of adults whose ages are above 21 is 10314, and the sample size of youths whose ages are from 12 to 21 is 2959. Sample sizes of non-Hispanic whites, non-Hispanic blacks, and Hispanics are, respectively, 10981, 1588, and 704.

difference is even more overwhelming among youth heavy drinkers. Similar conclusions of these comparisons can be also obtained among different race/ethnic groups.

The actual beverage-specific frequency measure in NHANES II has more categories than Table 1.[6] Those outcomes in NHANES II were collapsed into four categories in this study because the number of drinks consumed per drinking occasion is likely to rise as the number of occasions rises and because very frequent consumers are likely to underreport. The beverage-specific number of drinking occasions in the past three months is a categorical variable in NHANES II, and the four categories shown in Table 1 are employed as outcome measures in demand functions estimated by multivariate techniques described in Chapter III. Here it is important to note that the use of a categorical variable allows us to examine the determinants of beverage-specific drinking participation and infrequent, fairly frequent, and frequent participation simultaneously. It also permits the effects of prices and legal drinking ages on these outcomes to differ. In addition, if more alcohol is consumed per drinking occasion as the number of occasions rises, true consumption would not be linearly related to a continuous drinking frequency measure. To take account of this nonlinearity, a categorical variable would be preferable to a continuous one even if the latter were available.

The number of drinking occasions per week is closely related to, and in most cases probably coincides with, the number of drinking days per week. Under this interpretation, the most frequent drinking category identifies sample persons who consumed alcohol at least every other day in the past three months.

Information on youths' alcohol consumption was obtained directly from youths in NHANES II. Parents were not present during the interviews with youths and were not informed about alcohol responses of their children. Nevertheless, there is a possibility that youths may report their alcohol use with error. If any such response error is uncorrelated with the independent

[6] The complete set of outcomes is never, less than once a week, 1-6 times a week (each of the 6 outcomes can be reported), and 1-24 times a day (each of the 24 outcomes can be reported).

variables in the demand function for alcohol, coefficients will be unbiased, although their standard errors will be inflated. In this case the existence of response error essentially presents no problem for the statistical analysis. Response error becomes a problem only if it is systematic or correlated with some or all of the variables in the demand functions.

The validity of the NHANES II alcohol measures is underscored by referring to the related problem of the measurement of cigarette smoking by adolescents. William and Gillies (1984) have reviewed the literature on self-reported smoking behavior of adolescents and have concluded "that teenagers probably do report 'truthfully' about their smoking behavior when anonymous questionnaires are used." An additional consideration is that the drinking questions were included as a small part of a much larger survey that was focused on very different issues. Gordon and Kannel (1983) argue that this improves the quality of reports of alcohol consumption.

To be sure, it is possible that heavy consumers of alcoholic beverages are more likely to underreport their consumption than are other persons (Midanik, 1982). If heavy drinkers are more likely to be found in areas with low prices or low legal drinking ages, estimates of the demand parameters of these variables are biased toward zero. This is another reason for the use of a categorical rather than a continuous drinking measure. In particular, the former does not assume a linear relation between true and reported consumption. Moreover, people are unlikely to be found in one of the four outcome categories used here rather than in another as a result of reporting error.

2.3. Independent Variables

Table 2 contains definitions, means, and standard deviations of the key independent variables in the demand functions. In additional to the variables listed in Table 2, all demand functions include as regressors the sample person's age in years on the date of his or her NHANES II examination, a dichotomous variable that identifies female, and real family income

Table 2

Definitions, Means, and Standard Deviations of Independent Variables

Variable name	Definition	Mean	Std. dev.
Real beer price (1967 dollars)	Price of a package of six 12-ounce cans of a leading brand of beer divided by CPI	1.026	0.112
Real liquor price (1967 dollars)	Price of Seagram's 7-Crown, 80 proof (40% alcohol), 5th size bottle, divided by CPI	2.952	0.305
Beer legal drinking age (years)	Minimum legal age for youths to purchase or consume beer	19.050	1.336
Liquor legal drinking age (years)	Minimum legal age for youths to purchase or consume liquor	19.538	1.469
Border age	Indicator equals 1 if youth lives within 20 miles of a state with a lower legal drink age	0.186	0.389
Southern Baptist	Percentage of population who are Southern Baptists in the sample's primary sample unit	8.672	13.608
Mormon	Percentage of populations who are Mormons in the sample's primary sample unit	1.501	7.975
Catholic	Percentage of population who are Catholics in the sample's primary sample unit	18,787	15.656
Protestant	Percentage of population who are Protestants in the sample's primary sample unit, excluding Southern Baptists and Mormons	20.186	8.482

Note: The means and standard deviations of the variables are based on the full sample size 13273, except for those of both legal drinking ages and border age which are only relevant to youth samples with sample size 2959.

(in per thousand 1967 dollars). There are two dichotomous educational variables for adults only: one indicates that an adult has some high school education or graduated high school but no any college education, and the other identifies that an adult has some college education or above. The same two dichotomous educational variables are applied to head of the household only for a youth sample. A dichotomous variable is created in the full-sample analyses to separate the independent variables only relevant to youths from those only pertinent to adults. Legal drinking ages, border age, and all the educational variables of the head of household are multiplied by the dichotomous variable with value equal to one if a sample is a youth, while sample persons' own educational variables are multiplied by one minus the dichotomous variable. Not all of the independent variables are discussed or presented in detail in the fourth chapter, but it should be realized that all estimated price and legal drinking age effects control for (held constant) the

effects of these variables. A relatively sparse set of independent variables have been used because Arluck (1987) found that the coefficients of interest in the demand functions are not sensitive to the inclusion of additional family background and youth characteristics. They also do not change much when state-specific measures of the availability and regulation of alcohol are added to the set of independent variables.[7]

The beer price variable pertains to the transaction of a single leading brand of medium-priced, nationally sold beer. The specific brand is confidential. Prices are reported in two unidentified major markets in each state (one in the case of Rhode Island and the District of Columbia) in January and July of 1976, 1977, and 1978 and in July of 1979. The data were obtained and made available by Stanley Ornstein (1985).

Monthly prices for each state from January 1976 through January 1979 were obtained by linear interpolation of state-specific price series, computed by averaging the two prices for each state at a moment in time. Monthly prices for the period February 1979 through January 1980 were predicted from a regression of the state price on the state excise tax rate, time (a continuous variable), and dichotomous variables for all contiguous states except one. The beer price of the mid-month in the three-month period for which alcoholic beverage consumption was reported was then assigned to each subject.[8] To take account of trends in the prices of other goods during the four-year period of NHANES II, the monthly beer price is divided by the annual Consumer Price Index (CPI, 1967 = 1) to obtain the real or relative price of beer.

The real price of liquor is given by the price of Seagram's 7-Crown (a blended whisky) divided by CPI. This price is selected because Seagram's 7-Crown was the leading brand of liquor in the United States during the period of NHANES II, and its price commonly is used as a

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[7] The availability and regulatory measures considered by Arluck include the per capita number of establishments that are licensed to sell alcoholic beverages, a dichotomous variable that indicates whether off-premise alcoholic beverage stores are state owned and operated, a dichotomous variable that indicates whether drug and grocery stores can sell alcoholic beverages, and a dichotomous variable that indicates whether billboard advertising of alcoholic beverages is allowed. All of them pertain to the state in which a sample person resides. Arluck results are based on ordinary least squares regressions.

standard in the liquor industry. It was obtained from the annual survey of the retail prices of eight leading brands of distilled spirits in each state conducted by the Distilled Spirit Council of the United States.

There were no data available on wine prices by state for the period of NHANES II. As a result, wine demand functions are not discussed in the following chapters.

The NHANES II contains a family income variable reported in twelve intervals. The intervals are $1,000 increments up to $7,000, followed by a $3,000 increment to $10,000, then $5,000 increments up to $25,000, and a $25,000 and over category. Because the NHANES II income variable is only ordinal, it was converted into a cardinal measure by filling in values using the mid-point of the interval. The value $30,000 was chosen to represent the category of $25,000 and above.

The minimum legal drinking ages in years for the purchase of beer (alcoholic content 3.2 percent or less by weight) and liquor were taken from Wagenaar's (1981/82) extremely painstaking and definitive compilation for every state for the years 1970 through 1981. Each NHANES II youth was assigned beverage-specific legal drinking ages in his or her state of residence as of the mid-month of the three-month period culminating on the date of his or her examination. The two minimum-legal-drinking-age variables are highly correlated and cannot be included in the same demand function. Therefore, only the beverage-specific legal drinking age is used as a regressor in the demand function for that beverage. In principle, this algorithm takes account of the upward trend in state legal drinking ages during the period of the NHANES II examination.

Youths who reside in a state with a higher legal drinking age may be able to purchase alcohol in a border state with a lower legal drinking age. A dichotomous variable, border age, was created to deal with this phenomenon. It equals one for youths who live within twenty miles of a

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[8] The earliest NHANES II examination was conducted on February 20, 1976, and the latest day was conducted on February 27, 1980. Therefore the mid-month dates are January 1976 through January 1980.

state with a lower legal drinking age than the one in their state of residence. Border age was computed separately for beer and liquor but assumed the same value for each beverage. With the own state legal drinking age held constant, the coefficient of the border age variable in the demand functions should be positive.

To take account of the potential role of "drinking sentiment " in the endogenous determination of alcohol beverage prices, legal drinking ages, and alcohol consumption, the percentages of the population in a sample person's primary sample unit who are Mormons, Southern Baptists, Catholics, and Protestants (excluding Southern Baptists and Mormons) are included in some specifications of the demand functions. Drinking sentiment refers to cultural and taste variables that may either encourage or discourage alcohol consumption. For example, anti-drinking sentiment should be relatively widespread in states where religious groups that oppose the use of alcohol, such as Mormons and Southern Baptists, are prevalent. These states may enact high alcohol beverage excise tax rates as part of the political process. In this situation, the price coefficients that emerge from demand functions that omit drinking sentiment overstate in absolute value the true parameters. On the other hand, states in which pro-drinking sentiment is prevalent (anti-drinking sentiment is weak) and alcohol consumption is high may enact high tax rates because the taxation of alcoholic beverages is an attractive source of revenue. In this case, the price effects are understated if drinking sentiment is excluded from demand functions. Similar comments can be made with respect to drinking age effects that do not control for drinking sentiment.

The religion variables pertain to 1980, and were taken from a survey conducted by the National Council of Churches of Christ and the Glenmary Research Center (Quinn et al., 1980). Jews are included with non-church members in the omitted category because the size of the Jewish population was significantly underestimated in the survey. Since no measures of an individual's religion preference are available in NHANES II, the religion measures pertain to the sample person's primary sample unit of residence rather than to his or her state of residence

because the former are better predicators of the sample person's actual religion.

The results with the religion variables included as regressors should be interpreted with caution because the price of beer or liquor is specific to the state rather than to the primary sampling unit. Given errors of measurement in price and correlations between the true price and the religion variables, price coefficients are biased toward zero and religion coefficients are biased away from zero. In this context, it is important to note that the most relevant religion variables is the respondent's own religion preference. In theory, this variables is more closely related to the respondent's consumption of alcohol but less closely related to price than the community religion variables that are actually used as regressors.

Although youths and some adults are more likely to drink if their peers also drink, it is inappropriate to include peers' consumption of alcohol in the demand functions, since peer behavior is an endogenous rather than exogenous variable in a more broadly defined model of drinking. That is, peer behavior is determined by such a model rather than by factors not specified by the model. For instance, suppose one is evaluating a policy to curtail young adults and youth drinking by raising the federal tax rate on beer. An increase in the tax would raise the price of beer paid by youths and their peers, which would discourage consumption by both groups. Therefore, in evaluating the impact of such a policy, peers' beer consumption should not be held constant (included in the demand function). Exactly the same comments apply to alcohol consumption by siblings and parents.

3. METHOD

The beverage-specific frequency of drinking in the past three months consists of four outcome categories (see Table 1) and the measures of drinking frequency are ordered categorical variables. Therefore, ordered logit equations are fitted by the method of maximum likelihood. Ordered logit estimation methods are discussed in detail by Maddala (1983). Here is a brief illustration on the technique applied to this study. We begin with

$$y^* = \beta' x + \mu$$

y^* is unobserved. What we do observe is

$$y = 0 \quad \text{if } y^* \leq R_1,$$

$$y = 1 \quad \text{if } R_1 < y^* \leq R_2,$$

$$y = 2 \quad \text{if } R_2 < y^* \leq R_3,$$

$$y = 3 \quad \text{if } R_3 < y^*.$$

This is a form of censoring. The discrete values from 0 to 3 of y are codes representing the four outcome categories of alcohol consumption: never, less than once a week, one to three times a week, and more than three times a week, respectively. The R_i (i= 1, 2, 3) is an unknown parameter to be estimated with β. Consider the survey of NHANES II. The respondents have their own intensity of feelings, which depends on certain measurable factors, x, and certain unobservable factors, μ. In principle, they could respond to the questionnaire with their own y^* if asked to do so. Given only, say, four possible answers in this study, they choose the cell that most closely represents their own feelings on the question. Let P_1, P_2, P_3, and P_4 be the probabilities that the sample person consumes beer (or liquor) zero times, less than once a week, one to three times a week, and four times or more a week, respectively. Define $R_0 = -\infty$ and $R_4 = \infty$ so that $R_0 < R_1 < R_2 < R_3 < R_4$, and normalize the mean and variance of μ to zero and one. The probability of the ith outcome is

$$P_i = [\,1 + \exp(-R_i + \sum_{t=1}^{n} \beta_t x_t)]^{-1} - [\,1 + \exp(-R_{i-1} + \sum_{t=1}^{n} \beta_t x_t)]^{-1} \quad (1)$$

where x_t is the value of the tth independent variable for the sample person. The model results from assuming that the cumulative density of μ is the logistic function. Therefore, the estimation technique can be derived from

$$1 - \sum_i P_i = 1 - [\,1 + \exp(-R_i + \sum_{t=1}^{n} \beta_t x_t)]^{-1}$$

$$= [\exp(-R_i + \sum_{t=1}^{n} \beta_t x_t)]\,[\,1 + \exp(-R_i + \sum_{t=1}^{n} \beta_t x_t)]^{-1} \quad (2)$$

which is a logistic function. By solving for the logarithm of the odds of more beer consumption relative to less or no consumption, the logistic function is transformed into a linear equation

$$\ln\Big[(1 - \sum_i P_i) \Big/ \sum_i P_i\Big] = -R_i + \sum_{t=1}^{n} \beta_t x_t \quad (3)$$

The marginal effect of x_t on P_i is

$$(\partial P_i / \partial x_t) = \beta_t[\Lambda_{i-1}(1 - \Lambda_{i-1}) - \Lambda_i(1 - \Lambda_i)] \quad (4)$$

$$\text{where } \Lambda_i = [\,1 + \exp(-R_i + \sum_{t=1}^{n} \beta_t x_t)]^{-1}$$

Note that the marginal effects sum to zero; this follows from the requirement that the probabilities add to one. In this study marginal effects of both real alcohol prices and minimum legal drinking ages are calculated at the means of independent variables. On the basis of equation (4), the elasticity of P_i with respect to x_t is

$$\varepsilon_{i\,t} = \beta_t[\Lambda_{i-1}(1 - \Lambda_{i-1}) - \Lambda_i(1 - \Lambda_i)](x_t/P_i) \quad (5)$$

This real price elasticity of demand is computed at the mean values of the independent variables of interests in the samples by first predicting P_i from equation (1).

Although the multinomial logit or probit models also deal with categorical responses, they failed to account for the ordinal nature of the dependent variable. Ordinary regression analysis would err in the opposite direction: linear regression would treat the differences between all two neighboring codes, such as 4 and 3, 3 and 2, the same, while in fact they are only a ranking.

Since the beer frequency equation, for example, contains non-beer drinkers, it gives an estimate of effect of each independent variable on the probability of no beer participation. Some of the contemporary researches separate participation of alcohol consumption from frequency of drinking by modeling alcohol consumption as a two-stage process in which people first determine whether alcohol is their beverage of choice and then determine the frequency of beverage-specific consumption or the number of drinks per day given participation. In the two-stage model, non-beer participants would be excluded from the equation for frequency. The model is not used here because it is appropriate only when the determinants of participation differ from those of frequency. This condition is not satisfied in our research.

4. RESULTS

This chapter contains maximum likelihood estimates of the beverage-specific frequency equations for the three race/ethnic groups: non-Hispanic whites, non-Hispanic blacks, and Hispanics, based on the ordered logit model developed in the previous chapter. The results for the three key independent variables in this study: real alcohol prices, minimum legal drinking ages, and border age are introduced and discussed in the text. Logit coefficients and their asymptotic *t*-ratios are shown. Results for all of the independent variables can be found in the appendices. An equation that excludes the four religious measures and another equation that includes them are presented. In the discussion of these results, people who drink more than three times a week are termed frequent or heavy drinkers; those who drink one to three times a week are termed fairly frequent drinkers; and those who drink less than once a week are termed infrequent drinkers. Marginal effects and price elasticities are then computed for the four outcome categories at the means of the samples.

To get a general sense of what beverage-specific frequency equations look like, the empirical analysis begins with demand equations for the full samples of each race/ethnic group in the first section, followed by the second section for specific age groups in which adults and youths are separated. An in-depth analysis is attempted in the third section between males and females for each subgroup of race/ethnicity and age. Finally in the last section there is a brief discussion regarding the cross-price effect of the real liquor price in the beer demand functions and the real beer price in the liquor demand functions. However, the two legal drinking ages are not included in the same demand function because they are very highly correlated.

Problems arise in Section II and III where there are no or not enough observations in some minority groups for estimation. Consequently, each time a full sample of race/ethnic group is divided by age or/and gender, there is a risk that a reduced sample size is not large enough to fit the model, especially among minorities. There is no rule to use to draw the line for the minimum

number of observation for the analysis. For beer consumption, the research goes as far as it can until the subsample of Hispanic male youths with sample size of 103, in which there is not a complete separation in the sample points among independent variables so that the data do not converge to the estimates.[9] For both non-Hispanic black and Hispanic youths in this study, the numbers of observations in the category of heavy liquor drinkers are zero. As a result, the marginal effects and elasticities of that category are not available for the subsamples of youths among minorities. Since liquor is less popular than beer (see Section 2.2.), beer consumption is the main focus in the discussion and lack of frequent liquor drinkers in category of minority youths is not likely to be a problem in my research.

Based on the equations (4) and (5) in the Chapter III, a positive (negative) coefficient of an independent variable guarantees a negative (positive) marginal effect and a negative (positive) elasticity for the non-drinker category. In the meantime, the sign of marginal effects and elasticities for the frequent-drinker are always the same as that of the coefficient of the corresponding independent variable. It is very obvious that a negative coefficient, for example, means that a rise in the value of the variable will decrease alcohol consumption, which in turn increases the odds of the sample points being non-drinkers and decreases the odds of the sample points being frequent drinkers. However, we cannot conclude that the above example leads to a decrease in alcohol consumption of samples for the two middle categories, fairly frequent and infrequent drinkers. For example, an increase in price may move some respondents from the frequent to both the fairly frequent and infrequent categories. Fortunately, frequent drinkers receive more attention from the research because they have more social impact than moderate drinkers do.

In general, the results indicate that males drink more than females. As age increases, the frequency of alcohol use declines for adults but rises sharply for youths. Real family income is not a significant determinant of alcohol use and educational variables are inconclusive.

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[9] Maximum likelihood estimate may not exist in this case.

4.1. Full Sample Results

Table 3 contains ordered logit estimates of beer consumption equations for the full samples, their corresponding marginal effects and real beer price elasticities, respectively. The same formats of the results of liquor consumption equations, their marginal effects and real liquor price elasticities are presented in Table 4. Each table includes results with and without the religion variables for comparison.

In the beer consumption equation in Table 3, the logit coefficients of the real price of beer for both the white non-Hispanic and the Hispanic populations are negative. However, only the results without religion variables are statistically significant at the 5 percent level of significance. Of the equations of the black non-Hispanic population, with and without religion variables, the coefficients of the real beer price are positive but not statistically significant.[10] All of the full sample results of estimates of beer consumption equations indicate that the minimum beer legal drinking age has a negative and statistically significant impact on youths' beer consumption for the three race/ethnic populations. The only statistically significant border legal age effect is represented the coefficient of the equation excluding religion variables for the black non-Hispanics, which has the appropriate positive sign.

The marginal effects of minimum legal drinking age do not change too much between the equations with and without religion variables for each race/ethnic population. However, marginal effects of the real price of beer and the real beer price elasticities of the probabilities decrease by more than 50% for the white non-Hispanic and Hispanic populations when religion variables are included in the estimated equations. It is noteworthy that Hispanics are more price elastic than white non-Hispanics in every outcome category.

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[10] Statements concerning statistical significance in the text are based on one-sided tests except when the direction of the effect is unclear on a priori grounds or when the estimated effect has the "wrong sign". In the latter cases, two-tailed tests are used. In particular, the own price and legal drinking effects are expected to be negative, and the border legal age effects are expected to be positive. When no significance level is indicated, it is assumed to be 5 percent for all the tests. The critical asymptotic *t*-ratios at the 5% level are 1.64 for a one-sided test and 1.96 for a two-tailed test.

The real liquor price has statistically significant impact on both white non-Hispanics and black non-Hispanics. However, for the liquor consumption equations with and without religion variables for the white non-Hispanic population, the coefficients of real price of liquor are positive. One interpretation of this result is that liquor consumption is an inferior good for white non-Hispanics. A second interpretation is that the liquor price coefficients is biased because the price of wine is omitted, and wine and liquor are substitutes. If this is the case, and if wine and liquor prices are positively correlated, an increase in both prices could increase consumption of liquor. As discussed in Section 2.3, results of wine are not available in this study for lack of data of wine prices, and the past economic literature doesn't provide us a clear relation between liquor consumption and the wine price. If the price of wine and the price of liquor have always moved to the same direction, that is, an increase in the price of wine is always accompanied with a rise in the liquor price and vice versa, both increases in prices will lead to a higher consumption of liquor under the assumption that liquor and wine are substitutes.[11]

In Table 4, just as the full sample results for beer consumption, all of the coefficients of liquor legal drinking age are negative, but not statistically significant in the liquor consumption equations for white non-Hispanic population. Statistically significant border legal age effects are in equations excluding religion variables for both black non-Hispanic and Hispanic populations, and in the equation including religion variables for the black non-Hispanics.

The marginal effect of the real price of liquor in every outcome category of each equation is larger than that of the minimum liquor legal drinking age in the same category. In fact, most values of marginal effects of the liquor legal drinking age are very unsubstantial. The black non-Hispanic population is generally price elastic for liquor consumption, especially in the outcome category of frequent drinkers.

[11] In an attempt to measure the extent of substitution among various beverages, Uri (1986) employed aggregate data and discovered that beer, spirits, and wine are all substitutes. However, his finding was later contradicted by Heien and Pompelli's study (1989) based on individual data.

Table 3

Results of Beer Frequency Equations-Full Samples

	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
Real beer price	-0.562	0.327	-2.648	-0.274	0.456	-0.599
	(-3.266)	(0.621)	(-2.764)	(-1.409)	(0.809)	(-0.468)
Beer legal drinking age	-0.061	-0.105	-0.092	-0.061	-0.106	-0.089
	(-7.165)	(-6.528)	(-5.293)	(-7.075)	(-6.592)	(-5.104)
Border age	0.095	0.651	-0.091	0.021	0.564	-0.288
	(0.889)	(1.836)	(-0.128)	(0.193)	(1.570)	(-0.396)
	Marginal Effects of The Real Beer Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-0.039	0.022	-0.156	-0.018	0.030	-0.035
1-3 times a week	-0.059	0.037	-0.304	-0.029	0.052	-0.069
Less than once a week	-0.038	0.019	-0.179	-0.019	0.027	-0.041
Never	0.136	-0.078	0.640	0.066	-0.109	0.145
	Marginal Effects of The Beer Legal Drinking Age					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-0.004	-0.007	-0.005	-0.004	-0.007	-0.005
1-3 times a week	-0.006	-0.012	-0.011	-0.006	-0.012	-0.010
Less than once a week	-0.004	-0.006	-0.006	-0.004	-0.006	-0.006
Never	0.015	0.025	0.022	0.015	0.025	0.021
	Elasticities of The Real Beer Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-0.476	0.315	-2.458	-0.266	0.434	-0.563
1-3 times a week	-0.367	0.233	-1.873	-0.201	0.329	-0.425
Less than once a week	-0.203	0.125	-0.965	-0.104	0.178	-0.218
Never	0.250	-0.134	1.075	0.114	-0.186	0.244

Table 4

Results of Liquor Frequency Equations-Full Samples

	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
Real liquor price	0.222	-0.574	0.093	0.161	-0.851	0.125
	(3.575)	(-2.428)	(0.252)	(2.335)	(-2.898)	(0.329)
Liquor legal drinking age	-0.009	-0.089	-0.048	-0.006	-0.091	-0.046
	(-0.925)	(-5.012)	(-2.506)	(-0.632)	(-5.084)	(-2.385)
Border age	-0.015	0.865	1.102	-0.054	0.913	0.865
	(-0.123)	(2.050)	(1.665)	(-0.446)	(2.091)	(1.274)
	Marginal Effects of The Real Liquor Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	0.009	-0.013	0.002	0.006	-0.019	0.003
1-3 times a week	0.020	-0.051	0.008	0.014	-0.075	0.014
Less than once a week	0.023	-0.079	0.009	0.017	-0.080	0.008
Never	-0.052	0.143	-0.019	-0.037	0.174	-0.025
	Marginal Effects of The Liquor Legal Drinking Age					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	0.0	-0.002	-0.001	0.0	-0.002	-0.001
1-3 times a week	-0.001	-0.008	-0.004	0.0	-0.008	-0.005
Less than once a week	-0.001	-0.012	-0.005	-0.001	-0.008	-0.003
Never	0.002	0.022	0.010	0.001	0.018	0.009
	Elasticities of The Real Liquor Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	0.628	-1.609	0.277	0.456	-2.385	0.368
1-3 times a week	0.528	-1.394	0.241	0.392	-2.078	0.309
Less than once a week	0.313	-0.646	0.019	0.236	-1.440	0.214
Never	-0.243	0.768	-0.079	-0.173	0.696	-0.103

4.2. Age Specific Subsample Results

In this section the sample for each race/ethnic group is divided into two subgroups, adults and youths. As discussed in Section 2.1, sample persons with ages from twelve to twenty-one are classified as youths, and those with ages above twenty-one are adults. Obviously, the beverage-specific legal drinking age is not included in the estimated equations for adults because it should only have impact on youths. Table 5 and Table 6 are the results of beer consumption for adults and youths, and Table 7 and Table 8 are those of liquor consumption.

Due to the relatively very large sample size of adults, in the full samples the estimated coefficients of real prices primarily follow the results from adult samples. We still have positive and statistically significant coefficients of real liquor price for white non-Hispanic adults in Table 7 and negative ones for white non-Hispanic youths in Table 8. Therefore, the arguments in the previous section that there is a possible correlation between wine price and liquor price are principally applied to white adults. All of the statistically significant coefficients for adults have similar values as those in the full-sample results.

For beer consumption, even though the price coefficients for black non-Hispanic adults are not significant, the overall comparison of the results between adults and youths in Table 5 and Table 6 indicates that youths are more price-sensitive than adults. The price elasticities of the outcome categories of both non-drinkers and frequent drinkers for both white non-Hispanics and Hispanics are larger for youths than those for adults. For all of the negative coefficients of real beer price in both adult and youth beer consumption equations, the absolute values of the price coefficients and corresponding *t*-ratios are lowered when religion variables are included.

In Table 6, all of the real beer price coefficients are negative for youths, although in the equations for black non-Hispanic youths and Hispanic youths including religion variables they are not statistically significant. The minimum beer legal drinking age coefficients for white non-Hispanic and Hispanic youths are negative, but they lost their statistical significance when

religion variables are included. All of the coefficients of border legal age are not statistically significant for youths' beer consumption.

In Table 7, the real liquor price has significant negative impact on black non-Hispanic adults. All of the liquor price coefficients in Table 8 can not reach the conventional significance level. Those significant coefficients of liquor legal drinking age and border age have negative and positive sign, respectively. Due to zero observation for black and Hispanic youths in the category of heavy liquor drinkers, not many useful conclusions can be drawn.

Table 5

Results of Beer Frequency Equations-Adults

	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
Real beer price	-0.517 (-2.662)	0.550 (0.870)	-2.520 (-2.271)	-0.186 (-0.840)	0.562 (0.824)	-0.068 (-0.047)
	Marginal Effects of The Real Beer Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-0.035	0.042	-0.187	-0.012	0.042	-0.005
1-3 times a week	-0.051	0.065	-0.302	-0.018	0.066	-0.008
Less than once a week	-0.038	0.029	-0.092	-0.014	0.030	-0.004
Never	0.124	-0.135	0.582	0.044	-0.138	0.017
	Elasticities of The Real Beer Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-0.484	0.523	-2.282	-0.180	0.528	-0.063
1-3 times a week	-0.378	0.373	-1.631	-0.137	0.382	-0.043
Less than once a week	-0.204	0.172	-0.929	-0.074	0.178	-0.019
Never	0.214	-0.249	0.900	0.075	-0.254	0.032

Table 6

Results of Beer Frequency Equations-Youths

	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
Real beer price	-0.845	-0.557	-4.916	-0.813	-0.246	-0.935
	(-2.091)	(-0.515)	(-2.015)	(-1.759)	(-0.218)	(-0.271)
Beer legal drinking age	-0.136	0.037	-0.264	-0.068	0.124	-0.255
	(-3.602)	(0.288)	(-1.780)	(-1.632)	(0.886)	(-1.392)
Border age	0.064	0.246	0.439	-0.094	-0.105	0.005
	(0.513)	(0.500)	(0.603)	(-0.720)	(-0.194)	(0.0)
	Marginal Effects of The Real Beer Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-0.028	-0.014	-0.056	-0.025	-0.006	-0.009
1-3 times a week	-0.106	-0.049	-0.404	-0.100	-0.021	-0.073
Less than once a week	-0.067	-0.042	-0.450	-0.068	-0.019	-0.086
Never	0.201	0.105	0.909	0.193	0.046	0.169
	Marginal Effects of The Beer Legal Drinking Age					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-0.004	0.001	-0.003	-0.002	0.003	-0.003
1-3 times a week	-0.017	0.003	-0.022	-0.008	0.011	-0.020
Less than once a week	-0.011	0.003	-0.024	-0.006	0.009	-0.024
Never	0.032	-0.007	0.049	0.016	-0.023	0.046
	Elasticities of The Real Beer Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-0.844	-0.565	-4.923	-0.813	-0.250	-0.886
1-3 times a week	-0.665	-0.487	-4.386	-0.646	-0.213	-0.840
Less than once a week	-0.354	-0.358	-3.224	-0.355	-0.162	-0.624
Never	0.339	0.147	1.214	0.323	0.064	0.223

Table 7

Results of Liquor Frequency Equations-Adults

	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
Real liquor price	0.331	-0.625	0.210	0.249	-0.891	0.229
	(4.802)	(-2.456)	(0.497)	(3.244)	(-2.796)	(0.523)
	Marginal Effects of The Real Liquor Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	0.017	-0.023	0.007	0.011	-0.031	0.007
1-3 times a week	0.030	-0.068	0.018	0.022	-0.095	0.020
Less than once a week	0.033	-0.056	0.022	0.026	-0.083	0.024
Never	-0.080	0.147	-0.047	-0.059	0.209	-0.051
	Elasticities of The Real Liquor Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	0.913	-1.760	0.623	0.697	-2.431	0.664
1-3 times a week	0.759	-1.405	0.511	0.590	-2.022	0.589
Less than once a week	0.422	-0.791	0.335	0.329	-1.166	0.365
Never	-0.395	0.677	-0.215	-0.287	0.954	-0.231

Table 8

Results of Liquor Frequency Equations-Youths

	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
Real liquor price	-0.162	0.801	-0.101	-0.142	0.620	0.096
	(-0.946)	(1.244)	(-0.125)	(-0.735)	(0.736)	(0.114)
Liquor legal drinking age	-0.104	-0.008	-0.054	-0.038	-0.025	-0.319
	(-2.658)	(-0.071)	(-0.380)	(-0.899)	(-0.183)	(-1.731)
Border age	-0.144	0.321	1.985	-0.224	0.236	1.988
	(-1.064)	(0.663)	(2.621)	(-1.611)	(0.437)	(2.398)
	Marginal Effects of The Real Liquor Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-0.001	N/A	N/A	0.0	N/A	N/A
1-3 times a week	-0.007	0.024	-0.004	-0.006	0.018	0.003
Less than once a week	-0.018	0.034	-0.007	-0.016	0.027	0.006
Never	0.026	-0.058	0.011	0.022	-0.045	-0.009
	Marginal Effects of The Liquor Legal Drinking Age					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	0.0	N/A	N/A	0.0	N/A	N/A
1-3 times a week	-0.005	0.0	-0.002	-0.002	-0.001	-0.010
Less than once a week	-0.012	-0.001	-0.004	-0.004	-0.001	-0.021
Never	0.017	0.001	0.006	0.006	0.002	0.031
	Elasticities of The Real Liquor Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-1.051	N/A	N/A	-0.455	N/A	N/A
1-3 times a week	-0.448	2.265	-0.293	-0.407	1.743	0.268
Less than once a week	-0.356	2.020	-0.271	-0.321	1.615	0.244
Never	0.096	-0.154	0.036	0.081	-0.140	-0.031

4.3. Gender Specific Subsample Results

Historical studies have shown that females drink less than males. In this research, all of the coefficients of the dichotomous variable indicating female are negative and highly significant in all of the full sample and age-specific subsample beer consumption equations and most of liquor consumption equations for all of the race/ethnic populations (see Appendices). In order to attempt to analyze differences in price-responsiveness between females and males, this study divides all of the subsamples in the previous section into female and male groups.

Table 5 of the adult subsamples in the previous section shows statistically significant coefficients of real beer price in two equations—for white non-Hispanic and Hispanic adults without religion variables. Results indicate white non-Hispanic adult females are more sensitive to real beer price than white non-Hispanic adult males. The separation of adults by gender here makes significant and negative price coefficients in only two equations of beer consumption—one for white non-Hispanic female adults excluding religion variables in Table 9 and the other Hispanic male adults without religion variables in Table 10. Therefore, it is not enough to make any comparison of price sensitivity between adult females and males in beer consumption. However, in Table 11 and Table 12, the result does indicate that both white non-Hispanic and Hispanic female youths with significant coefficients of real beer price are more price-responsive than male youths. The three significant coefficients of real beer price in Table 6 for youths retain their significance in Table 11 for female youths, while all of the real beer price coefficients for male youths become non-significant in Table 12. Note that the results for Hispanic male youths are not available due to insufficient subsample size to fit the maximum likelihood method. For the Hispanic population in beer consumption equations from the discussions in the previous sections until now, there is a trend that the absolute values of significant real beer price coefficients and their corresponding *t*-ratios without religion variables are reduced significantly to non-significant level when religion variables are included. For beer consumption among the different race, age,

and gender populations, this is a strong evidence to justify the consideration of drinking sentiment discussed in Section 2.3.

In terms of comparison across different ethnic/race subsamples of gender, youths are the most sensitive to real beer price and black non-Hispanic are the least. Among male adults, Hispanics are much more responsive to real beer price than their white non-Hispanic counterparts. For all of the black non-Hispanic full samples and subsamples discussed from the previous sections until now, no coefficients of real beer price have reached significance level. All of the significant coefficients of beer legal drinking age and border age have the right signs. For male youths, the marginal effects of real beer price are larger than the corresponding effects of beer legal drinking age in all of the outcome categories.

In liquor consumption, just like the results in full sample and subsample analyses, the liquor consumption equations for black non-Hispanic male adults have statistically significant and negative signs. In Table 15 and Table 16, all of the liquor price effects are not significant.

Table 9

Results of Beer Frequency Equations-Female Adults

	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
Real beer price	-0.782 (-2.523)	-0.081 (-0.087)	-0.513 (-0.273)	-0.319 (-0.922)	-0.075 (-0.075)	2.325 (0.924)
	Marginal Effects of The Real Beer Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-0.019	-0.003	-0.010	-0.007	-0.002	0.038
1-3 times a week	-0.054	-0.008	-0.040	-0.021	-0.008	0.164
Less than once a week	-0.073	-0.007	-0.052	-0.030	-0.006	0.235
Never	0.147	0.017	0.101	0.058	0.016	-0.437
	Elasticities of The Real Beer Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-0.771	-0.096	-0.515	-0.318	-0.064	2.254
1-3 times a week	-0.694	-0.066	-0.443	-0.292	-0.066	2.031
Less than once a week	-0.517	-0.047	-0.318	-0.217	-0.040	1.493
Never	0.201	0.026	0.136	0.078	0.024	-0.574

Table 10

Results of Beer Frequency Equations-Male Adults

	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
Real beer price	-0.333	0.978	-3.470	-0.079	1.040	-1.682
	(-1.328)	(1.124)	(-2.496)	(-0.273)	(1.099)	(-0.930)
	Marginal Effects of The Real Beer Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-0.046	0.143	-0.563	-0.010	0.151	-0.272
1-3 times a week	-0.033	0.097	-0.304	-0.008	0.104	-0.148
Less than once a week	-0.002	-0.005	0.128	-0.001	-0.005	0.064
Never	0.081	-0.235	0.739	0.019	-0.250	0.356
	Elasticities of The Real Beer Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-0.289	0.836	-2.736	-0.065	0.891	-1.329
1-3 times a week	-0.157	0.399	-1.011	-0.038	0.429	-0.488
Less than once a week	-0.010	-0.030	0.666	-0.005	-0.030	0.330
Never	0.201	-0.609	2.381	0.047	-0.646	1.158

Table 11

Results of Beer Frequency Equations-Female Youths

	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
Real beer price	-1.509	0.015	-7.088	-1.560	0.440	-0.890
	(-2.468)	(0.010)	(-1.897)	(-2.192)	(0.253)	(-0.199)
Beer legal drinking age	-0.104	0.149	-0.534	-0.016	0.244	-0.657
	(-1.867)	(0.848)	(-2.272)	(-0.253)	(1.298)	(-2.456)
Border age	0.008	0.187	2.349	-0.206	-0.291	2.204
	(0.045)	(0.290)	(2.477)	(-1.062)	(-0.418)	(1.835)
	Marginal Effects of The Real Beer Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-0.025	0.0	-0.032	-0.022	0.006	-0.002
1-3 times a week	-0.152	0.001	-0.372	-0.146	0.024	-0.032
Less than once a week	-0.138	0.001	-0.749	-0.149	0.031	-0.092
Never	0.314	-0.002	1.153	0.317	-0.061	0.126
	Marginal Effects of The Beer Legal Drinking Age					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-0.002	0.002	-0.002	-0.001	0.003	-0.001
1-3 times a week	-0.010	0.009	-0.028	-0.001	0.013	-0.024
Less than once a week	-0.010	0.011	-0.057	-0.001	0.017	-0.068
Never	0.022	-0.022	0.087	0.003	-0.034	0.093
	Elasticities of The Real Beer Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-1.543	0.014	-7.120	-1.571	0.450	-1.009
1-3 times a week	-1.318	0.016	-6.686	-1.381	0.420	-0.862
Less than once a week	-0.880	0.011	-5.256	-0.952	0.344	-0.708
Never	0.458	-0.003	1.463	0.455	-0.076	0.154

Table 12

Results of Beer Frequency Equations-Male Youths

	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
Real beer price	-0.313 (-0.576)	-0.226 (-0.150)		-0.286 (-0.463)	-0.092 (-0.060)	
Beer legal drinking age	-0.158 (-3.076)	0.019 (0.106)		-0.113 (-1.979)	0.125 (0.606)	
Border age	0.046 (0.275)	0.126 (0.173)		-0.042 (-0.235)	-0.241 (-0.286)	
	Marginal Effects of The Real Beer Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-0.016	-0.008		-0.014	-0.003	
1-3 times a week	-0.048	-0.029		-0.044	-0.012	
Less than once a week	-0.013	-0.016		-0.013	-0.007	
Never	0.078	0.053		0.071	0.022	
	Marginal Effects of The Beer Legal Drinking Age					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-0.008	0.001		-0.006	0.004	
1-3 times a week	-0.024	0.002		-0.018	0.016	
Less than once a week	-0.007	0.001		-0.005	0.009	
Never	0.039	-0.005		0.028	-0.029	
	Elasticities of The Real Beer Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-0.297	-0.222		-0.273	-0.087	
1-3 times a week	-0.207	-0.179		-0.192	-0.075	
Less than once a week	-0.058	-0.100		-0.057	-0.044	
Never	0.167	0.088		0.151	0.036	

Table 13

Results of Liquor Frequency Equations-Female Adults

	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
Real liquor price	0.353	-0.345	1.744	0.247	-0.674	1.503
	(3.553)	(-0.890)	(2.422)	(2.208)	(-1.412)	(1.732)
	Marginal Effects of The Real Liquor Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	0.011	-0.002	0.021	0.007	-0.004	0.014
1-3 times a week	0.029	-0.031	0.079	0.018	-0.055	0.055
Less than once a week	0.039	-0.036	0.215	0.028	-0.071	0.182
Never	-0.079	0.069	-0.315	-0.053	0.130	-0.251
	Elasticities of The Real Liquor Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	0.968	-0.841	5.148	0.735	-1.909	4.521
1-3 times a week	0.898	-0.892	4.932	0.629	-1.743	4.281
Less than once a week	0.560	-0.610	3.696	0.407	-1.236	3.372
Never	-0.351	0.272	-1.249	-0.229	0.503	-0.963

Table 14

Results of Liquor Frequency Equations-Male Adults

	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
Real beer price	0.310	-0.846	-0.680	0.246	-1.116	-0.753
	(3.220)	(-2.481)	(-1.239)	(2.322)	(-2.571)	(-1.289)
	Marginal Effects of The Real Liquor Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	0.022	-0.067	-0.040	0.016	-0.087	-0.043
1-3 times a week	0.031	-0.105	-0.083	0.025	-0.140	-0.092
Less than once a week	0.024	-0.039	-0.045	0.020	-0.052	-0.051
Never	-0.077	0.211	0.168	-0.061	0.279	0.186
	Elasticities of The Real Liquor Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	0.859	-2.202	-1.907	0.664	-2.916	-2.115
1-3 times a week	0.642	-1.514	-1.442	0.531	-2.023	-1.609
Less than once a week	0.281	-0.488	-0.651	0.230	-0.643	-0.729
Never	-0.432	1.243	0.914	-0.340	1.641	1.010

Table 15

Results of Liquor Frequency Equations-Female Youths

	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
Real liquor price	-0.242	1.069	-1.389	-0.266	1.165	-1.517
	(-0.900)	(1.338)	(-1.156)	(-0.859)	(0.895)	(-1.135)
Liquor legal drinking age	-0.108	-0.057	0.045	0.023	-0.052	-0.332
	(-1.819)	(-0.347)	(0.219)	(0.348)	(-0.234)	(-1.190)
Border age	-0.196	0.153	3.605	-0.320	-0.085	3.189
	(-0.958)	(0.211)	(3.126)	(-1.514)	(-0.110)	(2.125)
	Marginal Effects of The Real Liquor Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-0.001	N/A	N/A	-0.001	N/A	N/A
1-3 times a week	-0.010	0.023	-0.035	-0.009	0.020	-0.022
Less than once a week	-0.023	0.031	-0.080	-0.025	0.031	-0.073
Never	0.035	-0.054	0.115	0.035	-0.051	0.095
	Marginal Effects of The Liquor Legal Drinking Age					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	0	N/A	N/A	0	N/A	N/A
1-3 times a week	-0.005	-0.001	0.001	0.001	-0.001	-0.005
Less than once a week	-0.011	-0.002	0.003	0.002	-0.001	-0.016
Never	0.016	0.003	-0.004	-0.003	0.002	0.021
	Elasticities of The Real Liquor Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-0.740	N/A	N/A	-0.798	N/A	N/A
1-3 times a week	-0.680	3.004	-4.069	-0.756	3.289	-4.418
Less than once a week	-0.556	2.841	-3.690	-0.636	3.199	-4.215
Never	0.125	-0.164	0.379	0.121	-0.153	0.306

Table 16

Results of Liquor Frequency Equations-Male Youths

	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
Real liquor price	-0.121 (-0.537)	0.471 (0.415)	1.229 (0.902)	-0.074 (-0.304)	0.222 (0.162)	0.789 (0.549)
Liquor legal drinking age	-0.105 (-2.006)	0.010 (0.065)	-0.244 (-1.112)	-0.083 (-1.459)	-0.033 (-0.177)	-0.480 (-1.560)
Border age	-0.102 (-0.560)	0.555 (0.796)	1.026 (0.752)	-0.150 (-0.796)	0.151 (0.178)	1.311 (0.920)
	Marginal Effects of The Real Liquor Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-0.001	N/A	N/A	0.0	N/A	N/A
1-3 times a week	-0.005	0.016	0.053	-0.003	0.007	0.023
Less than once a week	-0.015	0.027	0.081	-0.010	0.012	0.046
Never	0.021	-0.043	-0.134	0.013	-0.019	-0.069
	Marginal Effects of The Liquor Legal Drinking Age					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	0.0	N/A	N/A	0.0	N/A	N/A
1-3 times a week	-0.005	0.0	-0.011	-0.004	-0.001	-0.014
Less than once a week	-0.013	0.001	-0.016	-0.011	-0.002	-0.028
Never	0.018	-0.001	0.027	0.015	0.003	0.042
	Elasticities of The Real Liquor Price					
	Religion Variables Excluded			Religion Variables Included		
	White	Black	Hispanic	White	Black	Hispanic
More than 3 times a week	-0.356	N/A	N/A	-0.218	N/A	N/A
1-3 times a week	-0.339	1.157	3.518	-0.207	0.620	2.295
Less than once a week	-0.259	1.261	3.059	-0.155	0.559	2.067
Never	0.081	-0.139	-0.458	0.052	-0.061	-0.228

4.4. Results of Cross Price Effects

Past economic studies have yielded mixed and inconclusive results for cross price effects of beverage specific alcohol prices on beverage-specific alcohol consumption. By using the same NHANES II data to analyze alcohol use among youths aged from sixteen to twenty-one, Coate and Grossman (1988) included the real liquor price in the demand functions for beer in multinomial logit equations. No evidence of substitution between beer and liquor was revealed by those equations. They found, in most cases, the cross price effect is negative (suggesting complementarity) but not significant.

Equations with the real liquor price in beer demand functions and the real beer price in liquor demand functions are produced for the full samples in Appendix D. The results show differences among various ethnic/race populations. When the real price of liquor is included in the demand functions for beer, statistically negative effects are in the consumption equations for black non-Hispanics, with and without religion variables. For white non-Hispanic and Hispanics, the positive effects of the real liquor price on beer consumption without religion variables become negative when religion variables are included, although all of them are non-significant. On the contrary, the liquor consumption equations including the real beer price have almost opposite results to the above: negative cross price effects for both white non-Hispanics and Hispanics, and positive, statistically non-significant effects for black non-Hispanics. All of the other independent variables in each equation do not change much from a full sample analysis when both alcohol prices are included.

No firm conclusions can be drawn from these results. On the one hand, the significant cross price coefficients are negative, suggesting complementarity. On the other hand, I never find two negative and significant cross price coefficients for persons of a given race and ethnicity. For example, the liquor price coefficient in the black beer demand function is negative and significant, but the beer price coefficient in the black liquor demand function is positive and not significant.

5. DISCUSSION

With the large sample size and fully specified analytic model, this study provides the best available approximation of drinking within the sample studied. To summarize, the results of this study suggest that the drinking measure over age cohorts rises rapidly in youth and falls gradually with advancing age. Men drink more than women. The frequency of the consumption of beer, the most popular alcoholic beverage, is inversely related to the real price of beer for both white non-Hispanics and Hispanics. The negative effect of real liquor price exists in the black non-Hispanic population. The study also largely confirms the past belief that youths' beer consumption decreases as the real beer price rises regardless of their racial and ethnic backgrounds.

The major goal of this study is to explore whether various racial/ethnic populations differ significantly in the relationship between gender and age and alcohol drinking patterns. Although the past economic literature suggests that increasing the price of alcoholic beverages decreases alcohol consumption, the estimates presented here clearly indicate that the alcohol-demand responsiveness to real alcohol price is different among non-Hispanic whites, non-Hispanic blacks, and Hispanics. Besides, the age and/or gender specific subgroups of racial/ethnic populations also show diverse results in real alcohol price sensitivity and other policy variables. Thus, the policymakers can use excise taxes as a way of diminishing the amount of drinking but cannot ignore the differences of effects of excise taxes on various racial/ethnic, age, and gender segments of the whole population.

In addition, the estimates indicate that negative price effects generally have more impacts on heavy (frequent) drinkers due to their higher elasticities of real alcohol price than infrequent and fairly frequent drinkers'. This finding is important because heavy or frequent drinkers are likely to be responsible for a large percentage of alcohol-related problems. Nevertheless, the price elasticities obtained from logit models have a different meaning than those obtained from other models, such as OLS regressions. Consider the ordered logit model for the drinking occasions in

this study, which is divided into four categories. A rise in the real price of beer will change the probability of each outcome category, but it does not tell how the number of drinking occasions will change. The price elasticity here measures the percentage change in probability, not the percentage change in quantity and drinking occasions, resulting from one percentage change in real alcohol price. Accordingly, the estimates of price elasticities here cannot be compared directly with others in the literature.

On a modeling front, the OLS estimates are not appropriate given the categorical nature of the sample used. A two-stage regression process to separate drinkers from non-drinkers has also been ruled out because of the assumption that the determinants of drinking participation are the same as those of drinking frequencies. The ordered logit model is used in order to capture the intensity of feeling of drinking as the ordinal nature of the dependent variable.

The non-negative price effects suggest that future research should explore additional factors influencing gender and racial differences in drinking and alcohol-related problems. These include cultural or racial differences in gender-related roles such as childrearing and occupation, and more refined analyses of socioeconomic factors that could impact people of various races differently. Using individual-level measures of socioeconomic status may help researchers to explain the non-negative and statistically significant price effects.

APPENDIX TABLES

Table A

Definitions, Means, and Standard Deviations of Variables

Variable name	Definition	Mean	Std. dev.
Beer consumption	The number of beer drinking occasion per week in the past three months	0.768	1.034
Liquor consumption	The number of liquor drinking occasion per week in the past three months	0.593	0.883
Real beer price (1967 dollars)	Price of a package of six 12-ounce cans of a leading brand of beer divided by CPI	1.026	0.112
Real liquor price (1967 dollars)	Price of Seagram's 7-Crown, 80 proof (40% alcohol), 5th size bottle, divided by CPI	2.952	0.305
Real household income (per thousand 1967 dollars)	Nominal family income divided by one thousand and CPI	7.329	4.511
Age	Respondent's age in years	41.727	19.882
Female	Indicator equals 1 if a respondent is female	0.519	0.500
Some or full high school education	Indicator equals 1 if a respondent is an adult and has some or full high school but no college education	0.512	0.500
Some college education or above	Indicator equals 1 if a respondent is an adult and has some college education or above	0.260	0.439
Head household/Some or full high school	Indicator equals 1 if a respondent is a youth and the head of the household has some or full high school but no college education	0.471	0.499
Head household/Some college or above	Indicator equals 1 if a respondent is a youth and the head of the household has some college education or above	0.302	0.459
Beer legal drinking age (years)	Minimum legal age for youths to purchase or consume beer	19.050	1.336
Liquor legal drinking age (years)	Minimum legal age for youths to purchase or consume liquor	19.538	1.469
Border age	Indicator equals 1 if youth lives within 20 miles of a state with a lower legal drink age	0.186	0.389
Southern Baptist	Percentage of population who are Southern Baptists in the sample's primary sample unit	8.672	13.608
Mormon	Percentage of populations who are Mormons in the sample's primary sample unit	1.501	7.975
Catholic	Percentage of population who are Catholics in the sample's primary sample unit	18,787	15.656
Protestant	Percentage of population who are Protestants in the sample's primary sample unit, excluding Southern Baptists and Mormons	20.186	8.482

Note: The means and standard deviations of the variables are based on the full sample size 13273, except for those of both legal drinking ages and border age which are only relevant to youth samples with sample size 2959.

Table B-1

Beer Consumption of Full Samples
Without Religion Variables

	White	Black	Hispanic
Real beer price	-0.562 (-3.266)	0.327 (0.621)	-2.648 (-2.764)
Real Household income	0.002 (0.431)	0.013 (0.863)	-0.023 (-1.033)
Age	-0.025 (-17.461)	-0.035 (-8.238)	-0.023 (-3.699)
Female	-1.357 (-33.632)	-1.253 (-11.755)	-1.657 (-10.087)
Some or full high school education	0.526 (7.709)	0.114 (0.732)	-0.272 (-1.301)
Some college education or above	0.638 (8.488)	-0.271 (-1.299)	-0.575 (-1.960)
Head household/Some or full high school	0.650 (4.423)	0.021 (0.086)	-0.941 (-1.314)
Head household/Some college or above	1.203 (7.979)	0.615 (1.896)	0.928 (2.277)
Beer legal drinking age	-0.061 (-7.165)	-0.105 (-6.528)	-0.092 (-5.293)
Border age	0.095 (0.889)	0.651 (1.836)	-0.091 (-0.128)

- Sample sizes of the white, black, and Hispanic group are, respectively, 10981, 1588 and 704.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.

Table B-2

Beer Consumption of Full Samples
With Religion Variables

	White	Black	Hispanic
Real beer price	-0.274 (-1.409)	0.456 (0.809)	-0.599 (-0.468)
Real household income	-0.011 (-2.419)	0.009 (0.635)	-0.025 (-1.105)
Age	-0.026 (-17.977)	-0.037 (-8.498)	-0.023 (-3.746)
Female	-1.406 (-34.307)	-1.251 (-11.707)	-1.681 (-10.142)
Some or full high school education	0.395 (5.692)	0.058 (0.362)	-0.276 (-1.316)
Some college education or above	0.474 (6.194)	-0.334 (-1.579)	-0.694 (-2.338)
Head household/Some or full high school	0.483 (3.255)	-0.032 (-0.130)	-0.566 (-1.496)
Head Household/Some college or above	1.006 (6.606)	0.550 (1.681)	0.810 (1.977)
Beer legal drinking age	-0.061 (-7.075)	-0.106 (-6.592)	-0.089 (-5.104)
Border age	0.021 (0.193)	0.564 (1.570)	-0.288 (-0.396)
Southern Baptist	-0.020 (-9.517)	-0.005 (-0.817)	-0.026 (-2.958)
Mormon	-0.008 (-3.006)	0.016 (0.123)	0.017 (1.272)
Protestant	0.012 (4.039)	0.022 (2.504)	0.020 (1.397)
Catholic	0.015 (8.489)	0.007 (1.131)	+ (0.036)

- Sample sizes of the white, black, and Hispanic group are, respectively, 10981, 1588 and 704.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.
- "+" indicates a positive but not significant effect (less than 0.001).

Table B-3

Beer Consumption of Adults
Without Religion Variables

	White	Black	Hispanic
Real beer price	-0.517 (-2.662)	0.550 (0.870)	-2.520 (-2.271)
Real household income	0.017 (3.214)	0.018 (1.095)	- 0.0
Age	-0.029 (-19.587)	-0.042 (-9.373)	-0.027 (-4.259)
Female	-1.490 (-32.311)	-1.352 (-10.912)	-1.999 (-10.294)
Some or full high school education	0.471 (6.761)	0.001 (0.010)	-0.347 (-1.618)
Some college education or above	0.526 (6.807)	-0.437 (-2.043)	-0.722 (-2.380)

Table B-4

Beer Consumption of Adults
With Religion Variables

	White	Black	Hispanic
Real beer price	-0.186 (-0.840)	0.562 (0.824)	-0.068 (-0.047)
Real household income	0.003 (0.575)	0.015 (0.910)	0.001 (0.024)
Age	-0.030 (-20.263)	-0.043 (-9.603)	-0.028 (-4.392)
Female	-1.543 (-32.910)	-1.349 (-10.851)	-2.036 (-10.344)
Some or full high school education	0.321 (4.534)	-0.062 (-0.379)	-0.354 (-1.647)
Some college education or above	0.341 (4.330)	-0.502 (-2.313)	-0.853 (-2.760)
Southern Baptist	-0.021 (-8.954)	-0.003 (-0.325)	-0.029 (-2.737)
Protestant	0.011 (3.282)	0.020 (1.896)	0.008 (0.485)
Mormon	-0.005 (-1.719)	-0.079 (-0.515)	0.009 (0.571)
Catholic	0.015 (7.672)	0.010 (1.379)	+ (0.0)

- For both table 2-3 and 2-4, sample sizes of the white, black and Hispanic group are, respectively, 8678, 1141 and 495.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.
- "+ (-)" indicates a positive (negative) but not significant effect (absolute value less than 0.001).

Table B-5

Beer Consumption of Youths
Without Religion Variables

	White	Black	Hispanic
Real beer price	-0.845 (-2.091)	-0.557 (-0.515)	-4.916 (-2.015)
Real household income	0.017 (1.770)	0.019 (0.585)	-0.057 (-1.215)
Age	0.457 (23.505)	0.406 (8.930)	0.341 (5.356)
Female	-1.274 (-13.407)	-1.345 (-5.741)	-1.084 (-3.153)
Head household/Some or full high school	0.348 (2.169)	0.211 (0.806)	-0.341 (-0.895)
Head household/Some college or above	0.681 (4.110)	0.088 (0.247)	0.487 (1.082)
Beer legal drinking age	-0.136 (-3.602)	0.037 (0.288)	-0.264 (-1.780)
Border age	0.064 (0.513)	0.246 (0.500)	0.439 (0.603)

- Sample sizes of the white, black, and Hispanic group are, respectively, 2303, 447 and 209.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.

Table B-6

Beer Consumption of Youths
With Religion Variables

	White	Black	Hispanic
Real beer price	-0.813 (-1.759)	-0.246 (-0.218)	-0.935 (-0.271)
Real household income	0.009 (0.890)	0.007 (0.205)	-0.056 (-1.198)
Age	0.456 (23.340)	0.404 (8.783)	0.378 (5.571)
Female	-1.305 (-13.587)	-1.400 (-5.891)	-1.206 (-3.414)
Head household/Some or full high school	0.298 (1.824)	0.177 (0.653)	-0.445 (-1.131)
Head household/Some college or above	0.598 (3.538)	0.050 (0.136)	0.308 (0.671)
Southern Baptist	-0.013 (-2.573)	-0.011 (-0.798)	-0.039 (-2.124)
Protestant	0.016 (2.154)	0.037 (1.897)	0.040 (1.225)
Mormon	-0.016 (-2.472)	-0.157 (-0.519)	0.036 (1.552)
Catholic	0.015 (3.386)	+ (0.039)	-0.008 (-0.412)
Beer legal drinking age	-0.068 (-1.632)	0.124 (0.886)	-0.255 (-1.392)
Border age	-0.094 (-0.720)	-0.105 (-0.194)	0.005 (0.0)

- Sample sizes of the white, black, and Hispanic group are, respectively, 2303, 447 and 209.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.
- "+" indicates a positive but not significant effect (less than 0.001).

Table B-7

Beer Consumption of Female Adults
Without Religion Variables

	White	Black	Hispanic
Real beer price	-0.782 (-2.523)	-0.081 (-0.087)	-0.513 (-0.273)
Real household income	0.004 (0.536)	-0.009 (-0.355)	-0.032 (-0.813)
Age	-0.030 (-13.329)	-0.039 (-6.125)	-0.015 (-1.569)
Some or full high school education	0.546 (4.467)	0.034 (0.147)	0.125 (0.389)
Some college education or above	0.746 (5.618)	-0.209 (-0.657)	-0.149 (-0.316)

Table B-8

Beer Consumption of Female Adults
With Religion Variables

	White	Black	Hispanic
Real beer price	-0.319 (-0.922)	-0.075 (-0.075)	2.325 (0.924)
Real household income	-0.009 (-1.145)	-0.012 (-0.486)	-0.016 (-0.390)
Age	-0.031 (-13.698)	-0.040 (-6.204)	-0.020 (-1.967)
Some or full high school education	0.384 (3.080)	-0.044 (-0.184)	-0.018 (-0.053)
Some college education or above	0.543 (4.006)	-0.284 (-0.878)	-0.411 (-0.836)
Southern Baptist	-0.029 (-6.956)	0.001 (0.061)	-0.047 (-2.221)
Protestant	0.013 (2.570)	0.021 (1.342)	0.024 (0.879)
Mormon	-0.003 (-0.510)	-0.033 (-0.133)	0.035 (0.164)
Catholic	0.014 (4.582)	0.014 (1.409)	0.012 (0.726)

- For both table 2-7 and 2-8, sample sizes of the white, black, and Hispanic group are, respectively, 4532, 628 and 256.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.

Table B-9

Beer Consumption of Male Adults
Without Religion Variables

	White	Black	Hispanic
Real beer price	-0.333 (-1.328)	0.978 (1.124)	-3.470 (-2.496)
Real household income	0.025 (3.674)	0.040 (1.725)	0.029 (0.846)
Age	-0.028 (-14.347)	-0.042 (-6.914)	-0.035 (-4.152)
Some or full high school education	0.428 (4.976)	-0.013 (-0.061)	-0.689 (-2.383)
Some college education or above	0.377 (3.900)	-0.591 (-2.060)	-1.131 (-2.850)

Table B-10

Beer Consumption of Male Adults
With Religion Variables

	White	Black	Hispanic
Real beer price	-0.079 (-0.273)	1.040 (1.099)	-1.682 (-0.930)
Real household income	0.012 (1.664)	0.037 (1.563)	0.029 (0.831)
Age	-0.029 (-14.949)	-0.044 (-7.143)	-0.035 (-4.163)
Some or full high school education	0.289 (3.304)	-0.072 (-0.318)	-0.687 (-2.365)
Some college education or above	0.204 (2.076)	-0.660 (-2.259)	-1.201 (-2.997)
Southern Baptist	-0.017 (-5.835)	-0.005 (-0.471)	-0.015 (-1.158)
Protestant	0.008 (1.980)	0.020 (1.401)	-0.012 (-0.528)
Mormon	-0.007 (-1.748)	-0.095 (-0.489)	0.004 (0.236)
Catholic	0.016 (5.996)	0.006 (0.669)	-0.009 (-0.721)

- For both table 2-9 and 2-10, sample sizes of the white, black, and Hispanic group are, respectively, 4146, 513 and 239.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.

Table B-11

Beer Consumption of Female Youths
Without Religion Variables

	White	Black	Hispanic
Real beer price	-1.509 (-2.468)	0.015 (0.010)	-7.088 (-1.897)
Real household income	0.007 (0.516)	-0.092 (-1.577)	0.015 (0.215)
Age	0.336 (12.375)	0.267 (4.170)	0.208 (2.408)
Head household/Some or full high school	0.345 (1.360)	0.647 (1.479)	-0.556 (-0.978)
Head household/Some college or above	0.525 (2.029)	-0.043 (-0.069)	0.214 (0.331)
Beer legal drinking age	-0.104 (-1.867)	0.149 (0.848)	-0.534 (-2.272)
Border age	0.008 (0.045)	0.187 (0.290)	2.349 (2.477)

- Sample sizes of the white, black, and Hispanic group are, respectively, 1135, 233 and 106.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.

Table B-12

Beer Consumption of Female Youths
With Religion Variables

	White	Black	Hispanic
Real beer price	-1.560 (-2.192)	0.440 (0.253)	-0.890 (-0.199)
Real household income	-0.004 (-0.251)	-0.116 (-1.857)	- (0.0)
Age	0.339 (12.295)	0.260 (3.994)	0.294 (2.962)
Head household/Some or full high school	0.225 (0.857)	0.531 (1.160)	-0.646 (-1.034)
Head household/Some college or above	0.325 (1.209)	-0.148 (-0.233)	0.020 (0.030)
Southern Baptist	-0.026 (-2.954)	-0.013 (-0.601)	-0.081 (-2.442)
Protestant	0.029 (2.734)	0.050 (1.655)	0.019 (0.357)
Mormon	-0.012 (-1.300)	-0.215 (-0.474)	0.068 (1.795)
Catholic	0.018 (2.605)	0.007 (0.357)	-0.029 (-1.005)
Beer legal drinking age	-0.016 (-0.253)	0.244 (1.298)	-0.657 (-2.456)
Border age	-0.206 (-1.062)	-0.291 (-0.418)	2.204 (1.835)

- Sample sizes of the white, black, and Hispanic group are, respectively, 1135, 233 and 106.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.
- "-" indicates a negative but not significant effect (absolute value less than 0.001).

Table B-13

Beer Consumption of Male Youths
Without Religion Variables

	White	Black	Hispanic
Real beer price	-0.313 (-0.576)	-0.226 (-0.150)	
Real household income	0.016 (1.224)	0.078 (1.764)	
Age	0.550 (19.966)	0.520 (7.923)	
Head household/Some or full high school	0.388 (1.867)	-0.090 (-0.259)	
Head household/Some college or above	0.853 (3.945)	0.075 (0.159)	
Beer legal drinking age	-0.158 (-3.076)	0.019 (0.106)	
Border age	0.046 (0.275)	0.126 (0.173)	

- Sample sizes of the white and black group are, respectively, 1168 and 214; the Hispanic group is not considered due to insufficient observations.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.

Table B-14

Beer Consumption of Male Youths
With Religion Variables

	White	Black	Hispanic
Real beer price	-0.286 (-0.463)	-0.092 (-0.060)	
Real household income	0.009 (0.709)	0.063 (1.398)	
Age	0.548 (19.837)	0.523 (7.883)	
Head household/Some or full high school	0.367 (1.753)	-0.105 (-0.288)	
Head household/Some college or above	0.820 (3.749)	0.143 (0.294)	
Southern Baptist	-0.007 (-1.089)	-0.009 (-0.475)	
Protestant	0.004 (0.389)	0.029 (1.072)	
Mormon	-0.020 (-2.176)	-0.291 (-0.697)	
Catholic	0.012 (1.970)	-0.007 (-0.406)	
Beer legal drinking age	-0.113 (-1.979)	0.125 (0.606)	
Border age	-0.042 (-0.235)	-0.241 (-0.286)	

- Sample sizes of the white and black group are, respectively, 1168 and 214; the Hispanic group is not considered due to insufficient observations.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.

Table C-1

Liquor Consumption of Full Samples
Without Religion Variables

	White	Black	Hispanic
Real liquor price	0.222 (3.575)	-0.574 (-2.428)	0.093 (0.252)
Real household income	0.057 (12.459)	0.052 (3.422)	0.029 (1.298)
Age	-0.001 (-0.668)	-0.012 (-2.823)	-0.006 (-0.959)
Female	-0.449 (-11.291)	-0.934 (-8.254)	-0.737 (-4.360)
Some or full high school education	1.020 (13.726)	0.270 (1.691)	0.415 (1.884)
Some college education or above	1.517 (18.968)	0.171 (0.810)	0.560 (1.940)
Head household/Some or full high school	0.180 (1.072)	-0.221 (-0.672)	-0.676 (-1.465)
Head household/Some college or above	0.846 (4.969)	0.712 (1.831)	0.961 (2.191)
Liquor legal drinking age	-0.009 (-0.925)	-0.089 (-5.012)	-0.048 (-2.506)
Border age	-0.015 (-0.123)	0.865 (2.050)	1.102 (1.665)

- Sample sizes of the white, black, and Hispanic group are, respectively, 10981, 1588 and 704.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.

Table C-2

Liquor Consumption of Full Samples
With religion Variables

	White	Black	Hispanic
Real liquor price	0.161 (2.335)	-0.851 (-2.898)	0.125 (0.329)
Real household income	0.045 (9.607)	0.047 (3.029)	0.031 (1.348)
Age	-0.001 (-0.984)	-0.014 (-3.168)	-0.008 (-1.286)
Female	-0.470 (-11.657)	-0.941 (-8.257)	-0.785 (-4.581)
Some or full high school education	0.919 (12.097)	0.130 (0.798)	0.391 (1.760)
Some college education or above	1.387 (16.959)	0.025 (0.116)	0.433 (1.475)
Head household/Some or full high school	-0.018 (-0.108)	-0.375 (-1.127)	-0.703 (-1.517)
Head household/Some college or above	0.618 (3.623)	0.513 (1.299)	0.768 (1.736)
Liquor legal drinking age	-0.006 (-0.632)	-0.091 (-5.084)	-0.046 (-2.385)
Border age	-0.054 (-0.446)	0.913 (2.091)	0.865 (1.274)
Southern Baptist	-0.025 (-11.809)	-0.012 (-1.565)	-0.032 (-3.683)
Mormon	-0.014 (-4.878)	0.207 (1.382)	-0.008 (-0.503)
Protestant	- (-0.078)	0.005 (0.503)	0.022 (1.530)
Catholic	0.014 (8.137)	0.018 (2.787)	0.001 (0.139)

- Samples sizes of the white, black and Hispanic group are, respectively, 10981, 1588 and 704.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.
- "-" indicates a negative but not significant effect (absolute value less than 0.001).

Table C-3

Liquor Consumption of Adults
Without Religion Variables

	White	Black	Hispanic
Real liquor price	0.331 (4.802)	-0.625 (-2.456)	0.210 (0.497)
Real household income	0.087 (16.992)	0.066 (3.952)	0.046 (1.778)
Age	-0.003 (-2.217)	-0.016 (-3.587)	-0.011 (-1.614)
Female	-0.472 (-10.757)	-1.039 (-8.385)	-0.984 (-5.110)
Some or full high school education	0.913 (12.116)	0.184 (1.139)	0.350 (1.565)
Some college education or above	1.340 (16.479)	0.029 (0.136)	0.465 (1.579)

Table C-4

Liquor Consumption of Adults
With Religion Variables

	White	Black	Hispanic
Real liquor price	0.249 (3.244)	-0.891 (-2.796)	0.229 (0.523)
Real household income	0.075 (14.337)	0.059 (3.511)	0.050 (1.919)
Age	-0.004 (-2.740)	-0.018 (-4.029)	-0.013 (-1.911)
Female	-0.496 (-11.113)	-1.063 (-8.493)	-1.041 (-5.312)
Some or full high school education	0.794 (10.309)	0.023 (0.139)	0.333 (1.478)
Some college education or above	1.190 (14.318)	-0.134 (-0.613)	0.336 (1.119)
Southern Baptist	-0.026 (-11.436)	-0.013 (-1.643)	-0.033 (-3.248)
Protestant	-0.001 (-0.443)	0.004 (0.382)	0.019 (1.145)
Mormon	-0.014 (-4.171)	0.127 (0.756)	-0.010 (-0.578)
Catholic	0.014 (7.451)	0.020 (2.766)	+ 0.022

- For both table 3-3 and 3-4, sample sizes of the white, black, and Hispanic are, respectively, 8678, 1141 and 495.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.
- "+" indicates a positive but not significant effect (less than 0.001).

Table C-5

Liquor Consumption of Youths
Without Religion Variables

	White	Black	Hispanic
Real liquor price	-0.162 (-0.946)	0.801 (1.244)	-0.101 (-0.125)
Real household income	-0.004 (-0.349)	-0.004 (-0.101)	0.015 (0.297)
Age	0.474 (20.175)	0.492 (7.271)	0.420 (5.051)
Female	-0.446 (-4.227)	-0.569 (-1.865)	-0.096 (-0.241)
Head household/Some or full high school	0.001 (0.0)	0.028 (0.078)	-0.662 (-1.349)
Head household/Some college or above	0.547 (2.871)	0.614 (1.444)	0.512 (1.071)
Liquor legal drinking age	-0.104 (-2.658)	-0.008 (-0.071)	-0.054 (-0.380)
Border age	-0.144 (-1.064)	0.321 (0.663)	1.985 (2.621)

- Sample sizes of the white, black, and Hispanic group are, respectively, 2303, 447 and 209.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.

Table C-6

Liquor Consumption of Youths
With Religion Variables

	White	Black	Hispanic
Real liquor price	-0.142 (-0.753)	0.620 (0.736)	0.096 (0.114)
Real household income	-0.012 (-1.071)	-0.012 (-0.278)	0.014 (0.267)
Age	0.473 (19.990)	0.496 (7.239)	0.470 (5.391)
Female	-0.451 (-4.247)	-0.541 (-1.756)	-0.162 (-0.397)
Head household/Some or full high school	-0.063 (-0.331)	-0.054 (-0.146)	-0.707 (-1.422)
Head household/Some college or above	0.453 (2.334)	0.549 (1.229)	0.100 (0.200)
Southern Baptist	-0.010 (-1.710)	-0.001 (-0.075)	-0.061 (-2.886)
Protestant	0.007 (0.881)	0.015 (0.516)	0.033 (0.993)
Mormon	-0.015 (-1.780)	0.151 (0.332)	-0.023 (-0.291)
Catholic	0.017 (3.435)	0.018 (1.083)	-0.014 (-0.631)
Liquor legal drinking age	-0.038 (-0.899)	-0.025 (-0.183)	-0.319 (-1.731)
Border age	-0.224 (-1.611)	0.236 (0.437)	1.988 (2.398)

- Sample sizes of the white, black, and Hispanic group are, respectively, 2303, 447 and 209.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.

Table C-7

Liquor Consumption of Female Adults
Without Religion Variables

	White	Black	Hispanic
Real liquor price	0.353 (3.553)	-0.345 (-0.890)	1.744 (2.422)
Real household income	0.086 (11.681)	0.070 (2.915)	0.057 (1.499)
Age	-0.007 (-3.539)	-0.023 (-3.471)	-0.005 (-0.467)
Some or full high school education	1.093 (8.929)	0.164 (0.672)	0.742 (2.126)
Some college education or above	1.534 (11.777)	0.178 (0.550)	1.210 (2.758)

Table C-8

Liquor Consumption of Female Adults
With Religion Variables

	White	Black	Hispanic
Real liquor price	0.247 (2.208)	-0.674 (-1.412)	1.503 (1.735)
Real household income	0.072 (9.567)	0.060 (2.493)	0.078 (1.908)
Age	-0.008 (-3.953)	-0.024 (-3.679)	-0.010 (-0.881)
Some or full high school Education	0.978 (7.750)	-0.049 (-0.194)	0.583 (1.610)
Some college education or above	1.392 (10.359)	-0.031 (-0.094)	0.878 (1.902)
Southern Baptist	-0.034 (-9.312)	-0.028 (-2.135)	-0.071 (-2.531)
Protestant	- (-0.066)	+ (0.0)	0.078 (2.999)
Mormon	-0.015 (-2.951)	0.051 (0.187)	0.047 (0.175)
Catholic	0.018 (6.382)	0.019 (1.767)	0.017 (0.836)

- For both table 3-7 and 3-8, sample sizes of the white, black, and Hispanic group are, respectively, 4532, 628 and 256.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.
- "+ (-)" indicates a positive (negative) but not significant effect (absolute value less than 0.001).

Table C-9

Liquor Consumption of Male Adults
Without Religion Variables

	White	Black	Hispanic
Real liquor price	0.310 (3.220)	-0.846 (-2.481)	-0.680 (-1.239)
Real household income	0.086 (11.881)	0.062 (2.636)	0.037 (1.032)
Age	0.001 (0.313)	-0.010 (-1.662)	-0.014 (-1.568)
Some or full high school education	0.808 (8.284)	0.230 (1.049)	0.185 (0.618)
Some college education or above	1.238 (11.584)	-0.067 (-0.236)	-0.029 (-0.073)

Table C-10

Liquor Consumption of Male Adults
With Religion Variables

	White	Black	Hispanic
Real liquor price	0.246 (2.322)	-1.116 (-2.571)	-0.753 (-1.289)
Real household income	0.076 (10.282)	0.057 (2.438)	0.045 (1.238)
Age	- (0.0)	-0.012 (-1.921)	-0.015 (-1.739)
Some or full high school education	0.699 (7.054)	0.125 (0.554)	0.195 (0.649)
Some college education or above	1.096 (10.104)	-0.181 (-0.620)	-0.095 (-0.233)
Southern Baptist	-0.021 (-6.874)	-0.004 (-0.348)	-0.016 (-1.319)
Protestant	-0.003 (-0.616)	0.006 (0.401)	-0.023 (-0.995)
Mormon	-0.013 (-2.961)	0.220 (1.015)	-0.007 (-0.416)
Catholic	0.011 (4.204)	0.018 (1.889)	-0.007 (-0.510)

- For both table 3-9 and 3-10, sample sizes of the white, black, and Hispanic group are, respectively, 4146, 513 and 239.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.
- "-" indicates a negative but not significant effect (absolute value less than 0.001).

Table C-11

Liquor Consumption of Female youths
Without Religion Variables

	White	Black	Hispanic
Real liquor price	-0.242 (-0.900)	1.069 (1.338)	-1.389 (-1.156)
Real household income	0.010 (0.636)	-0.055 (-0.837)	0.020 (0.277)
Age	0.462 (13.053)	0.535 (4.767)	0.538 (3.936)
Head household/Some or full high school	0.051 (0.167)	-0.741 (-1.385)	-1.125 (-1.566)
Head household/Some college or above	0.614 (2.026)	0.320 (0.516)	0.083 (0.112)
Liquor legal drinking age	-0.108 (-1.819)	-0.057 (-0.347)	0.045 (0.219)
Border age	-0.196 (-0.958)	0.153 (0.211)	3.605 (3.126)

- Sample sizes of the white, black, and Hispanic group are, respectively, 1135, 233 and 106.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.

Table C-12

Liquor Consumption of Female Youths
With Religion Variables

	White	Black	Hispanic
Real liquor price	-0.266 (-0.859)	1.165 (0.895)	-1.517 (-1.135)
Real household income	-0.006 (-0.364)	-0.073 (-0.998)	0.048 (0.544)
Age	0.478 (13.014)	0.548 (4.766)	0.688 (4.200)
Head household/Some or full high school	-0.047 (-0.148)	-1.146 (-2.009)	-1.271 (-1.637)
Head household/Some college or above	0.412 (1.285)	0.086 (0.128)	-0.502 (-0.625)
Southern Baptist	-0.033 (-3.140)	-0.060 (-1.673)	-0.099 (-2.751)
Protestant	0.008 (0.725)	0.011 (0.210)	0.118 (1.798)
Mormon	-0.019 (-1.478)	-0.120 (-0.136)	-0.036 (-0.169)
Catholic	0.029 (3.896)	0.008 (0.256)	-0.063 (-1.555)
Liquor legal drinking age	0.023 (0.348)	-0.052 (-0.234)	-0.332 (-1.190)
Border age	-0.320 (-1.514)	-0.085 (-0.110)	3.189 (2.125)

- Sample sizes of the white, black, and Hispanic group are, respectively, 1135, 233 and 106.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.

Table C-13

Liquor Consumption of Male Youths
Without Religion Variables

	White	Black	Hispanic
Real liquor price	-0.121 (-0.537)	0.471 (0.415)	1.229 (0.902)
Real household income	-0.016 (-1.088)	0.035 (0.601)	0.034 (0.459)
Age	0.488 (15.377)	0.484 (5.429)	0.400 (3.368)
Head household/Some or full high school	-0.025 (-0.101)	0.600 (1.199)	-0.214 (-0.304)
Head household/Some college or above	0.506 (2.043)	0.722 (1.197)	0.762 (1.104)
Liquor legal drinking age	-0.105 (-2.006)	0.010 (0.065)	-0.244 (-1.112)
Border age	-0.102 (-0.560)	0.555 (0.796)	1.026 (0.752)

- Sample sizes of the white and black group are, respectively, 1168, 214, and 103.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.

Table C-14

Liquor Consumption of Male Youths
With Religion Variables

	White	Black	Hispanic
Real liquor price	-0.074 (-0.304)	0.222 (0.162)	0.789 (0.549)
Real household income	-0.018 (-1.208)	0.021 (0.350)	0.053 (0.654)
Age	0.486 (15.246)	0.496 (5.382)	0.478 (3.600)
Head household/Some or full high school	-0.034 (-0.141)	0.880 (1.645)	-0.618 (-0.836)
Head household/Some college or above	0.500 (1.996)	1.086 (1.650)	0.252 (0.321)
Southern Baptist	0.001 (0.177)	0.044 (1.807)	-0.045 (-1.310)
Protestant	0.005 (0.469)	0.049 (1.263)	-0.050 (-0.879)
Mormon	-0.011 (-0.973)	0.506 (0.914)	-0.020 (-0.184)
Catholic	0.006 (0.867)	0.041 (1.873)	0.013 (0.408)
Liquor legal drinking age	-0.083 (-1.459)	-0.033 (-0.177)	-0.480 (-1.560)
Border age	-0.150 (-0.796)	0.151 (0.178)	1.311 (0.920)

- Sample sizes of the white and black group are, respectively, 1168, 214, and 103.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.

Table D-1

Beer Consumption of Full Samples
Without Religion Variables
Cross Price Effect

	White	Black	Hispanic
Real beer price	-0.575 (-3.287)	0.446 (0.839)	-2.691 (-2.787)
Real household income	0.002 (0.387)	0.011 (0.748)	-0.023 (-1.044)
Age	-0.025 (-17.464)	-0.036 (-8.332)	-0.023 (-3.718)
Female	-1.357 (-33.633)	-1.259 (-11.792)	-1.659 (-10.094)
Some or full high school education	0.526 (7.709)	0.109 (0.699)	-0.272 (-1.300)
Some college education or above	0.638 (8.490)	-0.300 (-1.431)	-0.574 (-1.959)
Head household/Some or full high school	0.650 (4.420)	0.007 (0.028)	-0.495 (-1.324)
Head household/Some college or above	1.203 (7.981)	0.587 (1.811)	0.923 (2.264)
Beer legal drinking age	-0.061 (-7.169)	-0.105 (-6.528)	-0.092 (-5.297)
Border age	0.097 (0.907)	0.699 (1.967)	-0.057 (-0.080)
Real liquor price	0.025 (0.409)	-0.603 (-2.692)	0.133 (0.385)

- Sample sizes of the white, black, and Hispanic group are, respectively, 10981, 1588 and 704.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.

Table D-2

Beer Consumption of Full Samples
With Religion Variables
Cross Price Effect

	White	Black	Hispanic
Real beer price	-0.271 (-1.374)	0.637 (1.114)	-0.559 (-0.428)
Real household income	-0.011 (-2.407)	0.009 (0.600)	-0.025 (-1.100)
Age	-0.026 (-17.977)	-0.037 (-8.475)	-0.023 (-3.731)
Female	-1.406 (-34.307)	-1.254 (-11.728)	-1.680 (-10.134)
Some or full high school education	0.395 (5.692)	0.058 (0.361)	-0.276 (-1.316)
Some college education or above	0.474 (6.193)	-0.352 (-1.663)	-0.695 (-2.340)
Head household/Some or full high school	0.483 (3.256)	-0.030 (-0.120)	-0.566 (-1.495)
Head household/Some college or above	1.006 (6.606)	0.516 (1.576)	0.811 (1.980)
Beer legal drinking age	-0.061 (-7.075)	-0.106 (-6.593)	-0.089 (-5.098)
Border age	0.021 (0.193)	0.649 (1.789)	-0.299 (-0.410)
Southern Baptist	-0.020 (-9.467)	-0.004 (-0.598)	-0.026 (-2.962)
Mormon	-0.008 (-2.910)	0.134 (0.934)	0.017 (1.274)
Protestant	0.012 (3.978)	0.015 (1.545)	0.020 (1.372)
Catholic	0.015 (8.346)	0.008 (1.299)	+ (0.058)
Real liquor price	-0.006 (-0.093)	-0.544 (-1.949)	-0.058 (-0.158)

- Sample sizes of the white, black, and Hispanic group are, respectively, 10981, 1588, and 704.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.
- "+" indicates a positive but not significant effect (less than 0.001).

Table D-3

Liquor Consumption of Full Samples
Without Religion Variables
Cross Price Effect

	White	Black	Hispanic
Real liquor price	0.273 (4.358)	-0.575 (-2.424)	0.216 (0.590)
Real household income	0.057 (12.468)	0.052 (3.415)	0.029 (1.283)
Age	-0.001 (-0.805)	-0.012 (-2.823)	-0.007 (-1.147)
Female	-0.450 (-11.312)	-0.934 (-8.253)	-0.757 (-4.459)
Some or full high school education	1.007 (13.552)	0.270 (1.690)	0.387 (1.752)
Some college education or above	1.495 (18.666)	0.171 (0.810)	0.539 (1.851)
Head household/Some or full high school	0.177 (1.050)	-0.221 (-0.673)	-0.696 (-1.503)
Head household/Some college or above	0.833 (4.888)	0.713 (1.830)	0.873 (1.981)
Liquor legal drinking age	-0.010 (-1.081)	-0.089 (-5.012)	-0.047 (-2.468)
Border age	0.045 (0.377)	0.864 (2.035)	1.159 (1.747)
Real beer price	-0.912 (-5.094)	0.015 (0.024)	-3.125 (-2.870)

- Sample sizes of the white, black, and Hispanic group are, respectively, 10981, 1588, and 704.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.

Table D-4

Liquor Consumption of Full Samples
With Religion Variables
Cross Price Effect

	White	Black	Hispanic
Real Liquor price	0.183 (2.630)	-0.925 (-3.087)	0.210 (0.546)
Real household income	0.044 (9.587)	0.045 (2.914)	0.030 (1.311)
Age	-0.001 (-1.019)	-0.014 (-3.202)	-0.008 (-1.250)
Female	-0.470 (-11.658)	-0.937 (-8.219)	-0.785 (-4.580)
Some or full high school education	0.919 (12.095)	0.118 (0.720)	0.388 (1.746)
Some college education or above	1.385 (16.930)	0.024 (0.112)	0.451 (1.534)
Head household/Some or full high school	-0.021 (-0.127)	-0.394 (-1.182)	-0.706 (-1.522)
Head household/Some college or above	0.612 (3.594)	0.512 (1.297)	0.757 (1.710)
Liquor legal drinking age	-0.006 (-0.654)	-0.091 (-5.088)	-0.045 (-2.364)
Border age	-0.026 (-0.209)	0.841 (1.893)	0.911 (1.340)
Southern Baptist	-0.023 (-10.189)	-0.015 (-1.886)	-0.026 (-2.649)
Mormon	-0.014 (-4.731)	0.240 (1.580)	-0.008 (-0.485)
Protestant	0.002 (0.749)	0.002 (0.201)	0.027 (1.794)
Catholic	0.015 (8.388)	0.016 (2.561)	0.003 (0.366)
Real beer price	-0.427 (-2.117)	0.863 (1.371)	-1.556 (-1.118)

- Sample sizes of the white, black, and Hispanic group are, respectively, 10981, 1588, and 704.
- Asymptotic *t*-ratios are in parentheses. The critical values are 2.58 (2.33), 1.96 (1.64), and 1.64 (1.28) at the 1, 5, 10% significance levels, respectively, based on a two-tailed (one-tailed) test.

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IMAGE EVALUATION
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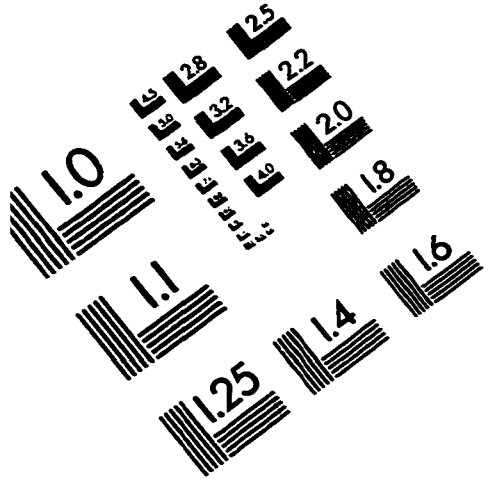

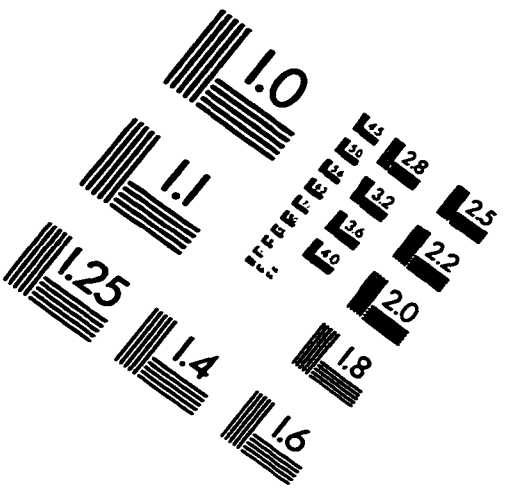

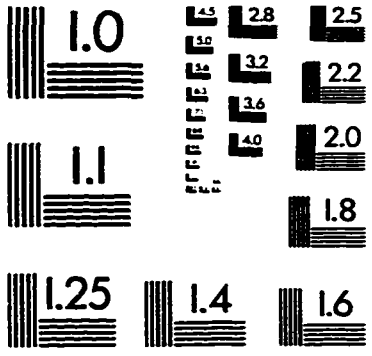

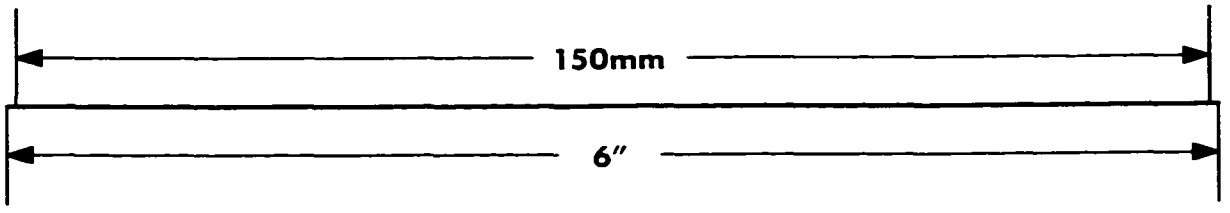

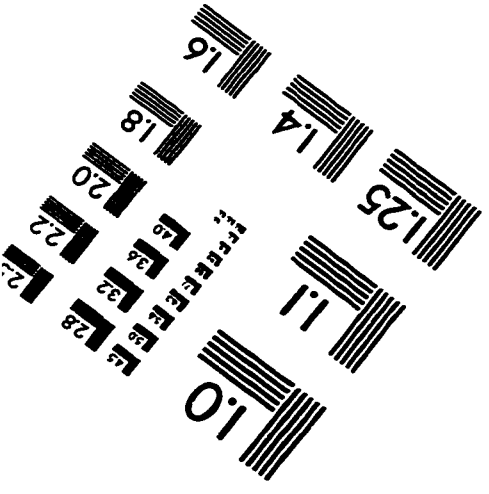

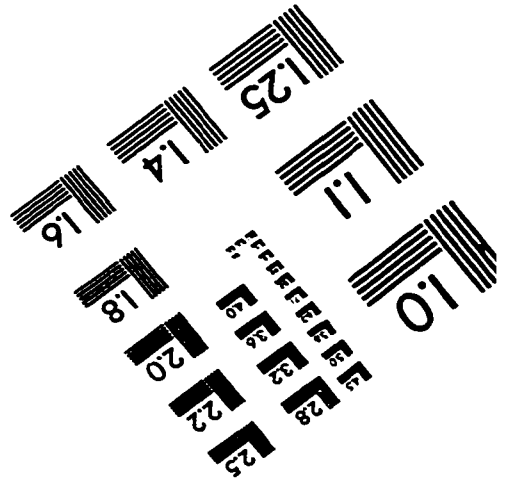

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