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Impact of Maryland's 2011 alcohol sales tax increase on alcoholic beverage sales

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Abstract

Background: Increasing alcohol taxes has proven effective in reducing alcohol consumption, but the effects of alcohol sales taxes on sales of specific alcoholic beverages have received little research attention. Data on sales are generally less subject to reporting biases than self-reported patterns of alcohol consumption.

Objectives: We aimed to assess the effects of Maryland's July 1, 2011 three percentage point increase in the alcohol sales tax (6–9%) on beverage-specific and total alcohol sales.

Methods: Using county-level data on Maryland's monthly alcohol sales in gallons for 2010–2012, by beverage type, multilevel mixed effects multiple linear regression models estimated the effects of the tax increase on alcohol sales. We controlled for seasonality, county characteristics, and national unemployment rates in the main analyses.

Results: In the 18 months after the tax increase, average per capita sales of spirits were 5.1% lower ($p < 0.001$), beer sales were 3.2% lower ($p < 0.001$), and wine sales were 2.5% lower ($p < 0.01$) relative to what would have been expected from sales trends in the 18 months prior to the tax increase. Overall, the alcohol sales tax increase was associated with a 3.8% decline in total alcohol sold relative to what would have been expected based on sales in the prior 18 months ($p < 0.001$).

Conclusion: The findings suggest that increased alcohol sales taxes may be as effective as excise taxes in reducing alcohol consumption and related problems. Sales taxes also have the added advantages of rising with inflation and taxing the highest priced beverages most heavily.

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Note

Declaration of interest

The authors have no declarations of interest to report.

Keywords

Alcohol sales; alcohol taxes; alcohol consumption; alcohol sales taxes; alcohol policy; prevention

Introduction

Excessive alcohol use is responsible for an average of 88,000 deaths in the United States (US) per year (1), and cost the US $249 billion ($2.05 per drink) in 2010 (2). In Maryland, excessive alcohol use is responsible for an average of 1318 deaths each year (1). In 2010, excessive drinking cost Maryland $4.96 billion ($2.22 per drink), similar to the state's costs for smoking and Medicaid (3). Most of these deaths and costs were due to binge drinking (consuming four or more drinks for women or five or more drinks for men, per occasion), which was reported by more than one in six Maryland adults in 2011 (4). Furthermore, Maryland adults who binge drink do so an average of nearly five times a month and consume nearly seven drinks per binge drinking episode (5).

There is strong scientific evidence that increasing alcohol taxes can reduce excessive alcohol consumption and related harms (6,7). Wagenaar et al. (8) conducted a meta-analysis of 112 studies and found that the price of alcoholic beverages consistently was inversely related to the quantity of alcohol consumed – as the price of alcohol increases, the quantity consumed decreases. This relationship was observed for all types of alcoholic beverages. A separate meta-analysis of 50 studies examining the association between alcohol prices and alcohol-related harms concluded that higher alcohol prices and taxation were associated with reduced violence, motor vehicle traffic crashes, sexually transmitted infections, the use of other drugs, and crime (9). The Guide to Community Preventive Services systematic review of 72 studies examined the evidence of the effectiveness of alcohol taxes in reducing alcohol consumption and alcohol-related problems (6). Based on strong evidence of effectiveness, the US Community Preventive Services Task Force recommends increasing alcohol taxes to reduce excessive alcohol consumption and related harms (7).

Despite a well-established relationship between increases in alcohol prices and decreases in alcohol consumption and related harms, alcohol is more affordable in the US now than at any time in the past 60 years (10). Maryland has not changed its alcohol excise taxes in nearly 40 years. The state last increased its distilled spirits excise tax in 1955, and its beer and wine excise taxes in 1972; as of January 1, 2011, the approximate state excise tax per drink in Maryland was less than two cents (11). Since the excise taxes are flat taxes based on volume rather than price, their value has eroded over time due to inflation. Alcohol excise taxes represent a declining percentage of Maryland's state revenues each year (12) and are among the lowest in the country (13). Of Maryland and its five bordering jurisdictions, in 2011, Maryland had the second lowest beer (tied with DC) and wine excise tax rates and the lowest distilled spirits excise tax rate (13). Maryland also levies a 6% sales tax on most consumer goods, including alcohol. This general sales tax was last raised in 2007, prior to which it stood at 5%. When sales taxes are included, in 2011 Maryland still had the lowest rate for distilled spirits (lower than DC) and the second lowest beer and wine tax rates. After Maryland's increased alcohol sales tax, the state's combined excise and sales tax rates were

the second highest for beer (after DC), third highest for wine (lower than DC and Virginia), and third lowest for spirits (after West Virginia and Delaware).

The alcohol tax evaluation literature is based almost entirely on experience with volume-based excise taxes (6,8). In a recent US study, Xuan et al. (14) found that using a combination of tax measures – volume-based as well as value-based measures, such as sales taxes – is a better predictor of binge drinking than volume-based taxes alone. However, despite the documented importance of sales taxes when assessing binge consumption (14), to our knowledge, there have been no evaluations of the impact of increasing value-based alcohol taxes on the sales of multiple types of alcoholic beverages.

On July 1, 2011, Maryland raised the sales tax on alcohol by three percentage points, from 6% to 9% (15). Evaluation of the effects of Maryland's 2011 alcohol sales tax increase can provide further insight into the association between alcohol sales taxes and alcohol sales. Measures of alcohol sales have been determined by the Community Guide to Preventive Services as an accepted proxy for alcohol consumption (6). They are generally less subject to reporting biases than self-reported patterns of alcohol consumption. One study found that self-reported alcohol consumption accounts for a median of 22–32% of sales data (16). Moreover, alcohol sales data have been used as part of the evidence base for the endorsement of raising alcohol prices and taxes as an effective strategy by the US Community Preventive Services Task Force (7).

Accordingly, the primary purpose of our study was to use the opportunity provided by the Maryland sales tax increase to fill the gap in knowledge regarding effects of alcohol sales tax increases on alcohol sales. Specifically, we assessed whether there was a difference in the mean volume of alcohol (spirits, beer, wine, and total alcohol) sold per capita in Maryland's counties after the alcohol sales tax increase relative to what would have been expected from trends in alcohol sales prior to the tax change. We hypothesized that, after the tax increase, the gallons of alcohol sold per capita by type would be lower than what would have been expected if earlier sales trends continued, after controlling for county characteristics including population density, average income, and unemployment rates, as well as seasonal variation and national unemployment rates.

Methods

Data source

The study included all of the Maryland counties and Baltimore City ($N = 24$). We obtained data on the monthly alcohol sales in gallons by county and by beverage type from January 1, 2010 to December 31, 2012, as originally reported by the counties, from the Maryland Comptroller's Office. If there were anomalies in the data from the state, we requested data directly from county liquor boards.[1]

[1]We contacted the Worcester County and Cecil County Liquor Boards due to large variations in the monthly data for spirits. The Worcester County Liquor Board was only able to provide data on gallons of spirits sold in 2012, so data for 2010 and 2011 are from the Comptroller's Office. Data were not attainable from Cecil County so we used the original data provided by the state.

Measures and design

The primary outcome measures were gallons of alcohol sold per 100 population age 15 and older during an 18-month period. We obtained data on gallons of alcohol sold by month for 18 months before the tax increase (January 2010–June 2011) and 18 months after the tax increase (July 2011–December 2012) for all of Maryland's counties and Baltimore City. We divided the gallons sold in each county by the county population estimate at midyear for residents aged 15 and older for the 3 years of data, respectively (2010, 2011, and 2012) and multiplied by 100 to generate continuous variables for gallons of alcohol sold per 100 population (herein-after referred to as "per capita"). Consistent with the World Health Organization and World Bank methodology for measuring per capita alcohol consumption, we defined the population as persons age 15 and older – because this generally represents the population susceptible to drinking (17).

To assess the effects of the tax increase on average changes in gallons of alcohol sold per capita relative to what would have been expected from trends in alcohol sales prior to the tax change, we created a binary "tax status" variable indicating whether a particular month was pre-tax (months 1–18; coded as 0) or post-tax (months 19–36; coded as 1). In our main model, we controlled for county characteristics including population density, annual county per capita income using Census Bureau data (18), and unemployment rates (19). We calculated population density by dividing the county population by geographic size. We also created a seasonality variable by coding the months according to the four seasons to control for changes in alcohol sales across months unrelated to the tax increase. In addition, based on economic theory, alcohol consumption is expected to increase with improving economic conditions (20). Therefore, as an indicator of the national economy, we also included monthly national unemployment rates (21). To accurately reflect results at the state level, we weighted each county by its midyear total population. The weights are based on the population size that each observation represents so that each observation contributes the correct proportion of the total when computing the regression parameters (22).

Statistical analyses

Data were analyzed using Stata statistical software version 12.1 (23). To assess the unadjusted effects of the tax increase on alcohol sales, we used multilevel mixed effects linear regression models with beverage-specific gallons of alcohol sold per capita as the dependent variables without additional covariates. Multilevel mixed effects regression models are the most appropriate in this case because these models do not assume that all counties have the same baseline intercept. For the main analysis, we controlled county characteristics (including population density, average income, and unemployment), seasonal variation, and national unemployment rates, using a multiple linear mixed effects regression model with the log of gallons sold per 100 population as the dependent variable, and separate mixed effects models for the three beverage types and total alcohol. The mixed effects models are defined as follows:

$$\log\left(Y_{ij}\right) = \beta_{00} + \beta_1 * \text{TaxStatus}_j + \beta_2 * \text{PopDensity}_{ij} + \beta_3 * \text{Income}_{ij} + \beta_4 * \text{Unemployment}_{ij} + \beta_5 * \text{Seasonality}_j + \beta_6 * \text{NationalUnemployment}_j + \varepsilon_{ij} + u_{0j}$$

where

$j = 1, 2 \ldots 36$ months.

$i = 1, 2 \ldots 24$ counties.

Y_{ij} = the quantity of spirits, beer, or wine sold per 100 population, respectively, for the ith county observed at month t_j.

u_{0j} = month-specific random intercept for the whole state.

β_{00} = overall mean intercept + u_{0j}.

β_1 = Coefficient for post-tax compared to pre-tax, interpreted as the impact of the tax on alcohol sales in percentage terms, since the dependent variable is expressed in log scale.

β_2,β_3,β_4 = Coefficients for county characteristics.

β_5 = Coefficient for seasonal variation.

β_6 = Coefficient for national unemployment rates.

ε_{ij} = Random error of prediction for counties.

The model assumes that that unobserved factors are not correlated with time and county. County characteristics (population, average income, and unemployment rates) and national unemployment rates are either exogenous or predetermined with respect to individual county level alcohol sales. The multilevel model explicitly accounts for the correlation of the error terms across observations within a larger group (24). To evaluate the effects of the tax on overall alcohol sales, we combined the quantities of beer, wine, and spirits sold by converting the three different types of alcohol to a standardized amount of ethanol content – equivalent to 12 oz of regular beer, 5 oz of wine, or 1.5 oz of 80-proof distilled spirits (25).

To examine the robustness of our model specification, we conducted two sensitivity analyses. While controlling for county characteristics and seasonality, we examined the effects of having no national economic indicators, as well as the effect of including annual national gross domestic product (GDP) per capita as a covariate. We obtained data on national GDP per capita from the US Bureau of Economic Analysis (26) and the Census Bureau (27). We tested the models for multicollinearity, estimated by variance inflation factors. We detected high collinearity between national unemployment rates and national GDP, suggesting that the variables acted as similar controls for national economic

conditions. To be conservative with our reported findings, we included national unemployment rates instead of national GDP in the final models. In addition, we did not include national alcohol data as a control in our analyses for two main reasons. First, national data from the Alcohol and Tobacco Tax and Trade Bureau (28) include other states that also had alcohol tax changes (29). Second, national data include a combination of states that have a government mono-poly system for alcohol sales (i.e., control states) and non-control states. Control state pricing has been found to function differently than prices in non-control states (30). These issues interfere with the suitability of using national alcohol data as a counterfactual control for the analyses; therefore, the monthly national unemployment rates are used to control for unmeasured economic factors that influence the volume of alcohol sold.

Results

The average gallons of spirits sold per capita was 20.8 (standard deviation [SD] = 15.7) in the 18 months prior to the tax increase and 20.0 (SD = 10.3) in the 18 months afterward. The overall average gallons of beer sold per capita was 208.7 (SD = 106.8) before the tax increase and 211.0 (SD = 108.8) after the tax change. The average gallons of wine sold per capita was 25.6 (SD = 12.1) pre-tax increase, and 27.2 (SD = 12.5) after the increased alcohol sales tax. In other words, without controlling for any other factors, the volume of per capita spirits sales decreased by 3.9%, but per capita beer sales increased by 1.1% and per capita wine sales increased by 6.3%. Figure 1 shows the beverage-specific average gallons sold per capita when converted to measures of pure alcohol for the 18 months prior to the increased alcohol sales tax and 18 months afterward. After combining the alcohol content of all beverage types together, without controlling for other factors, the average gallons of pure alcohol sold per capita was the same before the increased alcohol sales tax (0.21, SD = 0.11) and after the tax went into effect (0.21, SD = 0.09).

Overall alcohol sales post-tax versus pre-tax

Multilevel mixed effects multiple linear regression, controlling for county characteristics (i.e., population density, average income, and unemployment), seasonality, and national unemployment rates, shows that the alcohol sales tax increase was associated with 5.1% lower sales of spirits in the counties of Maryland in the 18-month period after the increase relative to what would have been expected based on sales trends in the 18-month period before the tax change ($p < 0.001$) (Table 1). Furthermore, in the 18 months after the tax went into effect, sales of beer were 3.2% lower ($p < 0.001$) and wine sales were 2.5% lower ($p < 0.01$) than what would have been expected had there not been any tax changes, controlling for county characteristics, seasonality, and national unemployment. Additionally, when all drinks were converted into the equivalent amounts of pure alcohol, the tax increase was associated with a 3.8% decline in total alcohol sold relative to what would have been expected based on sales trends of total alcohol in the prior 18 months, controlling for county characteristics, seasonality, and national unemployment ($p < 0.001$).

Sensitivity analyses

In the first sensitivity analysis, we did not adjust for national economic conditions and only controlled for county characteristics and seasonality (Table 1). Without controlling for the improving national economy, there were no significant changes in spirits and beer sold per capita after the increased alcohol sales tax relative to beforehand, but there was a 4.4% increase in wine sales per capita ($p < 0.001$) and a 1.4% increase in sales of total alcohol per capita ($p < 0.05$). However, since the national economy is a factor that needs to be considered when assessing trends in alcohol sales from 2010 to 2012, in the second sensitivity analysis, we controlled for national GDP instead of national unemployment rates, in addition to county characteristics and seasonality. In this model, the alcohol sales tax was associated with significant reductions in per capita sales of all beverage types and total alcohol, ranging from 4.6% lower sales of beer to 8.5% lower sales of spirits ($p < 0.001$) relative to what would have been expected from the 18-month sales trend prior to the tax change.

Discussion

These findings show that the three percentage point increase in Maryland's alcohol sales tax was associated with a 3.8% decrease in sales of total alcohol compared to what would have been expected if trends continued from the 18 months prior to the tax change; this observed reduction in alcohol sales is generally consistent with the findings of recent reviews that have assessed the effects of increasing alcohol excise taxes on alcohol sales (6,8). However, in contrast to volume-based excise taxes, sales taxes are value-based and applied at time of final sale so they are not in the shelf price seen by the consumer. Xuan et al. documented the usefulness of assessing both volume- and value-based taxes for predicting binge drinking behavior (14). This study further contributes to the literature on the effects of value-based alcohol taxes, as our findings indicate that Maryland's alcohol sales tax increase yielded significant reductions in sales of distilled spirits, beer, wine, and total alcohol relative to what would have been expected based on trends in sales from the 18 months prior to the tax change.

The finding that the alcohol sales tax increase had a smaller overall effect on beer and wine is likely due to somewhat of a shift in consumption from spirits to beer and wine. Since the tax was applied as a percentage of retail prices, the resulting increases in the price of beer and wine were lower in absolute terms than for spirits. The smaller effects on beer and wine sales may also be explained by the smaller magnitudes of the estimated price elasticity compared to spirits. Other studies have reported that beer consumption is less sensitive to changes in price than other beverage types (8,31). Although the price elasticities likely vary when taking into account sales taxes (14), the Guide to Community Preventive Services review found that price elasticity for beer and wine was smaller in absolute terms compared to spirits, with elasticities of −0.50 for beer, −0.64 for wine, and −0.79 for spirits (6).

The decreasing trend of national unemployment rates largely contributed to the differences between the unadjusted and adjusted models in this study. The national economy improved during the 2010–2012 time period of this study, and thus, rates of national unemployment decreased. As a result, controlling for national unemployment rates in the analyses

contributed to a greater measured negative effect of Maryland's increased alcohol sales tax on sales of alcohol. Our sensitivity analyses showed that the inclusion of national unemployment rates as the control for the improving national economic conditions was a conservative approach, as the magnitude of the observed reductions in alcohol sales associated with the increased alcohol sales tax were substantially larger when a measure of national GDP was included in the models. Furthermore, our sensitivity analyses also demonstrated that the improving economic conditions at the national level largely explain the observed reductions in per capita alcohol sales after the increased alcohol sales tax relative to what would have been expected in the absence of an alcohol sales tax increase. The importance of controlling for national economic conditions in our models suggests that the increased alcohol sales tax in Maryland slowed increasing trends in per capita alcohol sales in the state's counties from January 2010 to December 2012.

In addition, it is possible that the underlying relationships among average income, population density, alcohol prices, and alcohol sales may change over time, in which case our findings could misinterpret a reduction in alcohol sales as being attributable to the tax increase when in fact it may be due to a change in one or more of these relationships. However, we do not suspect that this type of change in the underlying relationships, known in statistical terms as non-stationarity, is likely to be a problem in our analyses. The relationships among average income, population density, alcohol price, and alcohol sales are unlikely to change substantially over a relatively short time period (36 months), except in the presence of an external stimulus, such as a substantial increase in the alcohol sales tax.

There are some limitations to our analyses. The outcome measures are based on sales data, which may be subject to reporting errors. Additionally, some of the data on gallons of alcohol sold may not accurately represent the monthly sales estimates, due to the state's recording procedure. If the counties reported adjustments to correct for reporting inaccuracies in earlier months, the state combined the adjusted reported gallons with that month's gallons of sales. However, there is no reason to believe that the pattern of adjustments differed before versus after the increased sales tax; thus, it is not likely that reported adjustments introduced biases in the results. Further, this study looked only at sales of alcoholic beverages. Based on prior research, it is reasonable to expect that lower alcohol sales relative to what would have been expected based on trends in sales from the 18 months prior to the alcohol sales tax increase translated into the reduction of negative consequences associated with excessive alcohol use, such as sexually transmitted diseases or motor vehicle crashes (9,32). In fact, a recent study found that Maryland's increased alcohol sales tax was associated with fewer annual cases of gonorrhea across the state than would have been expected given trends in that disease statewide (33).

Nonetheless, it is possible that some people crossed the state border to purchase alcohol (34–37). Thus, while we cannot be certain that there was an overall reduction in alcohol consumption and related adverse outcomes associated with the lower than expected sales of alcohol, a separate analysis of the impact of the alcohol sales tax on gonorrhea rates did find a significant effect, which is suggestive of a drop in the level of alcohol consumption compared to what would otherwise have been expected (33). We were not able to assess the impact of the increased sales tax on cross-border shopping because we did not have data on

the specific locations in each county where alcohol was sold. Some counties share a border with more than one state, and in a few counties, alcohol taxes are higher in one border state but lower in another state (varying by type of alcohol) (13) – making the use of county-level data to assess cross-border shopping problematic. Moreover, we did not have information on the average price of each type of alcoholic beverage in the bordering states to look beyond comparative alcohol tax rates.

To our knowledge, this is the first study that has evaluated the effects of a state-specific alcohol sales tax increase on beverage-specific alcohol sales. We found that after controlling for other factors, a three percentage point increase in the Maryland alcohol sales tax was associated with less alcohol sold relative to what would have been expected if trends from the previous 18 months had continued. Our findings point to differential effects of the alcohol sales tax on various types of alcoholic beverages – with the greatest reduction in sales of spirits per capita. Future studies could examine the effects of alcohol sales taxes directly on other alcohol-related harms, such as motor vehicle crashes, rather than on alcohol sales; any difference between alcohol sales and consumption may have important public health policy implications.

Conclusion

Following Maryland's increased alcohol sales tax from 6% to 9%, this study found significant reductions in alcohol sales for all types of alcoholic beverages relative to what would have been expected if trends from the 18 months prior to the tax change had carried on. These findings add to prior literature, suggesting that in addition to excise taxes, raising alcohol sales taxes may be an effective strategy for reducing excessive alcohol consumption and related problems. Sales taxes also have the added advantages of rising with inflation and taxing the highest priced beverages most heavily. Our study encourages further research on the potential public health benefits of increasing alcohol sales taxes in other states, as well as in other countries.

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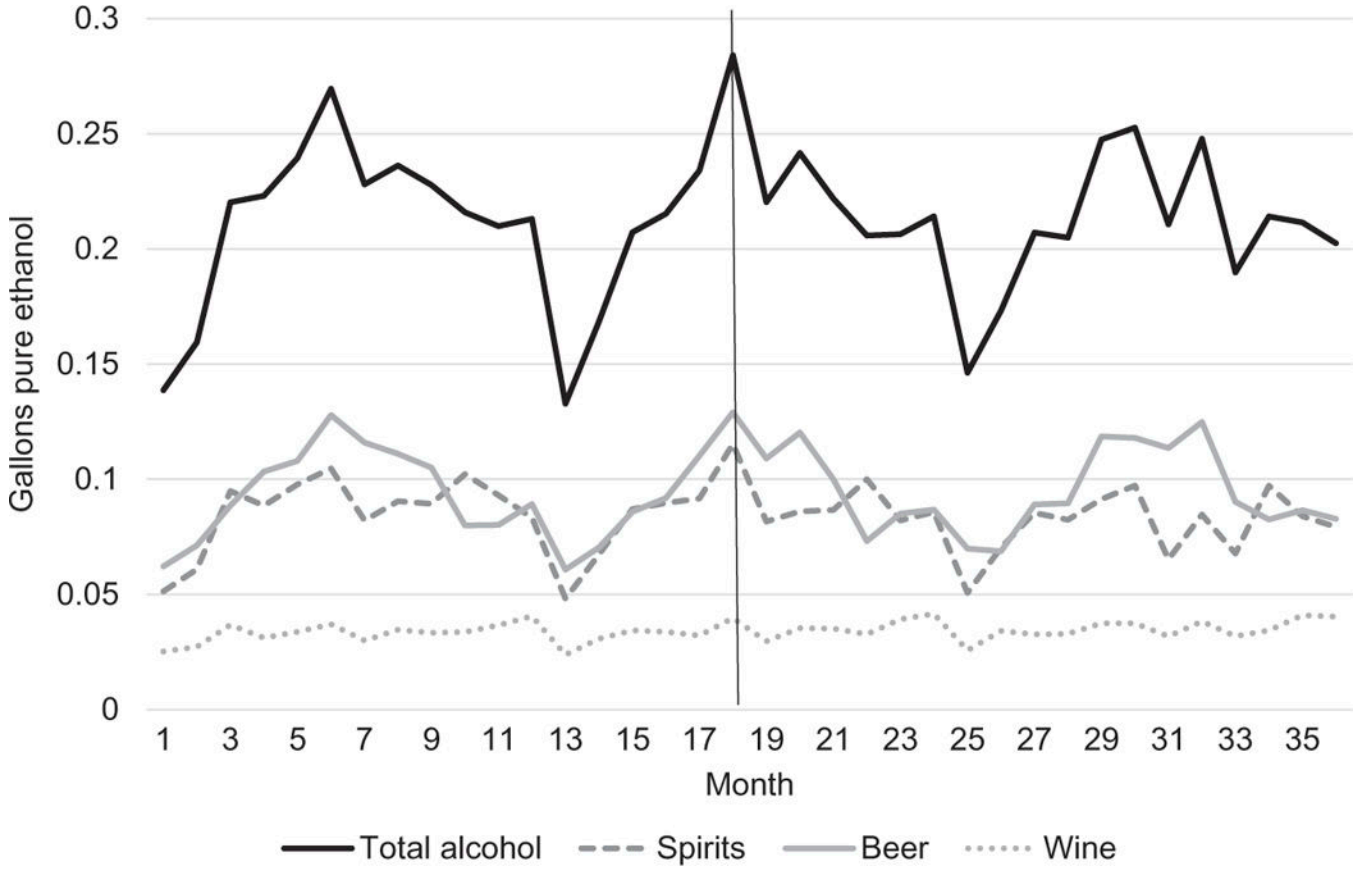

Figure 1.
Average gallons of alcohol (in pure ethanol) sold per 100 population (aged 15 years and older) by month, Maryland, 2010–2012.

Table 1.

Effects of tax increase on average gallons of alcohol sold[a].

Model	Type of alcoholic beverage			
	Spirits % change (95% CI)	Beer % change (95% CI)	Wine % change (95% CI)	Total alcohol % change (95% CI)
Unadjusted[b]	**4.51 (2.15, 6.87)** ***	0.14 (−0.38, 0.66)	**5.26 (3.60, 6.93)** ***	**2.87 (1.72, 4.02)** ***
Adjusted for county characteristics, seasonality, and national unemployment[c]	**−5.10 (−7.38, −2.82)** ***	**−3.15 (−3.83, −2.48)** ***	**−2.48 (−4.14, −0.83)** **	**−3.78 (−4.82, −2.74)** ***
Sensitivity analyses Adjusted for county characteristics and seasonality[d]	2.00 (−0.49, 4.41)	−0.56 (−2.15, 1.02)	**4.42 (2.89, 5.94)** ***	**1.42 (0.07, 2.78)** *
Adjusted for county characteristics, seasonality, and national GDP[e]	**−8.49 (−10.58, −6.39)** ***	**−4.59 (−5.22, −3.96)** ***	**−6.03 (−7.70, −4.36)** ***	**−6.50 (−7.48, −5.52)** ***

CI: Confidence interval; boldface indicates statistical significance

* $p < 0.05$;

** $p < 0.01$;

*** $p < 0.001$.

[a] Gallons of beverage-specific alcohol sold per 100 population aged 15 and older, based on midyear population estimates.

[b] Assessed using multilevel mixed effects linear regression models with beverage-specific gallons of alcohol sold per capita as the dependent variables without additional covariates.

[c] Adjusted for county characteristics (population density, average income, and unemployment rate), seasonality, and national unemployment rates.

[d] Adjusted for county characteristics (population density, average income, and unemployment rate), and seasonality.

[e] Adjusted for county characteristics (population density, average income, and unemployment rate), seasonality, and national gross domestic product (GDP) per capita.

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