The Impact of Alcohol Beverage Price and Tax on Alcohol Consumption

by

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ABSTRACT

   Alcohol involvement in auto crashes, violence, homicide and its associated health
consequences is an important concern, and the price (tax) for alcohol may have a significant
impact on these behaviors. Although some studies have indicated that total alcohol consumption
is responsive to price, little work has focused on the effect of specifically, alcoholic beverage
price (tax), considering economic, demographic and regional differences and the time trend on
the demand for those beverages, while still accounting for substitution between different types of
alcoholic beverages. In this study, I examine the price and tax effect on the demand for alcoholic
beverages namely, beer, wine and spirits using a variant of an Almost Ideal Demand System
(Banks, Blundell and Lewel, 1997)

   The study used state level aggregate data on consumption of alcoholic beverages and price
from NIAAA and ACCRA respectively. The results indicate that taxes on alcoholic beverages
would reduce consumption of all the alcoholic beverages. However, the price elasticities vary
considerably between the different types of alcoholic beverages. In consequence, if the aim of a
tax is to reduce alcohol consumption and its associated effects, then policy makers should target
spirits. On the other hand, if the aim is to raise revenue, then policy makers should target beer
and wine. The study used publically available state level aggregate data.

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INTRODUCTION

Alcohol research is dynamic. It is carried out in various fields and disciplines such as health, biological science and the social sciences especially in Economics. This is due to the fact that alcohol has health and economic consequences, safety issues associated with its consumption, and revenue and tax implications for governments. Some of the adverse health consequences of alcohol consumption include alcohol abuse, drunk driving, alcohol-involved crimes, liver cirrhosis, alcohol-related mortality, risky sexual behavior and others.

In view of these consequences, policy makers have tried to use certain policies to curb alcohol consumption. These policies include, but are not limited to minimum legal drinking age (MLDA), blood alcohol concentration (BAC), and imposing fines on those possessing alcohol while driving, controlling the sale of alcohol, taxes and others. Specifically, among these policies, taxes are the only one that affects demand for the alcoholic beverages directly. In this regard the paper will emphasize the impact of these taxes on the consumption of alcoholic beverages.

This paper will investigate the effect of alcohol price and tax on alcohol consumption. The paper will further explore which of the alcoholic beverages should be targeted for tax aimed at reducing the negative health effects of alcohol or for revenue purposes. Also how the reduction in alcohol consumption might affect alcohol related mortality. What is relevant in this analysis is the fact that it takes into consideration both the socio-demographic factors, time trend and combines these factors with a QUAIDS model. These elements are very important when estimating how consumers respond to changes in demand resulting from price, expenditure and income.

In this research, the demand analysis for the three types of alcoholic beverages will be carried out using the Quadratic Almost Ideal Demand System (QUAIDS). Budget shares, income, expenditure elasticities, compensated and uncompensated price elasticities will be computed for all the alcoholic beverages.

Ordinary Least Squares (OLS) and panel data may not be good enough for this analysis. This is because price taken as independent variable may be endogenous. Endogeneity would bias the coefficients and cause price elasticities of demand to be inefficient. This could be addressed by using a system approach which imposes restrictions on the model, coefficients and the parameters. A system approach like QUAIDS also allows for computation of cross-price elasticities. This is needed to determine the relation between goods. A complete demand model includes cross-price elasticity for the goods.

The Almost Ideal Demand System (AIDS) model of Deaton and Muellbauer (1980) allows for computation of cross-price elasticities of consumption goods (alcoholic beverages). It is able to capture the substitution effects of goods. The AIDS model assumes Engel Curves[1] are linear which could bias estimates if the assumption is violated. The slope of an Engel Curve also tells us whether or not the good is a normal good or inferior good. However, as income varies across individuals and income elasticities vary across goods, the income effect should be allowed to vary at different levels of income (Banks, Blundell, and Lewel 1997). Therefore, the model should ideally incorporate non-linear Engle Curves. With these and other properties such as aggregation, homogeneity, symmetry and substitution, make a Quadratic Almost Ideal Demand System (QUAIDS) model a good method for estimating demand system for this analysis.(Banks, Blundell, and Lewel1997).

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[1]The Engel Curve tracks the consumption of a good as an individual's income changes.

The QUAIDS approach has been used by a number of articles such as Jithitikuchai (2010) and Gil and Molina (2009.) In particular, Jithitikuchai (2010) used a QUAIDS approach to analyze the price responsiveness of demand for alcoholic beverages at different levels of consumption. Also, Gil and Molina (2009) used a QUAIDS approach to examine the demand for alcoholic beverages among young people in Spain.

The results from this study show an increase in the budget shares for spirit but a decrease in the budget share for beer and wine as expenditure on alcohol increases. It also came out that a percentage increase in the price for each alcoholic beverage results in an increasing budget shares. Expenditure on alcohol had a positive marginal effect on consumption for beer, and spirit but a negative marginal effect Aon wine. Beer and wine happened to be gross complements for each other, while wine and spirits are gross substitutes by uncompensated elasticity.

However, for compensated cross-price elasticities, wine and beer are net complements while wine and spirits are net substitutes. The relationship between beer and spirits is inconclusive in terms of net substitutes or net complements. The quantity demanded for beer and wine ended up being inelastic for uncompensated elasticities. When a tax increases the price of these alcoholic beverages, the percentage decrease in quantity demanded would be less than the percentage increase in the price, other things being equal. On the other hand, spirits showed up to be elastic. This indicates that price increase resulting from a tax will result in a greater percentage decrease in quantity demanded than the increase in price. For policy purposes, beer and wine should be targeted for tax purposes for revenue generation. If the aim of the tax is to reduce the alcohol consumption, then spirits would be good for such a policy.

The economic and demographic factors have very interesting outcomes. Per capita income affects the budget share of beer positively but it affects that of wine and spirits negatively. As the

male population increases, the budget share allocated to beer goes down but that of wine and spirits increases. The budget share allocated to beer and wine fall with an increase in unemployment but increases with spirits. For each additional year, the budget share allocated to beer decreases. In like manner, the budget shares allocated to wine and spirits increases for each additional year. Expenditure in the various regions, North East, Midwest, South and West) increases with the budget share on beer but decreases with the budget share on wine and spirit.

Specifically, the uncompensated price elasticities were -0.5 for beer, -0.9 for wine and -2.5 for spirits. In the same manner, the compensated price elasticities were -0.3,-1.0 and -1.6 for beer, wine and spirits respectively. For each additional year, the budget share on beer goes down by 0.006, but that of wine and spirits go up by0.02 and 0.05 respectively. The income elasticites were 0.12 for beer, -0.009 for wine and -0.0022 for spirits.

The remainder of the paper is organized as follows: the literature review describes other papers in the area of this research, section three describes the data employed, sources and how the data was prepared for the model, the theoretical background explains the model and how it works follows in section four, the results section shows the output by running the data through the model and its interpretation is in section five, and policy implications and conclusions are in sections six and seven respectively.

LITERATURE REVIEW

There have been several meta-analyses on alcohol consumption and prices, in particular, Wagenaar etal (2009), investigated the effects of beverage alcohol price and tax levels on drinking in a meta-analysis of 1003 estimates from 112 studies. The study came from a systematic review and meta-analysis, where evidence from an underlying relationship of theoretical and practical significance is gathered across studies based on the point estimates and estimated variances from individual studies using random- effect models.

The main aim of the research was to review the effectiveness of a policy for reducing drinking by imposing taxes on alcoholic beverages (beer, wine and liquor). They used quantitative estimates that indicate the magnitude and strength of those relationships and the variability of those estimates from the already completed studies. They argued that this method has an advantage of being conservative, producing a wider confidence bound in a meta-analysis.

They found the effect of alcohol price or tax on general alcohol consumption to be -0.51, and the specific mean price elasticity was found to be -0.46, for beer - 0.69 for wine and -0.80 for spirits. This means that on the average, a percentage increase in tax will result in a decrease in alcohol consumption by 0.46% for beer, 0.69% for wine and 0.80% for spirits. Wagenaar etal (2009) concluded that price affects drinking of all types of beverages inversely, and across the population of drinkers from light drinkers to heavy drinkers. They stated that price/tax affects heavy drinking significantly with a mean elasticity of -0.29.Cook and Moore (1993) summarized the economic literature on drinking and associated outcomes and concluded that the demand for alcohol is downward –sloping, indicating that taxes could be used as an effective alcohol control policy. Also, Chaloukpaetal (2002), reviewed studies that examine price effects on consumption

and alcohol-related outcomes for the youth and found out that the frequency of youth drinking and probability of heavy drinking can be decreased by an increase in beer excise taxes.

Apart from the meta-analysis, there are other individual papers in the area of alcohol consumption. Gil and Molina (2009) is one of such papers. Gil and Molina (2009) analyzed the demand for alcoholic beverages among young people in Spain. They considered alcoholic beverages as constituting addictive goods, which means the past consumption determines the present demand and this is common among young people. Also alcohol is a good subject to indirect taxes. The authors believed that the price paid by consumers of alcohol is lower than the marginal social cost of consumption. They argued that in order to perceive the real cost of consuming alcoholic beverages, taxes should be increased until that part of consumption derived from the excess of social cost over the individual's utility is eliminated.

Against this background, the paper analyzed the demand for alcoholic beverages among young people in a particular context that emerges from the addictive nature of alcohol, the special vulnerability of young people and indirect taxes. To this end, the paper characterized a theoretical framework in which elements from the Theory of Two-Stage Budgeting, which assumes that the consumer first divides total expenditure across different groups (first stage) and then divides the expenditure for any given group across different items in that group (second stage) and the Theory of Addiction, which assumes that the introduction of a substance into the body on a regular basis will inevitably lead to addiction were introduced. The model was empirically translated to a Quadratic Almost Ideal System (QUAIDS) in which the particular characteristics of young people were introduced by price scaling (PS) techniques. Price scaling is used on a chart that is plotted in such a way that two equivalent percent changes are represented by the same vertical distance on the scale, regardless of what the price of the good is when the

change occurs. The distance between the numbers on the scale decreases as the price of the underlying good increases. The specification is then estimated by using data drawn from the Spanish National Survey on Drug Use in the School Population (2000).

Gil and Molina (2009) observed that the longer the individual demands alcoholic beverages, the higher will be the expenditure share allocated to those products. The income elasticity reveals that the alcoholic beverages are necessities but they cautioned that since the value of elasticity is close to one, the alcoholic beverages could also behave as luxuries. They also found that the addiction stock is positively correlated to the budget share corresponding to spirits but negatively correlated to that corresponding to beer and wine.

The budget allocated to purchasing alcoholic drinks has a negative influence over the demand for wine and spirits, but positive over the demand for beer. In addition, they found that the longer the individual has been consuming alcoholic beverages, the higher will be the budget share allocated to liquor as compared to those allocated to wine and beer. Expenditure elasticities revealed that wine is anecessity, whereas beer and spirit are luxuries. These results appeared for both the elasticities with respect to the total expenditure and for specific elasticities with respect to expenditure on alcoholic beverages.

According to their established Mashallian demand, all the alcoholic beverages had normal demand whilst the Hicksian cross-price elasticities indicate that most of the alcoholic beverages are substitutes. The paper concluded that a higher price of alcoholic beverage had the effect of reducing demand. Therefore, a tax increase with the intention of reducing alcohol consumption would appear to be effective.

Theepakorn Jithitikulchai (2010) used data on alcohol consumption from 51 states in the period 1985 – 2002, to analyzed a Quadratic Almost Ideal Demand System (QUAIDS) compared

with linear regression models, Ordinary Least Squares (OLS), Two- stage Least Squares (2SLS), and panel data models. The data were from the American Chamber of Commerce Researchers Association, which is widely used. The study used beer, spirits and wine consumption with their respective prices and other economic characteristics but failed to consider demographic and geographical factors that may influence alcohol consumption.

In addition to a QUIADS approach, Jithitikuchai (2010) also used nonparametric regression to study the effects of expenditure and prices on nonlinear pattern of consumption. He found a more linear relationship between price and consumption and a non-linear relationship between expenditure and consumption. The paper also investigated the endogeneity and examined the price responsiveness of the demand to differential effect on light, moderate and heavy consumption and provided analysis of various elasticities.

The paper found the range of estimated income elasticities between the 0.702 and 1.484 only. The estimated income elasticities from pooled QUAIDS model were lower for beer and higher for spirits. Also, for the highest elasticities of clustered states data on each alcohol type, beer had the light-consumed states; spirits had the heavy-consumed states and wine had the moderate-consumed states. The clustered states were meant to capture state invariant characteristics. The uncompensated own-price elasticities had negative signs except that from panel models in case of wine. The differences in compensated own-price elasticities for spirits were higher and similar to uncompensated elasticities. Moreover, almost all compensated own-price elasticities were positive indicating that a higher price results in higher quantity demanded.

Molina and Wagenaar (2010) investigated the effects of alcohol taxes on alcohol related mortality. The paper discussed the contribution of alcohol towards mortality rates in Florida. The main objective was to identify the effects of alcohol taxation on alcohol-related mortality. This

study used a time-series data, and includes 102 monthly observations before the first tax increase in 1977 on beer, wine and spirits; 74 monthly observations after the first but before the second tax increase in 1983 on beer, wine and spirits; with 256 follow up monthly observations after the 1983 tax increase, adding up to a total of 432 repeated time-series observations from 1969 to 2004. Molina and Wagenaar (2010) used a Box-Jenkins method to fit autoregressive moving average (ARIMA) models. In addition, they used a generalized linear mixed model to examine the effects of each separate alcohol tax change on alcohol related- mortality outcomes.

Molina and Wagenaar (2010) found a reduction in mortality related to alcohol consumption resulting from the tax on alcohol in Florida. The results indicate a 23% decline in alcohol related mortality within the period under study. Also, from the elasticity effect, a 10% increase in tax was associated with a 22% decline in alcohol related mortality over the period 1969 to 2003. The paper concluded that there is a negative relationship between a tax on alcohol and its associated mortality.

 In the same vein, Christopher and Dobkin (2009) investigated the effects of alcohol consumption on mortality. They used regression discontinuity design in their analysis. They found large increases in drinking at 21. In addition, there was 9% increase in mortality rate as a result of motor vehicle accident, alcohol related deaths and suicides. Moreover 10% increase in drinking days consequently results in 4.3% increase in mortality. They concluded that policies that reduce drinking could have substantial public health benefits.

These papers as discussed above, only considered the economic factors that may affect alcohol consumption. Apart from the economic factors, this paper considered the influence of demographic, geographical (regional differences) and the time trend in its analysis. These factors are important in determining alcohol consumption. A place for this paper in literature would be

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the introduction of these factors as contributing to the overall alcohol consumption in United States.

DATA SOURCES AND DESCRIPTIVE STATISTICS

State-level annual data on alcohol consumption, alcohol prices and alcohol tax covering the period 1982- 2003 were used for this study. Data on alcohol prices are from the American Chamber of Commerce Research Association (ACCRA) with intercity cost of living index quarterly reports on price of beer, wine and liquor. The ACCRA prices are adjusted to standardized beer prices to represent the equivalent of Budweiser/Miller Lite 6-packs, wine prices to represent Gallo Chablis 1500ML bottles and spirit (liquor) price to represent J&B 750ML scotch.

Data on alcohol consumption (beer, wine, spirit) are per capita by age 14 and above. They were taken from the National Institute of Alcohol Abuse and Alcoholism (NIAAA).The consumption variables are in ethanol gallons per capita. Data on disposable personal income are from the United States Department of Commerce: Bureau of Economic Analysis. Per capita disposable income represents the nominal expenditure on goods and services. Unemployment data are from the U.S Department of Labor: bureau of Labor Statistics.

Beer, wine and spirit taxes contain state taxes per gallon converted from the Brewers Almanac and Adams/Jobson's Handbook. Beer rates were reportedly applicable to beer with 4.5% ethanol packaged in12 ounce containers. For spirits, it was computed from simple liquid gallon of beverage and such a tax would be the same whether the tax rate contains 100 or120 proof spirits while that of wine was computed by per gallon of table wine. Regional dummies were based on

demarcations in Wikipedia, "official regions of the United States". Data on population is per thousand from the U.S Department of Commerce (Table 1).

Table 1: Data Sources

Variable	Description	Source
Pbeer	price of beer (per gallon)	ACCRA
Pwine	price of wine (per gallon)	ACCRA
Pspirit	price of spirit (per gallon)	ACCRA
Pcconbeer	per capita beer consumption (ethanol per gallons)	NIAAA
Pcconwine	per capita wine consumption (ethanol per gallons)	NIAAA
pcconspirit	per capita spirit consumption (ethanol per gallons)	NIAAA
dispince	Total disposable income (in millions)	U.S Department of Commerce
p	population (in thousands)	U.S Department of Commerce
ppm	proportion of population male	U.S Department of Commerce
unempra	unemployment rate	U.S Department of Labor
wbeer	budget share of beer (percentage of expenditure on beer)	Author Calculation
wwine	budget share of wine (percentage of expenditure on wine)	Author Calculation
wspirit	budget share of spirit(percentage of expenditure on spirit)	Author Calculation

Notes: variables, description and sources

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Table 2: Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
Real price beer	108.70	10.88	87.40	170.16
Real price wine	72.25	10.50	44.89	119.79
Real price spirits	146.03	13.37	112.57	214.61
Pcconbeer	1.31	0.22	0.73	2.18
Pcconwine	0.31	0.16	0.08	1.10
Pcconspirits	0.79	0.34	0.35	2.91
Ppm	0.48	0.009	0.46	0.52
Unempra	5.95	2.11	2.2	18.00

Notes: Means of relevant variables. Real Price and Consumption variables are in Ethanol Gallons.

On the average, the real price of beer, wine and spirit are $108.70, $72.25 and $146.03per ethanol gallon respectively. The mean price of spirit is the highest and it is more than twice that of wine. Also, the average per capita consumption of beer, wine and spirit are 1.31ethanol gallons, 0.31ethanol gallon and 0.79 ethanol gallons respectively. Beer has the highest average consumption per capita, followed by spirit and wine per year. Spirit has the highest average real price.

According to NIAAA, the average ethanol content of a gallon of beer wine and spirit are 4.5%, 12.9% and 41.1% respectively. On the average, people consume 29.1gallons of beer, 2.4gallons of wine, and 1.92 gallons of spirit per year.

$$\text{Gallons of Beverage} = \frac{mean\ ethanol\ gallons}{Average\ ethanolgallons\ per\ beverage}$$

The highest mean price of beer, wine and spirit occurred in Alaska. Indiana, Nevada and Oklahoma had the minimum price for beer, wine and spirit respectively. Moreover, District of Columbia, on the average, consumed more wine and spirit than the other States. Nevada and

Utah had the highest and lowest consumed amount of beer respectively. Refer to figure 8, 9 and

10. These figures demonstrate the consumption of beer, spirits and wine by state respectively.

The color gradient represents per capita consumption of the beer, spirits and wine for the various

States. Lighter colors indicate lower levels of per capita consumption.

As already stated, the alcohol consumption variables are per capita by age 14 and above. It

is important to note that the level data of price and consumption for beer, wine and spirit were

used to compute the expenditure on each alcoholic beverage. The budget shares were computed

by multiplying the level data of price and quantity and then divided by the total expenditure on

alcohol. To further describe the relationship between alcohol consumption, alcohol prices,

budget shares and expenditure on alcohol, this paper uses quadratic prediction graphs to explore

the nonlinear relationship between the variables. The quadratic prediction calculates the

prediction for 'y' variable from a linear regression of 'y' variable on 'x' variable and 'x^2' variable

and plots the resulting curve. 'y' and 'x' represent the dependent (per capita consumption of

alcoholic beverages) and independent variables (total expenditure on alcohol, alcoholic beverage

prices and the budget shares) . The slope predicts how budget shares and elasticities would

behave. This provides the background for estimating budget share equations, elasticities and

captures the non-linearity in the system. Jithitikulchai (2010) used the local constant and local

linear estimators of nonparametric regression, extended from Banks, Blundell, and Lewel (1997)

to study the effects of expenditure and prices on nonlinear pattern of consumption.
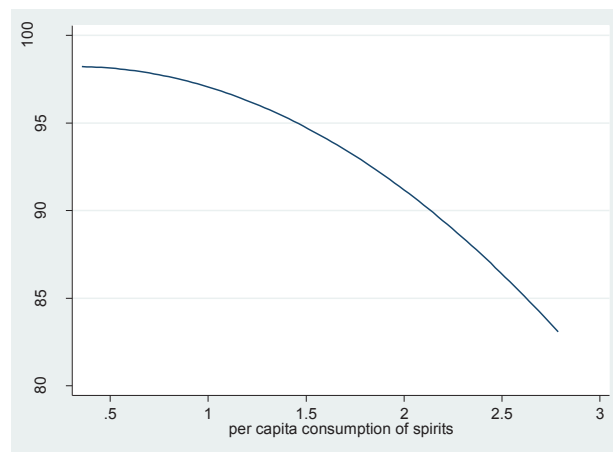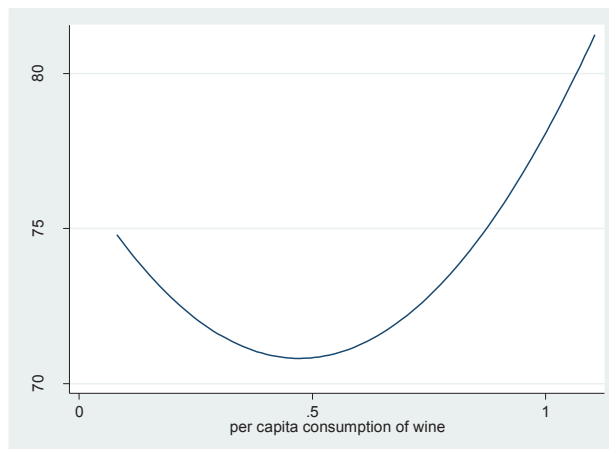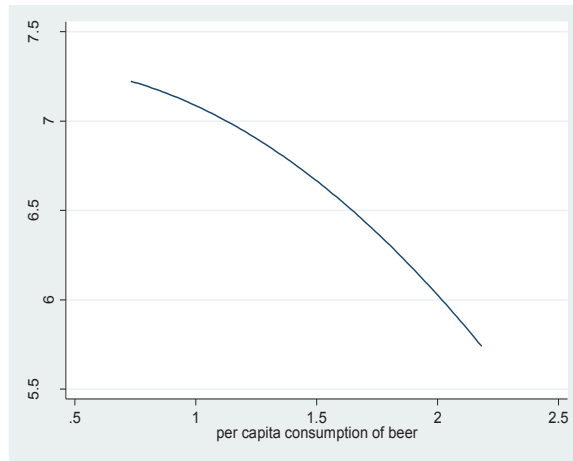
Figure 1: Quadratic Prediction for Consumption and Expenditure
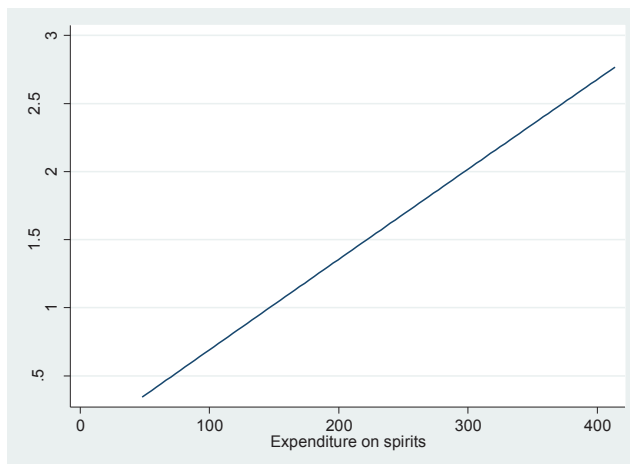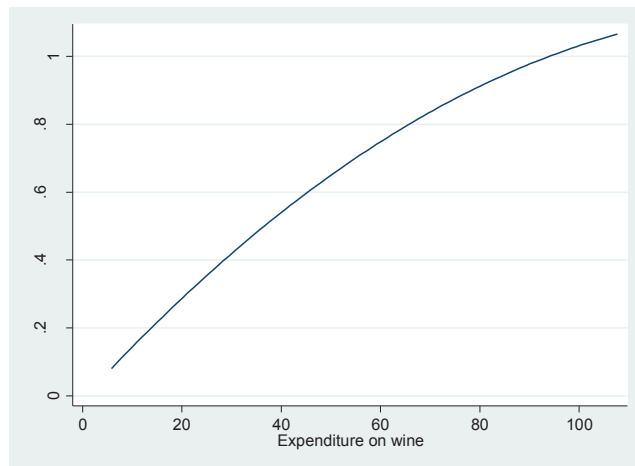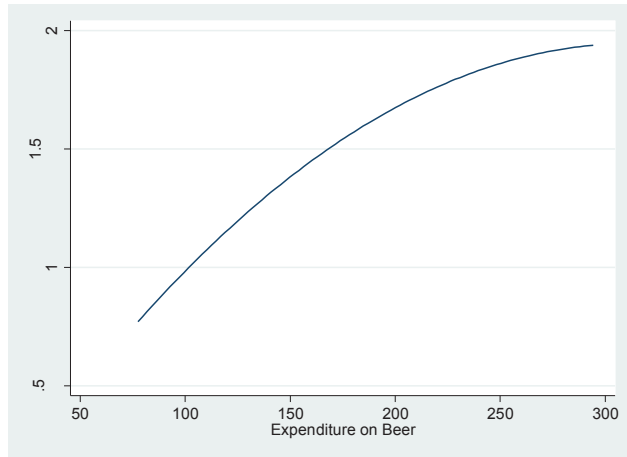
Notes: Predicted values of per capita consumption and total expenditure from Quadratic Prediction Graph

It is of interest to see how consumption changes as expenditures on the alcoholic beverages are allowed to vary (Fig 1). The alcohol expenditure expansion paths, similar to an Engel curve but only for alcohol, show the normal goods type behavior for all types of alcoholic beverages (beer, wine, and spirits). That is higher alcohol expenditure leads to higher consumption but the marginal effect of expenditure would be different at any point on the curve since they are nonlinear.

Figure 2: Quadratic Prediction for Price and Consumption

Notes: Predicted values of per capita consumption and price from Quadratic Prediction Graph

For the effects of price on consumption (Fig 2) there seems more non- linear relationship between the price of wine and its consumption. According to the Law of Demand, lower prices lead to higher quantity demanded for goods and services. Higher prices lead to lower level of consumption for beer and spirits. However, for wine, there are both upward and downward trends in consumption resulting from price changes. However, the majority of values for per capita consumption of wine are below 0.5 ethanol gallons, indicating most of the data is in the downward trend region.
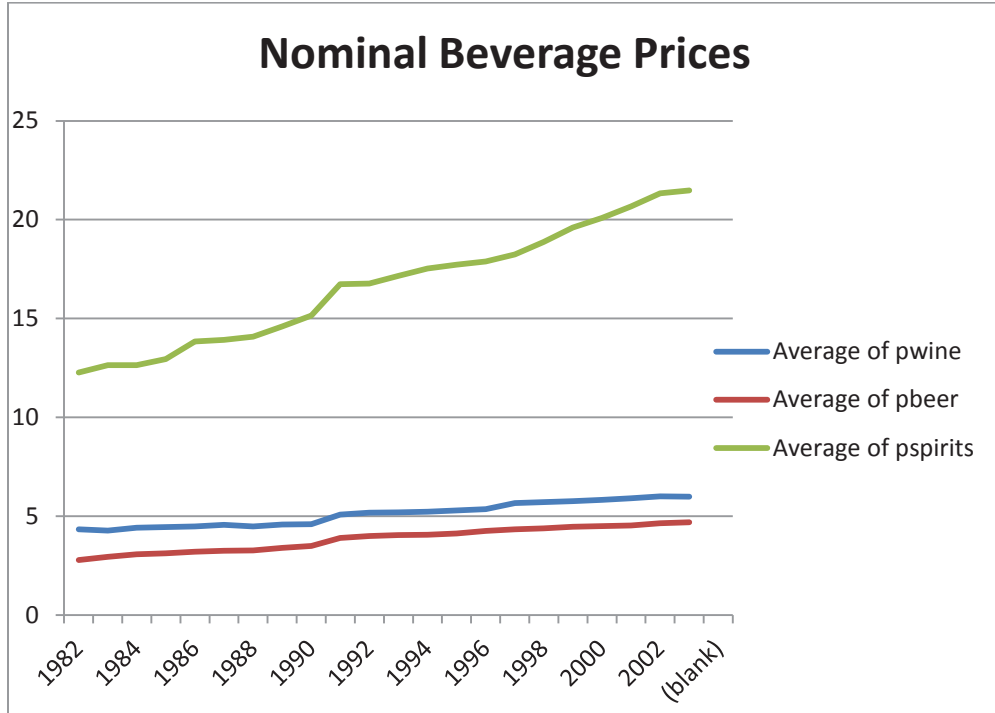
Figure 3: Quadratic Prediction for Budget Shares and Expenditure
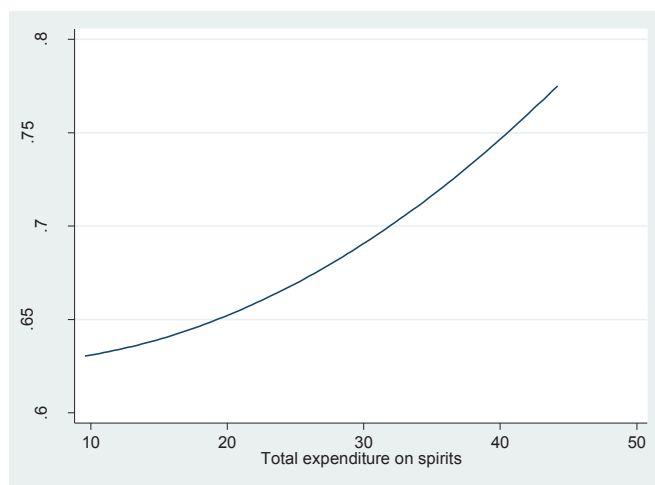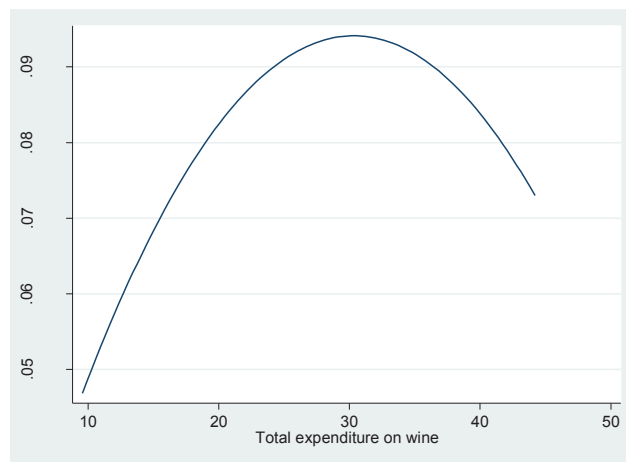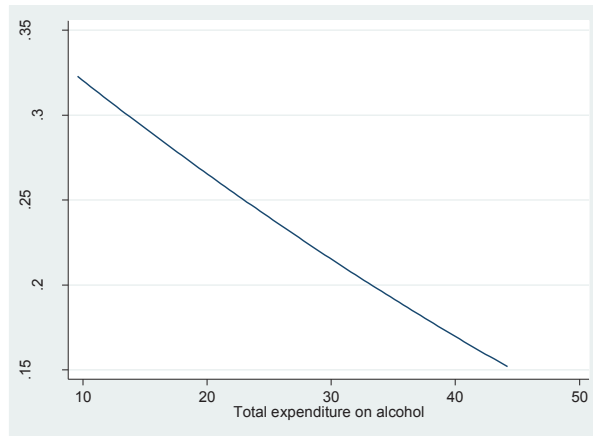
Notes: Predicted values of expenditure on alcohol and budget shares from Quadratic Prediction Graph

Figure (3) indicates how proportion of income spent on alcohol varies with expenditure. Seemingly, the budget shares on wine and spirits increase with expenditure on alcohol. This may mean that most of the expenditure allocated to alcohol goes into wine and spirits.

We could realize that there exists a non-linear relationship that may need a higher- order functional form of estimation of expenditure on alcohol and budget shares. An increase in the budget share for any of the alcoholic beverages seems to increase expenditure except in the case of beer.

Figure 4: Beverage Prices

Nominal Beverage Prices

Legend:
- Average of pwine
- Average of pbeer
- Average of pspirits

X-axis: 1982, 1984, 1986, 1988, 1990, 1992, 1994, 1996, 1998, 2000, 2002, (blank)

Y-axis: 0, 5, 10, 15, 20, 25
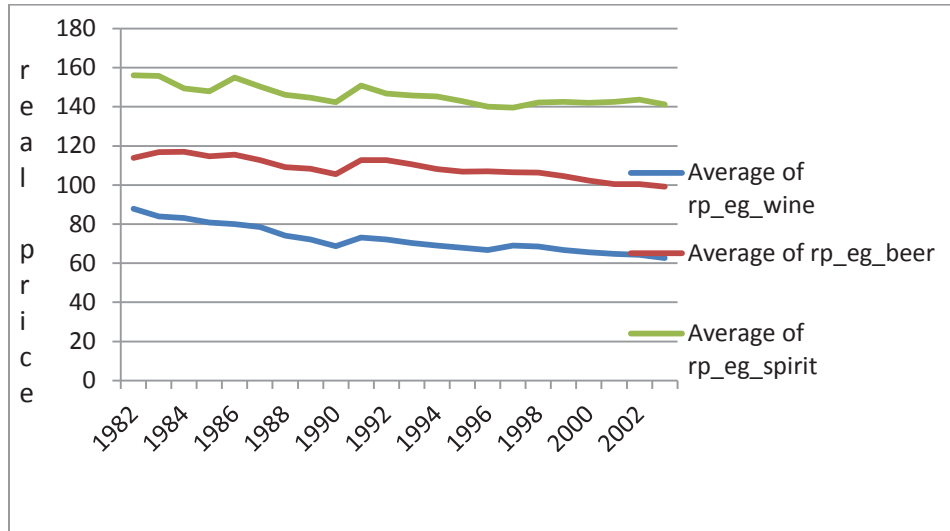
Notes: Trends in beverage prices from ACCRA

Alcoholic beverage prices have been increasing slightly in the period under study. The changes over the years have not been very significant. The price of spirit seems to be increasing faster than that of beer and wine. It could be observed that around 1990, there was a little significant jump in the prices of the alcoholic beverages.

Figure 5: Real Price of Alcoholic Beverage

**Note: trends in real alcoholic beverage price ethanol per gallon from ACCRA**

Base year= 1982

Despite the fact that nominal alcoholic beverage prices have been increasing slightly over the years, the real alcoholic beverage prices of beer, wine and spirit have been decreasing over the years. The decreasing real prices of beer, wine and spirit are due to inflation sweeping away the increases in nominal prices.

Figure 6: Description of Per capita consumption
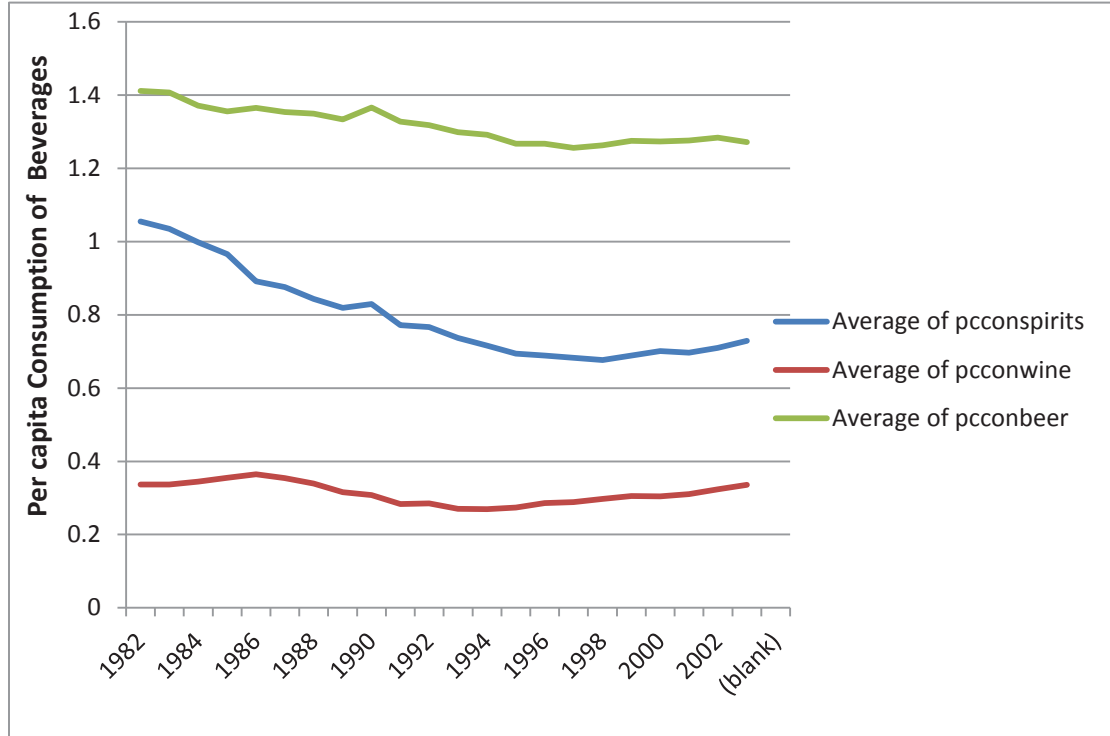
Notes: Trends in consumption of alcoholic beverages from NIAAA

In like manner, the average per capita consumption of beer, wine and spirit has been decreasing in the period under study. Even though, the decrease is not very significant, this may be attributed to preferences and demographics. In all, beer has the highest consumption followed by spirit and wine. Both the real price and quantity demanded of wine and spirits are decreasing over the years.

Figure 7: Description of real tax
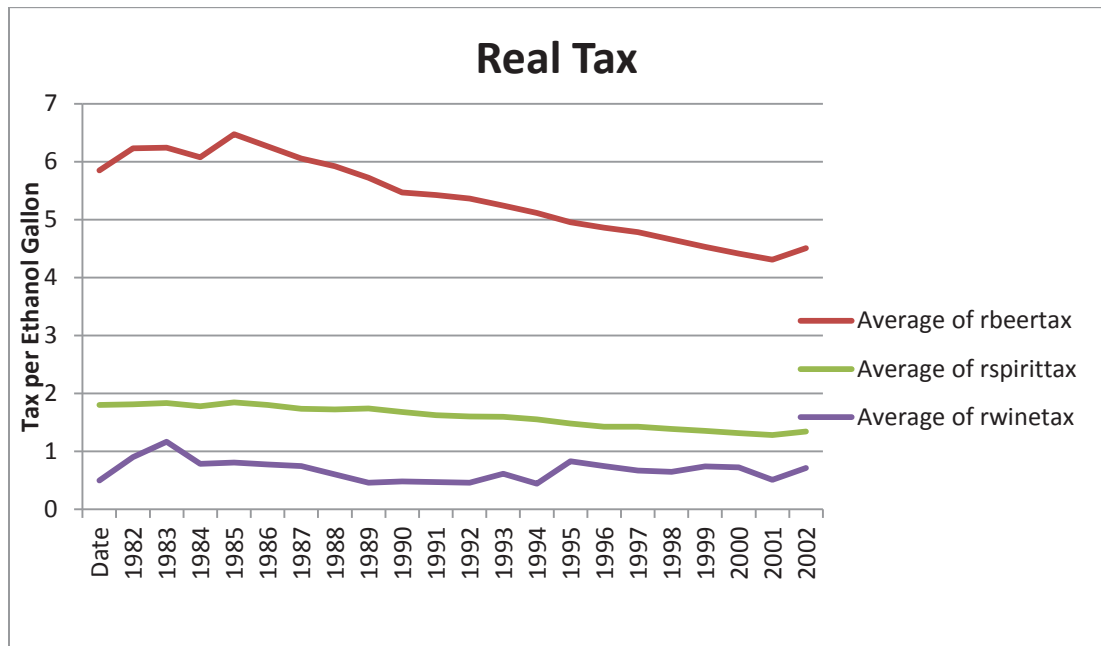
Real Tax

Notes: Trends in average real tax per ethanol gallon of beer, wine and spirits

Taxes are components of prices of goods and services and alcoholic beverages are no exception. The average real tax on alcoholic beverages has been declining over time. Taxes on beer are higher than that of wine and spirit. This may be in part as a result of lower ethanol volume of beer. Spirit has the second highest tax per ethanol gallon taxes followed by wine. In general alcohol taxes have not kept pace with inflation

Maps

Figure 8: **Per capita consumption of beer by state**

0.768 ▭▭▭▭ 1.792
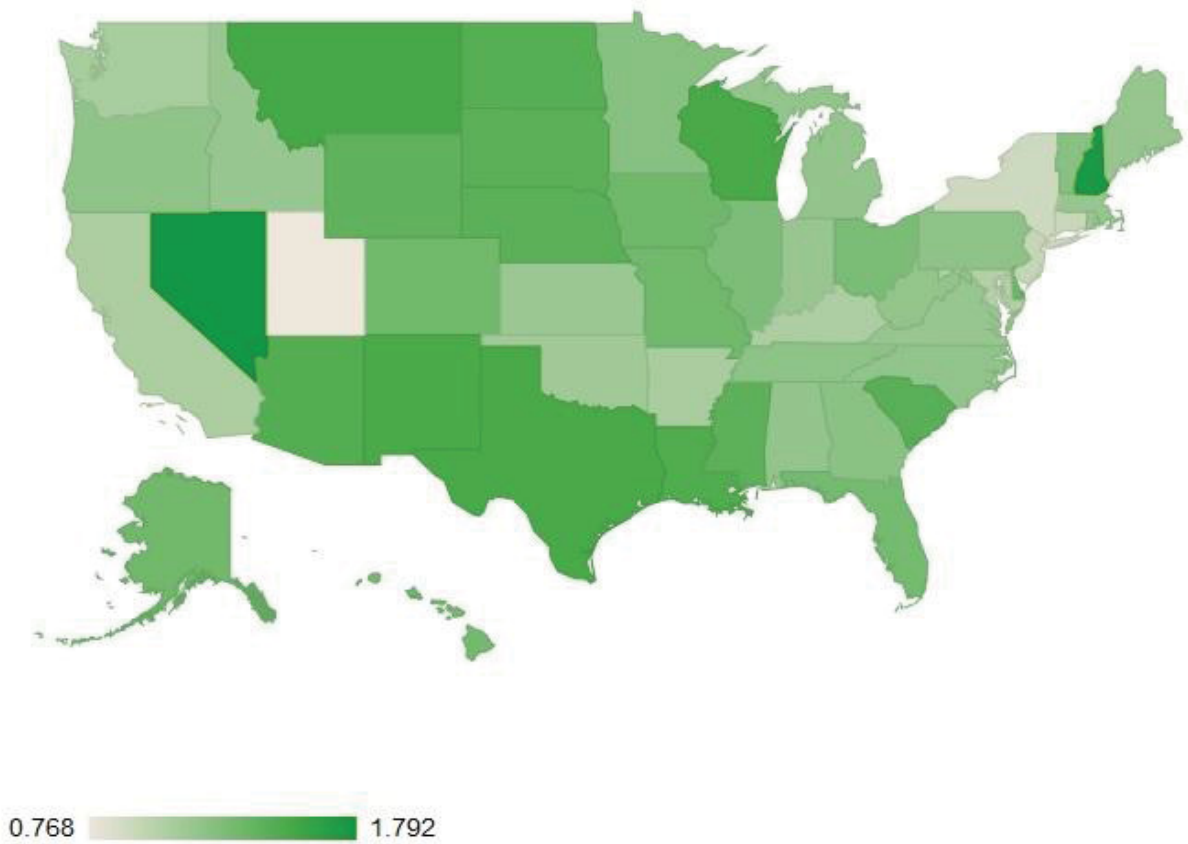
Data: Alch_2000 â€¢ Chart ID: PCBeer
R version 3.0.1 (2013-05-16) â€¢ googleVis-0.4.7 â€¢ Google Terms of Use â€¢ Data Policy

Notes: the color gradient resents the per capita beer consumption in ethanol gallons. Lighter colors refer to lower values.

Figure 9: per capita Consumption of spirit by State
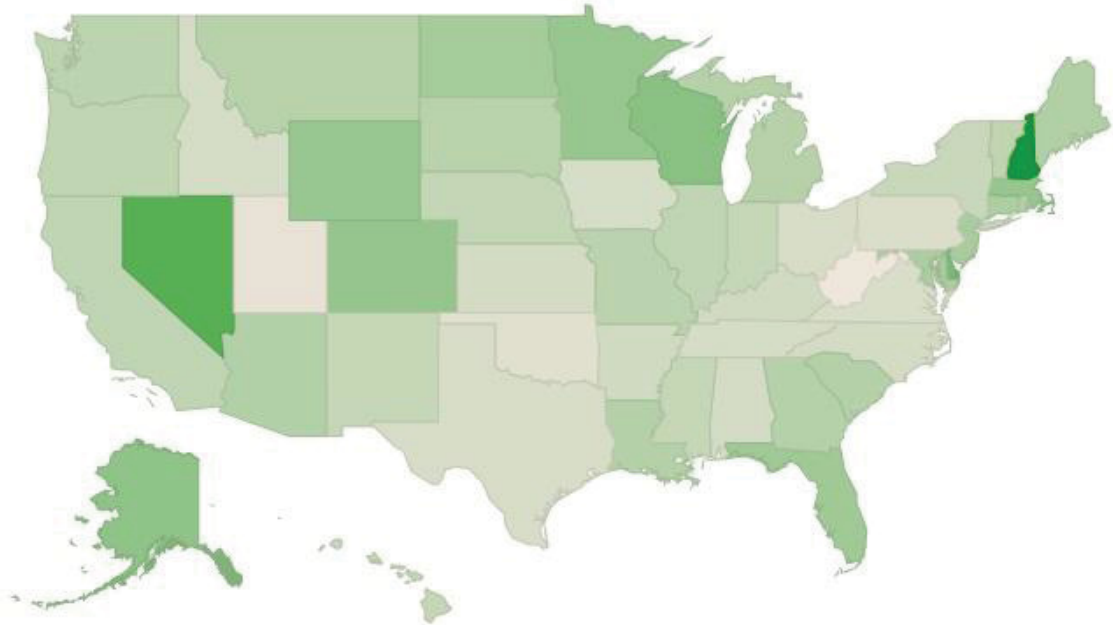
0.355   1.687

Data: Alch_2000 â€¢ Chart ID: PCSpirits
R version 3.0.1 (2013-05-16) â€¢ googleVis-0.4.7 â€¢ Google Terms of Use â€¢ Data Policy

Notes: the color gradient resents the per capita spirit consumption in ethanol gallons. Lighter colors refer to lower values.

Figure 10: Per Capita Consumption of wine

0.095 ▭▬ 0.698

Notes: the color gradient resents the per capita wine consumption in ethanol gallons. Lighter colors refer to lower values.

Table 3: Description of Regional Per capita consumption of Alcoholic Beverages

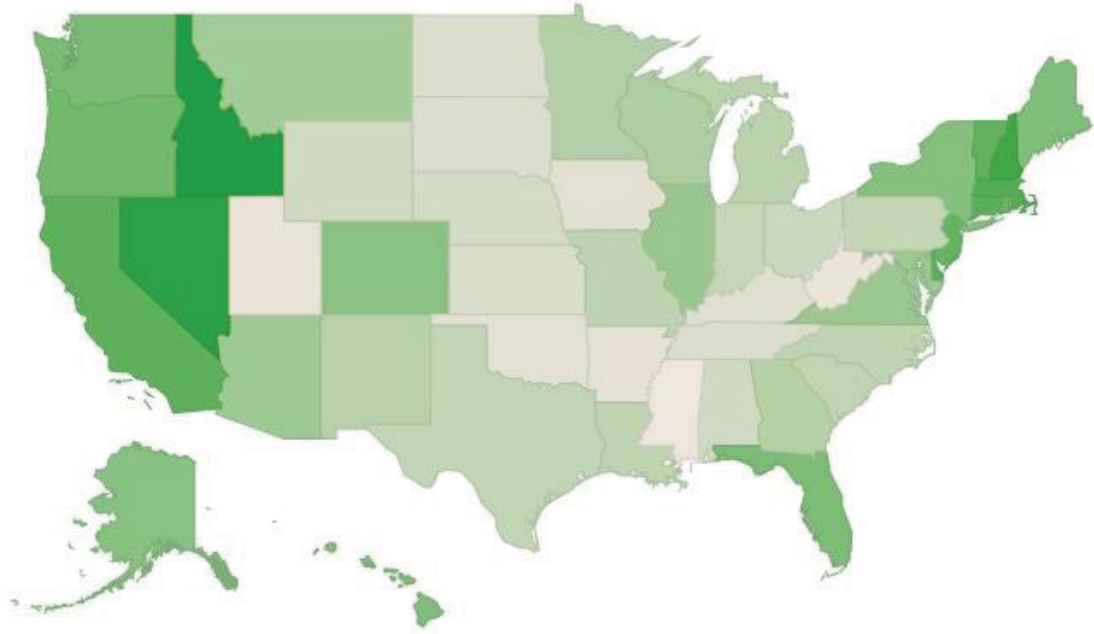| Regions	Average of per capita consumption of spirit	Average of per capita consumption of wine	Average of per capita consumption of beer
Midwest	0.72	0.22	1.33
North East	0.94	0.42	1.27
South	0.73	0.24	1.26
West	0.82	0.38	1.41

Notes: Average Per capita annual consumption of beer, wine and spirit in ethanol gallons

The consumption of spirit and wine is higher in North East while they are lower in the Midwest than the other regions. Consumption of wine is also greater in the West than the other regions. Even though the consumption of beer, wine and spirit are higher in these regions, they are pretty close. For all the alcoholic beverages beer consumption is higher than the others in all the regions.

Table 4: Description of Alcoholic Beverage Price

Regions	Average real price of beer	Average real price of wine	Average real price of spirit
Midwest	102.68	69.09	142.56
North East	114.37	76.32	140.96
South	108.13	74.57	146.04
West	110.61	69.60	152.17

Notes: Average nominal Price of beer, wine and spirit per ethanol gallon

The average real price of beer and wine is higher in the North East but North East has the lowest spirit price. The West has the highest spirit price. There is not much difference in the prices of wine in the various regions. The differences in the prices of beer are much larger than that of wine across regions.

Table 5: Description of Alcoholic Beverage Tax

Region	Average beer tax	Average wine tax	Average spirit tax
Midwest	4.639	0.522	3.025
North East	5.025	1.242	3.674
South	11.906	0.852	3.326
West	6.678	1.283	3.628

Notes: Alcohol tax per gallon of the beverage (in dollars) by region

Among the alcoholic beverages, beer is heavily taxed. In the South, the average tax on beer is as high as twice that of Midwest and North East. It could be observed that wine has the lowest taxes. This may be a consequence of an assumed positive health effect attached to some kinds of wine. The differences in the tax on spirit are very minimal across regions.

EMPIRICAL BACKGROUND

Empirically analyzing a demand relationship for an individual good in isolation is likely to cause misspecification. Such analysis would miss very important substitution and cross-price effects. Therefore, instead of investigating demand for individual goods in isolation, it is better to look at demand relationships for several goods at the same time. This is the approach first pioneered by Stone (1954) with his Linear Expenditure System Model. These demand systems are econometric models that are used to measure how consumers respond to changes in prices

and quantities of various goods and changes in income. The approaches are based on cost

minimizing consumer behavior and allow for the computation of not only specific price

elasticities but also cross price elasticities to determine the relationship between goods.

Microeconomic Theory provides the basis for empirically examining demand relationships.

Consider the following model of demand for a two-goods, x_1 and x_2:

From an expenditure minimization perspective, agents minimize expenditure

$$p_1 x_1 + p_2 x_2 \tag{1}$$

For a given level of utility,

$$U = U(x_1, x_2) \tag{2}$$

The values of x_1 and x_2 that solve that minimization problem are the compensated or Hicksian

demand functions for the two goods can be represented by:

$$x_1^* = h_1 = H_1(p_1, p_2, U) \tag{3}$$

$$x_2^* = h_2 = H_2(p_1, p_2, U) \tag{4}$$

Substituting those back into the expenditure gives the minimum expenditure, which is a function

of utility, U, and the two prices:

$$e = e(p_1, p_2, U) \tag{5}$$

The compensated demand function could be calculated from the expenditure function via

Shepard's Lemma. By differentiating the expenditure function with respect to either the price of

first good or second good, gives the compensated demand functions for each good.

$$\frac{\partial e}{\partial p_1} = H_1(p_1, p_2, U) = h_1 \tag{6}$$

$$\frac{\partial e}{\partial p_2} = H_2(p_1, p_2, U) = h_2 \tag{7}$$

The subsequent compensated elasticities indicate the responsiveness of quantity demanded to changes in price of the commodity, holding utility constant.

$$\frac{\partial h_1}{\partial p_1} * \frac{p_1}{h_1} = \epsilon_1 \qquad (8)$$

$$\frac{\partial h_2}{\partial p_2} * \frac{p_2}{h_2} = \epsilon_2 \qquad (9)$$

In like manner, the Utility maximization problem of households, the uncompensated (Mashallian) demand function could be stated as the values of x_1 and x_2 that maximize utility subject to a budget constraint:

$$D_2 = D_2 (p_1, p_2, Y) \qquad (10)$$

If Y equals the minimum expenditure needed to achieve the maximal level of Utility, then the Hicksian and Marshallian demand functions should be equal.

$$h_1 = D_1 = D_1 (p_1, p_2, e(p_1, p_2, U^*)) \qquad (11)$$

$$h_2 = D_2 = D_2 (p_1, p_2, e(p_1, p_2, U^*) \qquad (12)$$

Differentiating the function with respect to the price of each of the goods gives the Slutsky equation:

$$\frac{\partial h_1}{\partial p_1} = \frac{\partial D_1}{\partial p_1} + \frac{\partial D_1}{\partial e} * \frac{\partial e}{\partial p_1} = \frac{\partial D_1}{\partial p_1} + \frac{\partial D_1}{\partial e} * h_1 \qquad (13)$$

$$\frac{\partial h_2}{\partial p_2} = \frac{\partial D_2}{\partial p_2} + \frac{\partial D_2}{\partial e} * \frac{\partial e}{\partial p_2} = \frac{\partial D_2}{\partial p_2} + \frac{\partial D_2}{\partial e} * h_2 \qquad (14)$$

Setting $D_1 = h_1$ and $D_2 = h_2$ and rearranging

$$\frac{\partial D_1}{\partial p_1} = \frac{\partial h_1}{\partial p_1} - \frac{\partial D_1}{\partial e} * D_1 \qquad (15)$$

$$\frac{\partial D_2}{\partial p_2} = \frac{\partial h_2}{\partial p_2} - \frac{\partial D_2}{\partial e} * D_2 \qquad (16)$$

This tells us the effect of a price change on quantity demanded of the goods, in this case beer, wine and spirits. Price elasticity of demand considers the total effect of change. This change could be divided into two; the income effect and the substitution effect. As price increases for one good increases, agents will substitute away from it toward the other good, but also their utility will decrease as the item costs more to purchase. Compensated demand gives extra income to maintain the original level of utility. Thus (for normal goods) the change in demand for the good with respects to its own price compensated the utility loss should be less negative than when it is uncompensated. In terms of elasticity this could be written as:

$$\epsilon_1^* = \epsilon_1 - \theta_1 * \epsilon_{1,Y} \tag{17}$$

$$\epsilon_2^* = \epsilon_2 - \theta_2 * \epsilon_{2,Y} \tag{18}$$

Where

$$\epsilon_1^* = \frac{\partial D_1}{\partial p_1} * \frac{p_1}{D_1} \ and \ \epsilon_2^* = \frac{\partial D_2}{\partial p_2} * \frac{p_2}{D_2} \tag{19}$$

$$\epsilon_{1,Y} = \frac{\partial D_1}{\partial Y} * \frac{Y}{D_1} \ and \ \epsilon_{2,Y} = \frac{\partial D_2}{\partial Y} * \frac{Y}{D_2} \tag{20}$$

And

$$\theta_1 = p_1 * \frac{D_1}{Y} \ and \ \theta_2 = p_2 * \frac{D_2}{Y} \tag{21}$$

Here, the substitution effect is measured by the percentage that the quantity demanded falls for a given percentage increase in price after compensating the consumer to maintain utility. The income effect is the income elasticity times the budget share, θ_i , on that good. It should also be expressed that with two goods all the demand functions are functions of the price of both goods

and not just one good in isolation. Therefore cross-price elasticities will exist and will likely be non-zero. Expressed in terms of the uncompensated demand functions:

$$\epsilon_{1,p_2}^* = \frac{\partial D_1}{\partial p_2} * \frac{p_2}{D_1} \quad and \quad \epsilon_{2,p_1}^* = \frac{\partial D_2}{\partial p_1} * \frac{p_1}{D_2}. \tag{22}$$

In this case, the goods will be considered gross complements if the elasticities are negative and gross substitutes if the elasticities are positive. Expressed in terms of the compensated demand functions:

$$\epsilon_{1,p_2} = \frac{\partial h_1}{\partial p_2} * \frac{p_2}{h_1} \quad and \quad \epsilon_{2,p_1} = \frac{\partial h_2}{\partial p_1} * \frac{p_1}{h_2}. \tag{23}$$

From the above equation (equation 23), the goods will be considered net complements if the elasticities are negative and net substitutes if the elasticities are positive. (In this simple two-good case under typical assumptions, they must be net substitutes.)Total effect = substitution effect + income effect

When moving from the theory to estimating a real demand system, we need to specify a function form for the utility function. Ideally, we want one that is general enough to provide interesting results, but one that is not overly complicated and too hard to analyze and estimate. A Cobb-Douglas Utility function, for instance, would provide an easy to estimate system, but cross-price elasticities would be zero and the model would be too restrictive. Examples of demand systems are Linear Expenditure System (LES), Almost Ideal Demand System and the Quadratic Almost Ideal Demand System, which was used in this analysis.

Deaton and Muellbaur (1980) assumed a PIGLOG (price-independent generalized log-linear) expenditure function of the form:

$$\log(e(\boldsymbol{p}, U)) = (1 - U) * \log(a(\boldsymbol{p})) + U * \log(b(\boldsymbol{p})) \tag{24}$$

Given level of Utility that is normalized between 0 and 1 and set of prices **p**, they subsequently derive demands and elasticities for a certain functional form of a() and b(). The approach used by Deaton and Muellbaur allows for a very general demand system with many nice properties. These includes symmetry and homogeneity. Symmetry restriction implies that cross price derivatives are symmetric and homogenous of degree zero in prices and expenditure while homogeneity restriction means that the sum of the nominal price parameters in the share equations adds up to zero. In other words, if all prices and income are multiplied by a positive constant, the quantity demanded must remain the same.Demand systems can also be used for welfare analysis. This informs of us of the effects of making economic decisions on consumers and their welfare. The analysis indicates how consumer welfare changes from a change in prices resulting from an imposition of a tax on alcoholic beverages, namely beer, wine and spirits.

THEORETICAL BACKGROUND

Estimating demand for goods or products has a number of problems, especially when looking at multiple goods. Price may be endogenous because it is determined based on the cost functions of firms. Therefore a system approach is required to solve this and other problems posed by using ordinary regression. The Almost Ideal Demand System (AIDS) is common in demand analysis. This model was proposed by Deaton and Muellbauer (1980), and the model has the advantage of estimating the budget shares, compensated, uncompensated and expenditure elasticities through a theoretically consistent frame work. The AIDS model derives the budget shares as dependent variable and the prices and expenditure as explanatory variables and with

other demographic variables. The budget share equation including socio-demographic

characteristics for n goods and m demographic characteristics is of the form;

$$w_i = \alpha_i + \sum_{S=1}^{m} \delta_{is} Ds + \beta_i log\left(\frac{e}{p}\right) + \sum_{j=1}^{n} \gamma_{ij} log P_j \tag{25}$$

for all $i = 1, \ldots n$.

Where,

w_i is the budget share of the expenditure on good i.

e = real expenditure

p= is an overall price index

Ds= a vector of socio-demographic characteristics

While, α, δ, β and γ parameters.

Hausman, Newey and Powel (1995), argued that income effects and budget shares from

expenditure could be non- linear. As a consequence, a higher order expenditure terms may be

required to achieve better results. The usual AIDS model was extended to provide non-linear

expenditure effects resulting in the Quadratic Almost Ideal Demand System (QUAIDS).

QUAIDS is still consistent with demand theory and allows for a more general functional form

for the budget share equations.

Following Banks, Blundell and Lewel (1997) the QUAIDS model is;

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} ln P_j + \beta_i ln\left[\frac{e}{a(p)}\right] + \frac{\lambda_i}{b(p)}\left[ln\left(\frac{m}{a(p)}\right)\right]^2 \tag{26}$$

where,

w_i = budget share of the ith goods

P_j = price of good j

$$a(p) \quad = exp\left(\alpha_0 + \sum_{i=1}^{n} \alpha_i \, lnP_j + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} lnP_i lnP_j \right) \tag{27}$$

e = expenditure

A price aggregation is defined as;

$$b(p) = \prod_{i=1}^{n} P_i^{\beta_i} \tag{28}$$

According to Banks, Blundell and Lewel (1997), "the QUAIDS model assume utility to lie between 0 (subsistence) and 1 (bliss) so that the linear equations of $a(p)$ and b(p) as cost of subsistence and cost of bliss respectively". With adding up restriction in equation (29) in which the homogeneity and symmetry properties are satisfied as in (30) and (31)

$$\sum_i \alpha_i = 1, \quad \sum_i \gamma_{ij} = 0, \forall j \quad , \sum_i \beta_i = 0, \quad \sum_i \alpha_i = o \tag{29}$$

$$\sum_j \gamma_{ji} = 0 \tag{30}$$

$$\gamma_{ij} = \gamma \quad i \neq j \tag{31}$$

The choice of this functional form (QUAIDS) was not only based on practical criteria of goodness of fit, but also on the assumption of demand theory (Deaton and Muellbauer, 1980).

One of these assumptions is the adding-up condition, which is violated by most demand systems or forms. The adding-up requires that consumers do not spend more than their income. This assumption places some restrictions on the demand elasticities. These equations state that changes in income and prices determine changes in the composition of the budget constraint but leave its value unchanged.

Also, QUAIDS is derived from a specific utility cost function; therefore it is consistent with utility maximization behavior. It has the ability to examine relationship between goods and considers consumption and expenditure. It is shown to generate maximization when estimating demand equations.

Following Banks, Blundell and Lewel, (1997) when you differentiate equation (26) with respect to $\ln(e)$ and $ln(P_j)$, you have

$$
\begin{aligned}
\mu_i &= \frac{\partial w_i}{\partial lne} = \beta_i + \frac{2\lambda_i}{b(p)}\left[ln\left(\frac{e}{a(p)}\right)\right] \\
\mu_{ij} &= \frac{\partial w_i}{\partial lnP_j} = \gamma_{ij} - \mu\left(\alpha_j + \sum_k \gamma_{jk} lnP_k\right) - \frac{\alpha_i\beta_i}{b(p)}\left[ln\left(\frac{e}{a(p)}\right)\right]^2
\end{aligned}
\tag{32}
$$

Then the budget elasticities are given by

$$
e_i = \frac{\mu_i}{w_i+1}
\tag{33}
$$

The uncompensated price elasticities are given by:

$$
\epsilon_{ij}^{\mu} = \frac{\mu_{ij}}{w_i - \delta_{ij}}
\tag{34}
$$

$$
\delta_{ij=}\begin{pmatrix} 0 \; if \; i \neq j \\ 1 \; if \; i = j \end{pmatrix}
$$

The compensated elasticities are also given by:

$$
\epsilon_{ij}^{c} = e_{ij}^{\mu} + e_i w_j,
\tag{35}
$$

These are derived from the Slutsky equation.

Equation (33) specifies the how much consumers would allocate to the various alcoholic beverages (beer, wine and spirits) if they should increase their expenditure on alcohol. That is the amount of money that would go into the consumption of the alcoholic beverages. Consumers could allocate the same amounts or different amounts towards the consumption of the beer, wine and spirits. Equation (34) determines how consumers would react to changes in the prices of

alcoholic beverages. That is how much consumers would purchase when the price of each

alcoholic beverage decreases or increases holding other prices constant. The law of demand

stipulates that consumers buy more when price falls and vice versa. Equation (35) also shows

how consumers would respond to changes in the prices of alcoholic beverages, namely beer,

wine and spirits, holding utility constant. That is how much consumers would purchase when

they are compensated for a price increase.

Test of Linear and Nonlinear System

A Wald test can be used to test multiple parameters simultaneously. Banks, Blundell and

Lewel, (1997), recommended a Wald test for testing a null hypothesis that a set of parameters

associated with the non-linear terms are all equal to zero. In the model being tested here, the null

hypothesis tests the linear system. That is, the unrestricted system while the alternative

hypothesis is the nonlinear system, that is the restricted system.

RESULTS AND DISCUSSION

This section will discuss the results from the QUAIDS model which was estimated for

three predicted prices (price of beer, price of wine and price of spirit), from a robust regression in

Stata, Brian P. Poi (State-Journal – 2002). The main purpose of this research is to investigate

how the demand for alcoholic beverages responds to changes in expenditure (income), prices of

the alcoholic beverages and demographics. Specific elasticities (compensated and

uncompensated), associated with the various alcoholic beverages are computed.

Compensated price elasticities give the percentage variation of the demand for the ith good with

respect to a one percent variation of the price of the jth good after compensating for the loss in

purchasing power that is, holding real income or utility constant. The compensated demand is sometimes referred to as "Hicksian" demand. The own price-compensated elasticities describe the variation of the demand of a good when its own price changes. Both compensated own price elasticity and compensated cross price elasticity were computed.

The uncompensated price elasticities give the percentage variation of the demand for i^{th} good with respect to a one percent variation of the price of the jth good, holding other prices constant. The uncompensated demand is also sometimes referred to as "Marshallian" demand. In the same way, both the uncompensated own price elasticity and uncompensated cross price elasticity were computed for the various alcoholic beverages.

Expenditure elasticity measures a percentage change in consumption resulting from one percent change in expenditure on alcoholic goods. All these types of elasticities were computed from QUAIDS for all types of alcoholic beverages. They were computed at variable means. Finally, some of the results, especially the cross price elasticities might not be reliable. This is as a result data. Some of the prices, for instance wine prices were representative prices, producing somehow unfamiliar elasticities. Table 3 shows the results of QUAIDS model estimation with symmetry, homogeneity and additive constraints are imposed on the estimation procedure. For each equation of w_i, the budget share of the jth product, i = 1, 2, 3 represents for beer, wine and spirit respectively. The estimated budget share equations follow equation (2) and are augmented by various demographic variables that affect the budget share in a linear manner.

Table 6: Budget Share Parameter Estimates (from equation 26)

Beer	Coefficient	Std. Err.	z	P>|z|	[95% Conf. Interval]	
α_ beer	0.834	0.119	6.98	0.000	0.599	1.068
β_ beer	-0.143	0.514	0.051	0.005	-0.244	-0.042
γ_ beer	0.575	0.084	6.80	0.000	0.409	0.714
γ_ wine, beer	0.075	0.034	2.18	0.029	0.007	0.143
γ_ spirits, beer	-0.651	0.107	-6.04	0.000	-0.862	-0.439
λ_beer	-0.036	0.017	-2.62	0.009	-0.063	-0.009

Wine	Coefficient	Str. Err.	z	P>|z|	[95% Conf. Interval]	
α_ wine	0.047	0.064	0.74	0.460	-0.787	0.174
β_ wine	-0.224	0.030	-7.44	0.000	-0.248	-0.165
γ_ wine	0.128	0.029	4.40	0.000	0.071	0.185
γ_ wine, beer	0.075	0.034	2.18	0.029	0.007	0.143
γ_ spirits, wine	-0.203	0.058	-3.50	0.000	-0.317	0.089
λ_ wine	0.038	0.009	-4.14	0.000	-0.056	-0.020

Spirits	Coefficient	Str. Err.	z	P>|z|	[95% Conf. Interval]	
α_ spirits	0.118	0.179	0.66	0.511	-0.233	0.470
β- spirits	0.368	0.051	6.22	0.000	0.252	0.484
γ_ spirits, beer	-0.651	0.107	-6.04	0.000	-0.862	-0.439
γ_ spirits, wine	-0.203	0.058	-3.50	0.000	-0.317	0.089
γ_ spirits	0.855	0.147	5.78	0.000	0.565	1.145
λ_ spirits	0.074	0.020	3.61	0.000	0.339	0.114

α= constant,   N=955

Test of non-linearity

Test Results

(1) $\lambda_1 = 0$
(2) $\lambda_2 = 0$
(3) $\lambda_3 = 0$
Ho: $\lambda_1 = \lambda_2 = \lambda_3 = 0$
 Ha: Not Ho
Prob> chi2 = 0.000

The results for the test show the associated p-value, with two degrees of freedom. At a 5% significance level, I reject the null hypothesis and conclude that the nonlinear system provides a better estimation for this analysis. Brian P. Poi (State-Journal – 2002) indicated that in any event, the quadratic income (expenditure) terms may not be statistically significant in this particular application. Note that, λ is a parameter name, and 1, 2, and 3 are the equation names for beer, wine and spirits in equation (26).

Estimation of Budget Shares

From Table 6, the estimated budget share coefficients, α_i and λ_i, are statistically significant. This provides some additional support for the use of the quadratic form. The first part of Table 7 shows the expenditure elasticities. We should note that the various elasticities were calculated at the mean values for all variables. Spirits and beer showed an increase in budget shares as real expenditures on alcohol increases. On the other hand, as expenditure on alcohol goes up, the budget shares for wine decreases. A 1% increase in expenditure on alcohol would increase the budget share for beer by 0.4%, and 2.24% for spirits, but decrease the budget share of wine by 1.51%.

The results indicate that a percentage increase in the price per gallon of each alcoholic beverage results in increasing budget shares of their respective alcoholic beverages. The price per ethanol gallon of beer has a positive marginal effect on the budget shares of wine. However, the price of wine has a negative effect on the budget share of spirit. Also, an increase in the price per ethanol gallon of beer leads to a decrease in the budget share for spirits. All the coefficients of the budget shares with respect to prices of alcohol are statistically significant.

Estimation of Elasticities

The estimated elasticities from a QUAIDS model includes, income (expenditure), compensated and uncompensated elasticities which were derived from the formula discussed earlier. We should note that nonlinear elasticities changes with observations. That is a percentage change in price will not result in successively equal percentage change in quantity demanded.

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Table 7: Estimated elasticities from QUAIDS

Elasticities	expenditure	uncompensated	compensated
Beer			0.40
Wine			-1.51
Spirits			2.24
Own beer		-0.51	-0.30
Cross beer, wine		-2.15	-2.94
Cross beer, spirits		-0.22	0.95
Cross wine, beer		-0.17	0.14
Own wine		-0.93	-1.04
Cross wine, spirits		0.21	0.38
Cross spirits, beer		0.40	0.57
Cross spirits, wine		5.47	4.87
Own spirits		-2.56	-1.66

Note: Estimated elasticities from QUAIDS evaluated at the means

Expenditure Elasticity

A percentage increase in expenditure on alcohol has a positive marginal effect on consumption for beer and spirit. The expenditure elasticities range from -1.51 to 2.24. According to Baltagi and Li (2006) which investigated several cases of spatial and heterogeneity for pooled and panel data models using 43 states over the 1965-1994, their estimated expenditure elasticities for the real per capita disposal income range between 0.612 to 1.605 for all the alcoholic beverages. Despite the fact that some of the expenditure elasticitiesfall outside that range, it may be as a consequence of the differences in the period under study, methodology and type of data. However, expenditure elasticity is greater for spirit and beer than for wine.

Price Elasticity

Considering the estimation of price elasticities, there have been a number of studies on the effects of alcohol prices (taxes) on alcohol consumption. Most of them had relied on panel or

time series analysis of state or national data to observe the price elasticities for overall consumption of beer, wine and spirits separately or of total alcohol consumption. The range of estimates from aggregate data is between -0.08 and -2.0 for spirit, -0.64 and -1.0 for wine, and --- -0.25 and to 0.24 for beer and -0.5 and -1.6 for all types of beverages (Cook, 1981). The results indicated the range of elasticities from -0.51 to -2.56 for uncompensated elasticities and -0.30 to -1.66 for compensated elasticities. By comparison, both the compensated and uncompensated elasticities for wine fall within the range of elasticities from aggregate data. For spirit, the compensated elasticity falls within the range of elasticities from aggregate data but the uncompensated elasticity does not.

Also, none of the elasticities for beer falls within the range of elasticities from aggregate data. The reason for those elasticities that fell outside the range of elasticities from the aggregate data might be as a result of large cross-sectional data with the addition of other demographics and more importantly the time trend that was added to the model. That notwithstanding they are still consistent given the fact that they correspond to demand theory.

The compensated and the uncompensated elasticities are different because of income and substitution effects. For normal goods the income effect reinforces the substitution effect. The uncompensated elasticity could be computed by multiplying the compensated elasticity plus the budget share by income elasticity. This is the Slutsky Equation. For normal goods, the income effect strengthens the substitution effect.

The compensated elasticity might be better than the uncompensated elasticity, because the consumer is compensated for the price change. This is done by increasing the income of the consumers. The amount of money needed to compensate the consumers is referred to as compensated variation. That is, when the price changes consumers receive compensation that

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allows them to remain on their original bundles of consumption. Moreover, one should be careful in interpreting these elasticities, since they refer to non-linear demand systems and are computed at a point. The effect of a percentage change in price on consumption at a point will not lead to the same percentage change in consumption at another point.

Uncompensated Elasticities

For uncompensated own-price elasticities, all the alcoholic beverages have negative signs. This indicates that the price and quantity demanded for the alcoholic beverages move in different direction; an increase in the price of the alcoholic beverages leads to a decrease in quantity demanded. For cross-price elasticities, beer and wine are gross complements while wine and spirit are gross substitutes. This means an increase in price of wine will decrease the quantity demanded of beer but increase the quantity demanded of spirits. The uncompensated elasticities indicated that a percentage increase in price leads to about 0.51% decrease in the consumption of beer, 0.93% decrease in the consumption of wine and 2.5% decrease in the consumption of spirits, holding other prices constant.

Compensated Elasticities

The own price compensated elasticities are greater than the uncompensated elasticities comparably due to income effect, and this is a feature of normal goods. In addition, all the compensated own-price elasticitiesare negative. However, for compensated cross-price elasticities, beer and wine are complements. Spirits are substitutes to beer and wine. When consumers are compensated for their loss of income by holding real income constant, the

consumption of beer goes down by 0.30%. The consumption of wine and spirit also decreases by 1.0% and 1.6% respectively.

As quoted by Chaloukpa et al (2002), a review of fifteen studies that used State and national consumption data, found that every 1% in price translated to a 0.3% decrease in demand for beer, a 1.0% decrease in demand for wine and 1.5% decrease in demand for spirits (Leung and Phelps 1993). Given this, the compensated results support the benchmark elasticities.

Table 8: Economic and Demographic results from QUAIDS

For Beer

Demographics	Coefficient	Str. Err.	z	P>|z|	(95% Conf. Interval)	
Per capita income	0.011	0.001	6.33	0.000	0.008	0.015
Male population	-0.39	0.07	-5.59	0.000	-0.530	-0.254
Unemployment	0.0005	0.0001	-3.63	0.000	-0.0008	-0.0002
Time	-0.0006	0.00007	-8.88	0.000	-0.0007	-0.0004
North East	0.014	0.003	4.33	0.000	0.007	0.020
Midwest	0.005	0.003	1.60	0.110	-0.001	0.011
South	0.025	0.004	5.80	0.000	0.017	0.034
West	0.026	0.003	7.74	0.000	0.020	0.033

For Wine

Demographics	Coefficient	Str. Err.	z	P>|z|	(95% Conf. Interval)	
Per capita income	0.009	0.001	-9.32	0.000	-0.011	-0.007
Male population	0.212	0.030	7.07	0.000	0.153	0.271
Unemployment	-2.72	0.00006	-0.04	0.966	-0.0001	0.0001
Time	0.0001	0.00003	5.29	0.000	0.0001	0.0002
North East	0.008	0.0008	-10.11	0.000	-0.009	0.006
Midwest	-0.001	0.0005	-2.30	0.021	-0.002	-0.0002
South	-0.009	0.001	-7.36	0.000	-0.011	-0.007
West	-0.011	0.001	-10.40	0.000	-0.013	-0.009

For spirits

Demographics	Coefficient	Str. Err.	z	P>|z|	(95% Conf. Interval)	
Per capita income	-0.002	0.001	-1.66	0.096	-0.004	0.0003
Male population	0.180	0.054	3.31	0.001	0.073	0.286
Unemployment	0.0005	0.0001	4.78	0.000	0.0003	0.0007
Time	0.0004	0.00005	8.42	0.000	0.0003	0.0005
North East	0.006	0.002	-2.23	0.026	-0.011	-0.0007
Midwest	-0.003	0.002	-1.40	0.160	-0.008	0.001
South	-0.016	0.003	-4.70	0.000	-0.023	-0.009
West	-0.015	0.002	-5.24	0.000	-0.020	-0.009

Note: 1) 1=beer, 2=wine, 3=spirit
The coefficients represent a percentage change in associated variable with respect to budget share

The economic and demographic factors also have interesting results. A change in per capita income has a positive effect on beer and a negative effect on wine and spirit. The per capita income coefficients were all significant at 10% confidence interval. A percentage increase in per capita income increases the budget share of beer by 1.18%, but reduces the budget share of wine and spirit by 0.9% and 0.2% respectively. Unemployment reduces the budget share allocated to beer and wine but increases that of spirit. When people are unemployed they tend to consume more spirit than wine and beer. A percentage increase in unemployment results in 0.05% reduction in the budget share of beer -2.7% for wine and increases the budget share of spirit by0.05%all else equal. We could observe that these changes are very small.

The proportion of male population also affects the budget share for wine and spirits positively but inversely related to the budget share for beer. An increase in the male population decreases the budget share allocated to beer by 0.39%. The marginal effects of an increase in male population on wine and spirits are 0.21% and 0.18%.

The analysis also provided an insight into how time trend influences the budget shares and consumption. For every additional year, the budget share for beer reduces but that of wine and spirit increases. It is an indication as to how the consumption of these alcoholic beverages changes over time. This is relevant because it takes time for people to change their attitude towards specific goods and to find substitutes. For any additional year, the budget share for beer would decreases by 0.06%. However, the budget share for wine and spirit increases by 0.02% and 0.05% respectively.

The analysis also considered how regional or geographical differences might affect the budget shares and consumption of alcohol. All the coefficients for the regional dummies were significant. The results indicated that the expenditure allocated to beer increases with an increase in alcohol expenditure in the North East. The budget share falls with regards to wine and spirits. The situation is not different from the other regions.

Policy

The signs associated with the elasticities of the alcoholic beverages may provide an indication of the effect of fiscal policies in the form of indirect taxes. Policy makers should also consider the impact of a tax on a particular alcoholic beverage on the others. Assuming an increase in tax is equivalent to a 1% price increase. In this regard a 1% increase in price would decrease the consumption of beer by 0.5%, 0.93% for wine and 2.5% for spirits per gallon. These tell us that the demand for beer and wine are inelastic while that of spirits are elastic. If the aim of the tax is to increase just revenue, then beer and wine should be highly taxed. Such a tax will reduce quantity demanded but less than the proportionate increase in price as a result of the tax. On the other hand, if the aim is to reduce the consumption of alcoholic beverages, because of

their negative health consequences and externality, then policy makers should target spirits for tax.

The net effect of a 1% increase in tax is that the overall alcohol consumption would reduce by about 4%. Alcohol consumption has negative health consequences and sometimes leads to death. Alcohol related diseases include dizziness, cirrhosis, gallstone, pancreatitis, hepatitis, internal bleeding and others. According to Molina and Wagenaar (2010), from elasticity point of view, a 10% increase in tax on alcohol is related to a 2.2% decline in alcohol mortality. Given this background, the reduction in beer consumption (as a result of 1% increase in tax) would be 1.1% decrease in alcohol related mortality for beer, 0.19% for wine and 0.55% for spirit. In total, there would a reduction in alcohol related mortality by 0.85%. This is significant and should be considered for health policies.

Table 9: Predicted Elasticities in the State of Ohio in the year 2001

Elasticity	(Uncompensated)coefficient
Own beer	-0.53
Cross beer, wine	-0.08
Cross beer, spirit	-0.09
Own wine	-0.53
Cross wine, beer	-2.75
Cross wine spirit	0.05
Own spirit	-1.8
Cross spirit, beer	-3.35
Cross spirit, wine	0.02

Notes: predicted elasticities in Ohio

I also predicted the effect of a 1% tax (which is assumed to be equivalent to 1% increase in price per ethanol gallon) on alcoholic beverages in the state of Ohio in 2001. The results can be found in Table 9. Such a tax would decrease the consumption of alcohol by 0.53%, 0.53% and 1.8% for beer, wine and spirits per ethanol gallon respectively. These include substitution effects. In addition, such a tax on wine would decrease the consumption of beer by 0.018%. But a similar tax on spirit would decrease beer consumption by 0.09%.This shows that beer and spirits are gross complements.

Policies in the form of a tax should also consider substitutability of the goods involved. Normally, taxes increase the price of the affected alcoholic beverage, thereby shifting demand to the other whose price had not changed if they are substitutes and decrease quantity demanded if they are gross complements. In this analysis, a tax on wine will shift quantity demanded to spirits since they behave as gross substitutes. A percentage increase in the price of wine will reduce quantity demanded for spirits by 0.02%.

Indirect taxes are important, but not the only factor in determining prices of alcoholic beverages. Factors such as the incidence of a tax, which is the extent to which a tax is transferred to the consumer or absorbed by the producer, is also important. For competitive firms, economists expect taxes to be fully passed on to consumers. In this case, prices rise by the full amount of the tax. This may not be possible where competition is limited which is the case for alcoholic beverages. Taxes may be passed on to the consumers fully or less than the amount of the tax. Also taxes could be passed on to consumers at different rates depending on where the sales took place, as the price of the same beverage may differ within a given geographical area even though the tax rates are the same.

In addition, some States exercise direct influence over alcoholic beverage prices by maintaining monopoly control over the retail and wholesale of alcoholic beverages. Prices of alcohol are under direct State control. We should note that alcoholic beverage prices have not been continuously increased to compensate the effects of inflation. As a result, real tax rates have declined over time. In effect real beverage prices have also decline.

From the results (Table 9), we can conclude that beer and wine have inelastic demand that is a percentage change in price would lead to a smaller percentage change in quantity demanded. Spirit has an elastic demand. A percentage change in the price of spirits would result in a bigger percentage change in the quantity demanded of spirits. The policy implications are that a tax on the alcoholic beverages would be effective and provide more revenue to the state. Such a tax on spirits will offer the state less revenue than beer and wine. This is because the percentage change in the quantity demanded of spirits is bigger than beer and wine. The state will not be able realize the needed revenue as quantity demanded falls.

If the aim of the tax is to reduce alcohol consumption, then such a tax should be targeted on all the alcoholic beverages. There is the need for policy makers to consider the substitutability of these alcoholic beverages. Taxes may lead consumers to shift their demand from one alcoholic beverage to the other. All the alcoholic beverages are gross complements except wine and spirits. An increase in the price of one results in the quantity demanded of the other increasing.

Table 10: The effect of 1% tax on alcoholic beverage consumption in 2001 for Ohio

Alcoholic Beverage	Uncompensated elasticity	Mean consumption in ethanol gallons	Change in ethanol gallons	Estimated change gallons
Beer	-0.53%	0.026	-0.000137	-0.003
Wine	-0.53%	0.032	-0.000169	-0.0013
Spirit	-0.18%	0.120	-0.000216	-0.0005
Total		0.178		

Notes: Author calculation

A 1% tax per ethanol gallon in the State of Ohio in 2001 would decrease beer, wine and spirit consumption by 0.000137, 0.00169 and 0.000216 ethanol gallons per capita based on the mean consumption in the state. The 1% tax will increase the price of beer by $0.05, $0.06 for wine and $0.22 for spirits. These were computed by taken 1% of the approximate price of the alcoholic beverage in the State of Ohio in 2001. These were approximately $5, $6 and $22 for beer, wine and spirits respectively.   In terms of estimated reduction in actual gallons of alcohol, the consumption of beer will go down by 0.0003 gallons, 0.0013 gallons for wine and 0.0005 gallons for spirits.

CONCLUSIONS

This analyzed the impact of alcohol prices(tax) on the consumption of alcoholic beverages (beer, wine, spirit).The research question discusses the influence of taxes on alcohol consumption and whether this may lead to a reduction of some amount of alcohol consumption.

We should keep in mind that those taxes on alcohol work through their prices. They are important because consumption of alcohol has adverse results on health and safety. QUAIDS (Quadratic Almost Ideal Demand System) model which is recently used to estimate demand because of its ability to capture non-linear relationships and overcomes endogeneity, was applied in this analysis. QUAIDS computes budget share equations and elasticities. It also has the ability to compute cross price elasticities.

The results suggest that the budget shares for spirit increases as real expenditure on alcohol increases. The budget share for beer and wine had a negative relationship with expenditure on alcohol. A percentage increase in the price of each alcoholic beverage affects their respective budget shares positively. For uncompensated own-price elasticities, the results suggest that higher price of alcoholic drinks would reduce the consumption of wine, spirit and beer. What is important is that, a tax increase with the intention of reducing alcohol consumption would appear to be effective for spirit.

If the intention of the tax is to raise revenue, then a tax on beer and wine would be appropriate. In addition, wine and beer showed up as gross complements, wine and spirits as gross substitutes for the uncompensated elasticities. The relationship between beer and spirit was inconclusive. The compensated elasticities indicated that beer and wine were net complements while spirits with beer and wine were net substitutes.

The analysis revealed that generally, taxes imposed on alcoholic beverages which increase prices will reduce alcohol consumption and its associated health implications. Therefore alcohol taxation can be a major policy tool that will effectively reduce alcohol consumption and its associated negative consequences.

Despite the fact that this paper considered economic, geographical factors and the time trend that influence alcohol consumption, state effects were ignored. Any further research should include the state effects to improve the analysis. In addition, further research could focus on how much revenue states could make by imposing taxes on alcoholic beverages. In addition, further research should introduce alcohol control policy variables as other instruments. Such control policy variables may include the minimum age, blood alcohol concentration and others.

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