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Estimated increase in cross-border purchases by Washington residents following liquor privatization and implications for alcohol consumption trends

Yu Ye and William C. Kerr

Alcohol Research Group, Public Health Institute, 6475 Christie Ave., Suite 400, Emeryville, CA, 94608, USA

Abstract

Aims—To estimate changes in liquor sales occurring in Washington, USA and bordering states following the privatization of government controlled liquor stores.

Design—Trend analyses of data from January 2009 to October 2014 of a natural experiment beginning 1 June 2012 when liquor prices increased and the number of stores selling liquor increased in the state of Washington. Difference-in-differences (DID) models and interrupted time series methods were used.

Setting—Washington and bordering counties in Oregon and Idaho.

Measurements—Monthly liquor sales in 9 liter cases.

Findings—DID model estimates of adjusted change in liquor sales as a result of privatization produced a cross-model average increase of 10.1% in Oregon and 8.2% in Idaho (both $p < 0.001$). Similar results were found using interrupted time series. This represents a total loss to Washington of 89,865 liters of liquor, 0.226% of total Washington sales, for June 2012 to May 2013. Adding these sales to Washington totals for fiscal 2013 and 2014 we find that per capita spirits sales were 5.80 liters in both 2012 and 2013, declining slightly to 5.76 liters in 2014.

Conclusions—The privatization of liquor sales in the state of Washington, USA in 2012 and the price increases associated with this resulted in a significant increase in sales in bordering counties in the states of Oregon and Idaho. However, the amount of alcohol sales and revenue lost by Washington was relatively small. Per capita liquor sales in Washington appear to have remained flat after privatization.

Introduction

The privatization of Washington's state liquor stores began in June 2012 when alcohol purchases began in licensed outlets. In November of 2011 voters approved Proposition 1183 authorizing this change and implementing a regime of taxes and fees designed to replace the revenues generated by the state stores. These taxes include a number of different elements

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yye@arg.org.

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but can be summarized as fees equal to 10% of the wholesale price (paid by the distributor) plus 17% of the retail price (paid by the retailer), with both of these included in the retail price. Additionally there are further taxes on top of the retail price of 20.5% plus \$2.83 per 750ml bottle. These taxes on top of the retail price are listed on each price label (as required by 1183).

Our study of price changes after privatization found that prices rose by 15.5% for a six brand index of 750ml containers and 5.5% for a five brand index of 1.75L containers. (1) The study also found wide variation by brand and store type with cases ranging from reductions in price of over 25% to increases of over 60%. These price changes contrast with relative stability in the neighboring states of Oregon and Idaho, where average price increases were 1.9% and 1% respectively for the 750ml size and 5.5% and 1.8% respectively for the 1.75L size. These changes indicate a general widening of price differences between states with the exception of 1.75L containers for Oregon. Washington now has highest tax rates on spirits in the US with a wholesale excise tax equivalent estimate of \$25.42 per gallon of spirits for 2012 compared to estimates of \$6.48 for Idaho and \$10.44 for Oregon, the third highest rate in the US.(2)

This study examines the impact of the Washington privatization on cross-border purchasing in Oregon and Idaho by Washington residents. Washington also shares a border with British Columbia in Canada but alcoholic beverage prices there are substantially higher and cross-border traffic is incentivized in the opposite direction as well as being limited by the international border crossing. Privatization has substantially increased the number of stores selling liquor in Washington from 333 to about 1,500, which is expected to reduce cross-border effects relative to a situation where only prices changed. Washington already had higher prices than Oregon and Idaho before privatization, about 20% higher for the 1.75L size and 10-15% higher for 750 ml size. After privatization for 1.75 5-brand index Washington was 29% higher than Idaho and 17% higher than Oregon. The 6 brand index for 750ml bottles was 30% higher than Idaho and 23% higher than Oregon. (2)

Two separate analyses have evaluated the impact of the Washington privatization on cross-border purchasing in terms of dollar sales. Both utilized methodologies comparing changes in sales in border stores or counties with changes in non-border areas. A study of Oregon liquor store sales found that those closest to the border with Washington had an additional 21% increase in sales compared to interior stores. (3) A study of Idaho liquor store sales after privatization found that there was a 10% increase, corresponding to \$4.86 million in gross receipts, in counties that border Washington. (4) Our analyses goes further by evaluating changes in spirits volume, rather than dollars spent, as this metric is more relevant to implications for per capita consumption of alcohol in Washington. Analyses also consider data from both Idaho and Oregon and utilize multiple analytic methods with potential casual interpretations, difference-indifferences (DID) models and interrupted time series models. This study aims to evaluate the impact of privatization in Washington on spirits sales in bordering counties of Idaho and Oregon. We will also frame the results in terms of lost sales and revenues in the state of Washington, adding the estimated increase in cross-border sales to per capita apparent consumption estimates to document changes in spirits consumption by Washington residents following the June 1, 2012 privatization.

Methods

Data

Liquor sales data in counties from Oregon and Idaho were derived from the Statistics for Alcohol Management Database (SAM) database compiled by National Alcohol Beverage Control Association (NABCA). NABCA regularly collects the sales information of controlled beverages such as brand, size, class and price for all control states including Oregon and Idaho. For Oregon, Idaho and Washington (to May of 2012), the database includes store and county-level sales of all liquor products, including those to bars and restaurants. For this study, monthly liquor sales (in 9L cases) from January 2009 to Oct 2014 were analyzed to examine how the Washington's liquor privatization starting June 1st 2012 affected liquor sales in Oregon and Idaho, considering counties that border and do not border Washington separately. The nine border counties in Oregon are Clatsop, Columbia, Gilliam, Hood River, Morrow, Multnomah, Sherman, Umatilla and Wasco, and the six border counties in Idaho are Benewah, Bonner, Boundary, Kootenai, Latah, and Nez Perce.

Measures

The outcome measures are the logged values of monthly spirits sales in the border and off-border counties of Idaho and Oregon, both separately and grouped depending on the specification, and for the state of Washington. Month and year indicators are also included in some specifications.

Analyses

Two types of statistical models have been commonly used to evaluate the effect of a natural experiment introduced by a policy change such as the Washington liquor privatization. One approach is the difference-in-difference (DID) model in which the pre- and post-intervention differences are examined for both treated and control groups (5). In the current study, the border counties will be considered the treated group, while the off-border counties constitute the control group. The model can be expressed as $\ln(\text{sales})_{it} = \alpha_i + \delta_t + I_{it}\psi + e_{it}$, where α and δ represent fixed effects for county and time, and I_{it} is an indicator variable coded 1 for border county i for time t after Washington privatization, and ψ is thus the estimated change in liquor sales of border counties as an effect of Washington privatization after controlling for liquor sales in the off-border counties. Since autocorrelation and large differences in cross-county variance were observed, a generalized least squares model is used to fit the cross-sectional time-series data in which each observation represents a county in a given year, as in analysis of similar data. (4) Alternatively, a simple regression model is used where all border (off-border) county sales in the same month of a year are combined to one observation in the analysis, thus α_i above becomes an indicator variable for border versus off-border. Very similar results were derived for the two different data formats and regression models.

The second method employed is interrupted time-series analyses, which has been widely used in studies of alcohol-related policy effects (6, 7). Built on the versatile autoregressive integrated moving-average (ARIMA) model, the method explicitly models all aspects of the autocorrelation structure of the series, using AR or MA terms, and accounts for variability

due to identifiable trends, most commonly by using first-order differencing to de-trend the series. The model can be written as $Y_t = f(I_t) + N_t$, in which N_t is the noise component described by the ARIMA model and $f(I_t)$ is the transfer function from which various intervention effects can be defined (8). In this study, the ARIMA model is specified as $(p,d,q)(P,D,Q)_{12}$, where the first part represents the non-seasonal order of the autoregressive parameter (p), order of differencing (d) and order of the moving-average term (q), while the second part shows the same parameters in the seasonal ARIMA model for the monthly data.

There are two major differences between the DID model and Interrupted ARIMA model. First, DID model assumes a deterministic time trend, i.e. treating time as fixed effects, while the ARIMA model assumes a stochastic process, which could be stationary or non-stationary. When unit root tests (i.e Augmented Dickey-Fuller test) as well as the examination of observed autocorrelation function (ACF) patterns suggests the time-series data is non-stationary, first-order differencing (and/or seasonal differencing for quarterly/monthly data) is usually performed to de-trend the data. While there are tests designed to distinguish deterministic versus stochastic trend, these tests tend to have low power and researchers are recommended to use substantive theory to help with model selection. (9) As both DID and ARIMA models have been widely used for similar data, we present both to highlight the robustness of the findings. Second, for the DID model, the intervention effect is estimated after adjusting for the control group, off-border sales in this analysis. In the interrupted ARIMA model, border and off-border data are analyzed separately, with non-significant changes expected for the off-border data.

Results

Figure 1 shows total monthly liquor sales for Oregon and Idaho counties that border Washington and those that do not from January 2009 to October 2014 as well as liquor sales for the whole state of Washington during this period. Clear seasonal patterns were observed with sales peaking in December. Moderate increases in liquor sales after the Washington privatization were also observed in the border counties.

Before fitting statistical models, descriptive analysis were performed to examine the change in liquor sales from the year before the Washington liquor privatization to the year after and results are shown in Table 1. Since the initiative took effect on June 1st, 2012, we used 2011-06 to 2012-05 as the pre-period and 2012-06 to 2013-05 as the post-period. Comparing pre- and post-periods, total liquor sales in Oregon border counties increased by 10.4%, in contrast to a 2.3% increase in Oregon off-border counties. Similarly there was an 11.7% increase in liquor sales for Idaho border counties, versus a 3.4% increase in off-border counties. After adjusting for off-border change, the net change for Oregon and Idaho border county liquor sales was an increase of 7.9% and 8.1%, respectively.

Table 2 shows results from the DID models. When analyses were performed at the county level (i.e. treating counties as fixed effect), the coefficients for the adjusted change in border county liquor sales ranged from 0.095 to 0.097 for Oregon, based on whether the time fixed effects were modeled as time dummies or as year/month dummies. When all border or off-border sales were combined, the estimates ranged from 0.095 to 0.098. Since the sales

outcome was log-transformed, the coefficient estimates may be approximated as a percentage change, or more exactly be transformed by $e^{\beta}-1$. Thus the effect of Washington privatization on Oregon border county liquor sales was estimated to range from 10.0% to 10.3%. For Idaho, the estimates of change in adjusted liquor sales after the Washington privatization ranged from 7.7%-8.7%, based on how counties were treated in the analysis and how the time effect was modelled. As shown in Table 2, all coefficient estimates in the DID models were significant at $p<0.001$ level. Note that the DID model assumes that pre-intervention trends are similar between the treated and control groups, as can be observed in Figure 1. To confirm, likelihood ratio tests for pre-intervention data show that interactions between time and border were not significant ($p>0.80$) suggesting that differential time trends were not observed. Finally, Washington state liquor sales in 9 liter cases were 364,276 and 368,958 for the 12 months periods before (2011-06 to 2012-05) and after privatization (2012-06 to 2013-05), respectively, reflecting a 1.3% increase (not shown). Finally, when Washington state liquor sales were compared to combined Oregon and Idaho non-border sales, the effect of privatization on Washington was estimated as -0.011 (95% CI -0.03 to 0.01) using the DID model (not shown).

Findings from the ARIMA model are presented in Table 3. Estimates assume a zero-order permanent impact function, a permanent step change from June 2012, and are thus comparable from estimates from the DID models. Time-series data for border and off-border liquor areas were analyzed separately. The coefficient estimates represent changes of 10.3% and 11.4% increase for the Oregon and Idaho border counties, respectively. For the off-border areas, the estimated change from June 2012 was 2.6% for Oregon and 2.7% for Idaho, neither estimate was significant. Last, the non-significant coefficient estimate was 1% for Washington. While the ARIMA model estimates are quite consistent with findings from the descriptive analysis (Table 1) and DID models (Table 2), the models fit based on ARIMA model diagnosis such as Ljung-Box test were not optimal for either Oregon or Idaho. This poor model fit suggests the data generation process assumed by ARIMA models cannot fully capture the movement of these time series data, leading us to consider these ARIMA models mainly as a sensitivity analysis.

Finally, we utilize our results to estimate the impact of privatization on liquor sales in Washington in terms of the amount of alcohol bought in Oregon and Idaho. Based on the DID model estimates of adjusted change in liquor sales as a result of privatization, which range from 10.0% to 10.3% for Oregon and 7.7% to 8.7% Idaho, and taking the midpoint of these ranges, we estimate an increase of 10.1% in Oregon and 8.2% in Idaho. Considering the whole years liquor sales in the border counties (Jun 2011 to May 2012), these percentage changes translate to a total increase of 89,865 liters of liquor for June 2012 to May 2013. Liquor sales in Washington during this same period totaled 39,847,458 liters, so the estimated loss in sales to Oregon and Idaho represents 0.226% of total Washington sales.

Adding these lost sales to per capita liquor consumption estimates for Washington indicates of trend from 39,545,004 liters of spirits in fiscal year 2012 (Jun 2011 to May 2012), before privatization, to 39,937,323 liters in fiscal year 2013 and 40,141,469 liters in fiscal year 2014. This translates to 5.80 liters per capita (all ages) for 2012, 5.80 liters again in 2013 and 5.76 liters per capita for 2014. (10)

Recent official statistics through the 2013 calendar year show Washington trends for apparent per capita consumption of pure alcohol from all sources among those aged 14 and older declined from 8.82 liters per capita in 2009 to 8.37 liters in 2011, then rose to 8.52 liters in 2012 followed by a small decline in 2013 to 8.48 liters. Reduced beer consumption in 2010 and 2011 following a large beer tax increase in 2010 was the main source of this decline. Consistent with our calculations for recent fiscal years above, spirits consumption fell from 2.8 liters of ethanol per capita in 2009 to 2.76 liters in 2010 before rising to 2.84 liters in 2011 and then to 2.88 liters in 2012 where it remained in 2013. This pattern of declining per capita consumption over this period in Washington contrasts with an increasing trend in the US as a whole where there was a similar pattern of consumption shifting from beer to wine and spirits with per capita spirits increasing from 2.8 to 3.03 liters of ethanol per capita ages 14 and older. (11) Trends in per capita consumption for Oregon and Idaho also show rising consumption from 2010 to 2013 with a shift toward wine and spirits. Notable increases in per capita spirits sales of about 5% are seen from 2011 to 2012 in both states, confirming the impact of Washington consumers on bordering states.

The amount of tax and fee revenue associated with the cross-border sales would have been \$1,086,314 a year (based on 89,865 liters and \$12.09 per liter average revenue estimate; 6.64 per liter from taxes and 5.45 per liter from fees) for Washington and was instead \$523,113 (based on 70,560 liters and \$7.41 per liter revenue estimate) for Oregon and \$134,799 (based on 19,305 liters and \$6.98 per liter revenue estimate) for Idaho. (2)

Discussion

Our results indicate that the June 2012 privatization of the liquor monopoly resulted in increased cross-border traffic by Washington residents to buy liquor in both Idaho and Oregon. While these increased sales represented significant revenues for Idaho and Oregon, the amount of alcohol sales lost by Washington was only a small proportion of total liquor sales volume, about a quarter of one percent. While the loss of revenue to Washington is not trivial it represents less than a quarter of a percent of revenues from spirits for fiscal 2013. In this context, efforts to reduce tax and fee rates in Washington for the purpose of reducing cross-border sales would very likely results in reduced overall revenues from liquor. We note that we did not consider potential changes in cross-border sales in Washington to Canadians, which could have declined. However, the price differential between Washington and bordering British Columbia remained large and such sales are limited by the time and travel costs associated with the international border.

Our analyses utilized multiple methods and control areas in two bordering states and the consistency of findings across these provides strong evidence for both the existence and size of cross-border sales effects. Our estimates are also consistent with those from previous studies focused on dollar sales where substantial and significant increases in border stores and counties were found. (3, 4) However, when we contextualize the volume of cross-border sales in terms of Washington liquor sales the impact on Washington consumption estimates and revenues is relatively small. An earlier study of retail liquor privatization in Iowa utilizing a population survey asking about cross-border purchasing did not find a significant change in this from an estimated 6% price increase.(12) Together these studies confirm the

reality of cross-border purchases while also finding that they are small relative to overall sales. This suggests that neither the loss of revenue or impact on consumption estimates amount to major problems requiring actions such as increased enforcement at the borders or tax reductions.

A 2012 study found that states with private retail stores selling liquor had slightly (6.9%) lower prices than states with government control of liquor sales. (13) This small price difference is accompanied by substantially higher revenues from spirits in control states, (2) consistent with our group's finding that liquor prices increased after the privatization in Washington where taxes were implemented to maintain revenues from liquor sales. (1) While there is strong evidence that higher prices are associated with reduced alcohol consumption and related outcomes, they also spur efforts by drinkers to avoid reducing consumption such as quality downgrading, context shifting and cross-border purchasing. (12, 14, 15) Meta-analyses from 112 studies confirm that there are negative relationships between alcoholic beverage prices and alcohol consumption, including heavy drinking. (16) Findings include a higher price elasticity estimate for spirits, -0.80 , while beer is less responsive at -0.46 . This could suggest that spirits drinkers are more willing or able to reduce consumption or shift to other beverage types rather than engage in avoidance behaviors such as cross-border shopping. Cross-border shopping is also limited by the population's proximity to the border. In Washington less than 20% of the population lives in counties bordering either Idaho or Oregon. Thus, our results are not necessarily generalizable to states or countries with different population distributions, tax differentials or availability of liquor in terms of store types and outlet density. However, in the US context, cross-border price differentials of 20-30% are relatively large suggesting that while cross-border purchases are a real phenomenon they are not a major concern for tax policy.

Our findings also show that even when including estimated cross-border sales of liquor to Washington residents per capita apparent consumption of liquor based on sales did not increase or decrease in Washington during the year following privatization. This suggests that the substantial increase in liquor availability was countered by the general rise in prices, at least in the short term. Further research is needed to document potential changes in drinking patterns and related harms that may have occurred as measures of sales cannot provide details on population sub-groups and the patterns in which the alcohol was consumed, which can be relevant to alcohol-related health and social problems.

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Figure 1.

Total Monthly Liquor Sales (in 9 liter cases) for Oregon and Idaho from January 2009 to October 2014 for Counties that Border and those that are off-border in relation to Washington as well as the Sales for the whole Washington State during the same period. Vertical Line is time of the Start of Washington Liquor Privatization (June 2012).

Table 1

Change in liquor Sales for Oregon and Idaho in Border and Off-border Counties after the 2012 Washington Liquor Privatization

	Oregon	Idaho
Border counties		
Pre-privatization monthly average sales (9L cases) ¹	77,623	26,154
After-privatization monthly average sales (9L cases) ²	85,689	29,219
Percentage change (%)	10.4	11.7
Off-border counties		
Pre-privatization monthly average sales (9L cases) ¹	158,654	53,021
After-privatization monthly average sales (9L cases) ²	162,272	54,800
Percentage change (%)	2.3	3.4
Additional percentage change of border counties after adjusting for Off-border change (%) ³	7.9	8.1

¹ Average of monthly sales from 2011-06 to 2012-05

² Average of monthly sales from 2012-06 to 2013-05

³ The adjusted rate = $(1 + \text{border rate}) / (1 + \text{Off-border rate}) - 1$

Table 2

Difference-in-Difference Model Estimates and 95% Confidence Intervals of the Net Change in Log-transformed Liquor Sales of Border Counties Adjusting for Off-border County Sales

	Oregon	Idaho
By counties ¹	(n = 2,450)	(n = 3,500)
Model 1: controlling for time dummies	0.097 *** (0.083, 0.111)	0.074 *** (0.050, 0.098)
Model 2: controlling for year and month dummies	0.095 *** (0.081, 0.110)	0.077 *** (0.055, 0.100)
By border and off-border regions ²	(n = 140)	(n = 140)
Model 1: controlling for time dummies	0.098 *** (0.085, 0.110)	0.081 *** (0.049, 0.113)
Model 2: controlling for year and month dummies	0.095 *** (0.074, 0.115)	0.083 *** (0.055, 0.111)

¹Counties are entered as fixed effects in the model

²border region as compared to off-border region

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p<0.001

Table 3

Interrupted Time-series ARIMA Model Using Zero-order Permanent Impact Function on log-transformed Liquor Sales of Oregon and Idaho Border and Off-border Counties

	Oregon	Idaho
Border	(n = 70)	(n = 70)
Coefficient (standard error)	0.098 (0.015) ***	0.108 (0.016) ***
ARIMA model specification	(0,0,1)(0,1,0) ₁₂	(0,1,1)(0,1,0) ₁₂
AR	-	-
MA	0.23 (0.11) *	-0.79 (0.07) ***
Off-border	(n = 70)	(n = 70)
Coefficient (standard error)	0.026 (0.023)	0.027 (0.021)
ARIMA model specification	(1,1,0)(0,1,0) ₁₂	(1,1,0)(0,1,0) ₁₂
AR	-0.69 (0.10) ***	-0.56 (0.11) ***
MA	-	-

***
p<0.001

*
p<0.05