Alcohol consumption: an econometric investigation

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Steve Kilkenny contributes to the numerous studies on the factors which combine to influence alcohol consumption by constructing his own econometric model. In doing so, Kilkenny offers insights which point the way to further investigation by governments and various health organisations seeking to reduce alcohol consumption among the addicted. This article also illustrates the adaptability of economic theory and techniques which can be used to explain almost any phenomenon in society.

Introduction

"Alcohol may be man's worst enemy, but the bible says love your enemy."

Frank Sinatra

Alcohol and the consumption thereof is a topic that generates a lot of discussion. Production and sales of alcoholic beverages is a global industry, with companies such as Anheuser-Busch and Diageo recording revenues of $16.685 billion and $12.270 billion in 2007 respectively. According to the World Health Organisation (WHO) estimates in 2004, there are about two billion people worldwide who consume alcoholic beverages. It generates employment all over the world and at all levels of production, from the production of crops such as barley and hops, to the production of alcohol by breweries and distilleries and finally to the sale of alcohol by retailers. It also generates considerable revenues for government.

Many figures in public life voice an opinion on the effects of alcohol, amongst them healthcare professionals and public policymakers. Both the good and the bad aspects of alcohol consumption have been well documented. While its positive side effects are relatively minor and confer no real externalities, the economic costs of alcohol abuse are quite staggering. A study published in December 2000 by the National Institute on Drug Abuse (NIDA) and the National

Institute on Alcohol Abuse and Alcoholism (NIAAA)[1] in the USA estimated the economic cost of alcohol abuse in 1998 to be over $184 billion. This creates a need to:

(a) find ways to reduce this unwanted burden on the rest of society.
(b) come up with ways to finance these social costs.

In order to start discussing and offering solutions to these problems, it is helpful to investigate and understand what drives alcohol consumption and to what extent.

Literature review

There have been many studies undertaken examining alcohol consumption. Apart from the studies that focus on its health effects, many examine the variables affecting consumption. Authors such as Niskanen (1962) and Manning, Blumberg, and Moulton (1995) explore in detail the price and income elasticities of demand with policy implications in mind (more specifically the tax and excise duty levels most appropriate to tackling (a) and (b) above). The general consensus is that demand for alcohol consumption is relatively inelastic, which is to be expected given that alcohol is often categorised as an addictive good (Grossman, Chaloupka & Sirtalan, 1998). The magnitude of these elasticities, however, is the subject of much discussion in economic literature.

Niskanen (1962) derives an in-depth model for alcohol consumption, tackling both the supply and demand side in order to come up with a system of equations that attempts to explain expected consumption. The author uses these to posit a more appropriate tax structure than that which previously existed, one that implied the following objectives:

(a) "Tax rates should be set at such a level that the prices faced by consumers reflect the true marginal costs (private plus social cost) of their consumption of each beverage".
(b) "Total tax revenue should be equal to the estimated total social cost of alcoholic consumption."

(Niskanen, 1962: 69)

Manning , Blumberg and Moulton (1995) also investigate alcohol consumption and price elasticities but they divide drinkers into three groups: light, moderate and heavy, with heavy drinkers assumed to impose the majority of the social costs on the

[1] Both are part of the National Institutes of Health (NIH).

rest of society, with light and moderate drinkers creating little or no externalities. They find that heavy drinkers' demand for alcohol is relatively price inelastic. However, light and moderate drinkers are somewhat more responsive to price changes. With this in mind, they suggest that to calculate the efficient excise tax on alcohol

> "We must trade off the economic and social gains of making alcohol abusers face prices that more accurately reflect the full social costs of their actions with the adverse effects of the increase in taxes on non-abusive drinkers."

(Manning, Blumberg & Moulton, 1995: 124)

Although the dataset collected for this investigation is more aggregated than that of Manning, Blumberg and Moulton (1995), it is instructive to bear in mind the differing responses of the three groups to price changes when considering the observed results.

Furthermore, there is evidence to suggest that demographic factors may provide some explanatory power for the dependent variable in question. Notwithstanding the legal restrictions on the sale and consumption of alcohol with respect to minors, use of certain gender and age variables could be informative. In 2007, a Special Eurobarometer (2007) report was published by the European Commission containing survey data pertaining to alcohol consumption patterns and other viewpoints on alcohol in general across the European Union (EU). They asked respondents whether they drank alcohol at least once in the past year and 84 per cent of men replied "yes", compared to 68 per cent of women. In the age categories 25-39 and 40-54, 81 per cent said "yes". Including these variables may add some explanatory power to the hypothesised model. That said since the sampling method employed was a survey, one must be cautious in inferring too heavily from these findings.

Empirical approach

The results of this investigation were obtained by running the following Ordinary Least Squares regression:

$$\mathbf{Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + u_i}$$

Where:

Y = Alcohol consumption, litres per capita, based on the population of age 15 and above (ALC).

$\mathbf{X_1}$= Consumer price index, with 2000 as the base year (CPI2000).
$\mathbf{X_2}$ = GDP per capita, based on Purchasing Power Parity (PPP) and measured in current US dollars (GDPPPPCD).
$\mathbf{X_3}$ = Percentage of population aged between 15 and 64 (POP1564).
$\mathbf{X_4}$ = Percentage of males in population (POPMALE).
$\mathbf{u_i}$ = Error term

It was deemed suitable, upon investigation, to convert the model into a double logarithmic functional form in order to identify the income and price elasticities in the sample. This also helped rectify the problem of X_1 and X_2 being of greater magnitude than Y, which would have resulted in unhelpfully small beta values. By the same reasoning, it was also deemed appropriate to scale down the percentages X_3 and X_4 by a factor of 100. With these modifications complete, it is thought that a clearer analysis can take place.

It is anticipated that CPI2000 will have an inverse relationship with ALC, and that GDPPPPCD will have a positive relationship with ALC. However, the exact magnitude of these relationships will, to an extent, depend on the proportions of light, heavy and moderate drinkers in each sample population, in light of the findings of Manning, Blumberg and Moulton (1995).

It is also expected that the demographic factors included in the model will add some explanatory power. According to the Eurobarometer (2007) report, such a model should expect to find a positive relationship between ALC and both POPMALE and POP1564.

Data set issues

The time series 1984-2003 was chosen largely due to data availability. The WHO published the "Global Status Report on Alcohol 2004", a major international study on alcohol consumption patterns, which proved to be a rich source of data. Information on alcohol consumption since then has been less abundant. It is not anticipated that any sample specific factors will be encountered that may compromise the generality of the findings.

Initially, the cross-section of the panel data was going to include all 30 member states of the Organisation for Economic Co-operation and Development (OECD). Unfortunately, due to the unavailability of data, the omission of the Czech Republic, Slovakia and South Korea was necessary. It was deemed appropriate to exclude Turkey from the study, owing to the fact that the majority of its population are Muslim and religious factors may distort the presented model[2].

[2] In Islam, alcohol is generally forbidden.

The 26 counties used are all classified by World Bank, as of July 2008, as 'high income' countries, with the exception of Mexico and Poland, who were classified as 'upper middle income'. These are all developed countries and may help in our analysis, as the WHO states in a fact sheet:

> "Unrecorded production of alcoholic beverages contributes significantly to overall alcohol availability, especially in developing countries and countries in the former Soviet Union. In some countries production in the informal sector is as high as 80% of total production"
>
> (WHO, 2003)

Due to the narrow focus of the sample obtained, the variation between groups may be minimised and so the results may be stated with more confidence.

A scatter plot of ALC against POP1564 indicates the existence of a positive relationship between ALC and POP1564. Similarly, a scatter plot of ALC against GDPPPPCD suggests a positive relationship between these variables. This is consistent with the evidence presented earlier.

	Alcohol Consumption	Consumer Price Index	GDP per capita	Proportion Male	Proportion Aged 15-64
Australia	10.2900	84.2547	19677.60	0.50069	0.66741
Austria	11.8450	87.9532	22396.60	0.48561	0.67615
Belgium	11.4600	88.4401	21330.90	0.49163	0.66431
Canada	8.0300	87.3805	22174.20	0.49828	0.68137
Denmark	12.1500	86.3379	22039.90	0.49697	0.66980
Finland	8.7200	87.0825	19298.20	0.48891	0.67200
France	15.3900	89.5845	20218.00	0.49052	0.65419
Germany	11.9550	88.3738	20884.50	0.48679	0.68568
Greece	10.2050	65.0244	17019.90	0.49695	0.67259
Hungary	13.2050	49.6742	9664.40	0.48169	0.67313
Iceland	5.2050	76.5634	23467.80	0.50458	0.64482
Ireland	11.7500	85.6347	18259.30	0.50106	0.63560
Italy	10.2600	80.6110	20016.20	0.48926	0.68062
Japan	8.5250	94.8113	20681.00	0.49367	0.68803

Luxembourg	14.8700	88.1936	37256.00	0.49277	0.68320
Mexico	4.8450	46.7198	7071.20	0.49578	0.58556
Netherlands	10.0550	87.9756	21304.20	0.49720	0.68358
New Zealand	9.6650	85.9027	16685.40	0.49556	0.65454
Norway	5.2200	84.5644	23795.30	0.49859	0.64686
Poland	8.6350	46.0093	7421.90	0.48825	0.66365
Portugal	14.165	75.7117	12566.20	0.48544	0.66610
Spain	12.765	79.8013	15811.40	0.49357	0.67171
Sweden	6.2800	86.5109	21199.80	0.49892	0.64258
Switzerland	12.0850	89.3458	25876.10	0.49307	0.68276
United Kingdom	9.8450	81.5590	19091.70	0.49012	0.65223
United States	8.8550	83.8940	26635.00	0.49388	0.66097

Table 1: Mean summary statistics: 1984-2003.
Source: United Nations Database and WHO.

Empirical Results

$$\widehat{APC} = -0.916 - 0.0189CPI2000 + 0.276GDPPPPCD - 1.061POPMALE + 1.227POP1564$$
$$(0.2894) \quad (1.103) \quad (0.00763) \quad (0.0533) \quad (1.106)$$

$$N = 520 \qquad F_{48,\,471} = 191.33 \qquad \text{Adjusted } R^2 = 0.94625$$

The direction of the relationships implied by the coefficients for all variables, with the exception of the intercept term and POPMALE, are as expected. The results would indicate that people, in general, are more income elastic than price elastic, with respect to alcohol (although neither is of a large magnitude). Indeed, alcohol appears to be very price inelastic, with a one per cent increase in price corresponding to a *ceteris paribus* 0.0189 per cent drop in alcohol consumption.

The intercept term is negative and given that one cannot consume a negative amount of alcohol, this finding is a little unusual, although, it is only significantly different from zero at very high significance levels. This suggests that there is no 'subsistence' level of alcohol consumption.

This analysis also suggests that the amount of males in the population has a negative impact on the dependent variable ALC, which is at odds with the findings of the Eurobarometer study mentioned earlier. However, the beta value for this variable is only statistically different from zero at a significance level of 35 per cent, so gender would appear to provide little explanatory power. It was decided that a second regression should be run, this time omitting the variable POPMALE. This generated the following regression:

$$\widehat{APC} = \underset{(0.625)}{-\ 0.0432} - \underset{(0.0075)}{0.0175}CPI2000 + \underset{(0.0527)}{0.268}GDPPPPCD + \underset{(0.258)}{1.353}POP1564$$

$$N = 520 \qquad F_{47,\ 472} = 195.416 \qquad \text{Adjusted } R^2 = 0.94625$$

The adjusted R-squared value for the omitted variable regression is the same as the original model. Furthermore, the new F-statistic is higher than in the original figure but not by much. This suggests that the variable POPMALE provides little or no explanatory power to alcohol consumption behaviour.

The results also tell us that our sample suffers from both serial correlation and heteroscedasticity. There are many possible explanations for why this is so and there exists ways of rectifying these problems. Gujarati (2002) puts forward the following as a possible cause of heteroscedasticity:

> "As incomes grow, people have more discretionary income and hence more scope for choice about the disposition of their income. Hence, σ_j^2 is likely to increase with income"
>
> (Gujurati, 2002: 389)

It is well known that incomes tend to rise over time, in nominal terms at least, and so this may account for the presence of heteroscedasticity. In light of this difficulty, the method of Weighted Least Squares (WLS) was employed in order to the efficiency of the estimates. The following regression was obtained:

$$\widehat{APC} = \underset{(1.014)}{-\ 0.9159} - \underset{(0.00733)}{0.0189}CPI2000 + \underset{(0.0583)}{0.276}GDPPPPCD - \underset{(0.9427)}{1.061}LPOPMALE + \underset{(0.307)}{1.227}POP1564$$

$$N = 520 \qquad F_{47,\ 472} = 195.416 \qquad \text{Adjusted } R^2 = 0.94625$$

Note the OLS estimation is based on White's heteroscedasticity adjusted standard errors.

The problem of serial correlation is more serious in this model. Again, there may be a number of reasons for this. Gujarati (2002) put forward the possibility that excluded variables can have an impact on serial correlation. In the above model, macroeconomic and demographic variables were used, but it is possible that country specific cultural and social factors may have driven alcohol consumption to a certain extent. Collecting data for these factors is a challenge as some factors are hard to quantify for inclusion in a linear regression.

Possible extensions

As discussed above, it may be instructive to add some cultural variables to the model. Adding such factors will enable researchers to better differentiate between countries' population dynamics, rather than homogenise all countries into the 'representative agent' so beloved of economists. In doing so, it may allow public policy to be better informed by an analysis like the one presented here.

Given more detailed data, it may be useful to group drinkers according to levels of alcohol consumption, as in Manning, Blumberg, and Moulton (1995). Knowing a country's profile of drinkers may enable a more efficient tax framework to be constructed and may reduce the unwanted distortionary and welfare-loss effects of alcohol taxation.

Conclusion

This investigation initially set out to try and explain what drives alcohol consumption using a number of macroeconomic and demographic variables from the perspective of public policy. By and large the data revealed what was expected, although there were a few surprising results. Evidence was found suggesting that gender does not help to explain alcohol consumption. If this is a significant finding, it would contradict the Eurobarometer (2007) report amongst others. That said, whether the evidence is definitive or not is difficult to ascertain.

Demand for alcohol appears to be more income elastic than price elastic, although neither appears to be particularly strong. The notion of alcohol being an addictive good is well established (Grossman, Chaloupka & Sirtalan, 1998). People tend to develop habitual alcohol consumption and price or income changes tend not to alter their consumption patterns substantially. This would suggest a discrepancy between governments' rhetoric on the subject of alcohol and its practice of levying taxes. Indeed, taxing alcohol is a relatively easy way for a government to extract revenue from the taxpayer, with little or no distortions to the economy.

Of course, with a richer data set, researchers will be able to undertake a more comprehensive study of other factors driving alcohol consumption. This model demonstrates what fundamentally drives alcohol consumption, at least on an

aggregate level. However, if individual governments wish to design alcohol policy effectively, it may be instructive for them to conduct individual studies, exploring deviations from the analysis presented here.

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