Abstract

This paper uses store-level data on consumer liquor revenues and volume sales in Oregon to estimate the effect of state tax differentials on consumer demand. Liquor privatization in Washington led to higher prices from new taxes. I calculate the impact of tax incidence on tax avoidance using variation in store proximity to the Washington-Oregon (WA-OR) border. By calculating driving distances between Oregon liquor stores and border crossings, I find that stores closest to the WA-OR border experienced an additional 20 percent increase in revenues relative to interior stores, and that avoidance behavior dissipates monotonically from the Washington-Oregon state line.

JEL: D40, H20, H21, H22, H26, L10

Keywords: Tax avoidance, tax incidence, cross-border shopping, alcohol.

Driving to Drink: Tax Avoidance Along the Washington-Oregon Border

Katherine LoPiccalo*

April 13, 2016

*Economist, Federal Communications Commission, 445 12th St. SW, Washington, DC 20554, lopiccalo.katherine@gmail.com. This paper was completed in my personal capacity. The views expressed are my own and do not necessarily represent the views of the Federal Communications Commission or the United States Government. All errors are my own. I would like to thank Carlos Dobkin, Justin Marion, Jonathan Robinson and Jesse M. Cunha for their guidance and support. I also appreciate helpful comments from Curtis Kephart, Shilpa Aggarwal and seminar participants at the University of California, Santa Cruz. I would also like to thank staff at the Oregon Liquor Control Commission and Washington State Liquor Control Board for background information and data.

Liquor is an economically significant, easily transported and widely used commodity subject to differential tax rates (Beard, Grant and Saba, 1997). Variation in taxation may affect not only consumption activity, but shopping location decisions. Examining consumer tax avoidance in the context of cross-border shopping for alcohol is therefore important for several reasons. Consumers may take advantage of price differentials by transporting commodities across borders, and price differentials may be a factor in explaining variation in state-level demand for alcohol. Border effects may also reduce overall consumer welfare if resources wasted by avoidance exceed the benefit of consumption changes (Lovely, 1994).

Governments have a significant interest in the regulation of alcohol. If raising the price of alcohol lowers per-capita consumption, the incidence of social and health problems commonly associated with excessive consumption may also fall. Avoidance strategies can reduce the effectiveness of government regulation, in addition to diminishing the tax base and the revenue-generating potential of liquor tax increases. In the cross-border context, avoidance strategies may impose real costs on the part of the consumer. Traveling across borders represents a time and resource investment which may be additionally borne by society. As taxes on alcohol change relatively infrequently, examining cross-border shopping may help inform government policy. Consumer response may also depend on the availability of avoidance opportunities. Consumers located near borders with significant differential tax rates may modify their purchasing behavior enough to alter equilibrium prices (Slemrod and Yitzhaki, 2002).

The findings contribute to a body of literature assessing the impact of tax avoidance on cross-border alcohol sales. Beard, Grant and Saba (1997) rely on state-level variation in prices in major cities to estimate the extent to which tax differentials produced border crossing for alcohol in the U.S. from 1989 to 1993. The authors find evidence of cross-

border sales for a representative beer product but not for the representative liquor product. However, prices may be endogenous if they are set by retailers in the context of changing demand. Using variation in state excise taxes, Stehr (2007) finds that 20 percent to 40 percent of the elasticity for spirits stems from displacement of sales across state borders, rather than decreases in home-state consumption. Asplund, Friberg and Wilander (2007) use variation in relative liquor prices from major tax changes and volatile exchange rates to show that price elasticities in Sweden decrease in distance to the border with Denmark.

Ye and Kerr (2015) examine the impact of privatization in Washington state on cross-border shopping using county-level volume sales data for Oregon and Idaho. The authors find a sales increase of 10 percent in counties border Washington. Winfree and Watson (2015) study the impact of Washington privatization on Idaho liquor stores in bordering counties, and find an increase in Idaho counties bordering Washington of approximately 10 percent. This paper builds on this work in several respects. I observe store-level consumer revenue and estimate the effect of the exogenous change in taxes by store proximity to the border. By calculating driving miles between stores and crossings, I more accurately estimate cross-border shopping effects as well as test the hypothesis that stores located closest to the border experienced the largest sales increases. I find that sales increases are strongest for the first group of stores located near border crossings, and that this effect declines monotonically for stores located farther away from the Washington-Oregon state line. In secondary analysis, I classify store-level sales by item, including brand name and spirits category. Therefore, I am able more accurately identify the nature of substitution for consumers crossing the border to take advantage of the price difference.

There is a large related literature on cross-border shopping in other contexts, including employment (Fox, 1986; Thompson and Rohlin, 2013), grocery store sales (Walsh and

Jones, 1988; Tosun and Skidmore, 2007), Internet shopping (Goolsbee, 2000; Alm and Melnik, 2012), cigarettes (Lovenheim, 2008; Merriman, 2010; Goolsbee, Lovenheim and Slemrod, 2010), state lotteries (Garrett and Marsh, 2002; Knight and Schiff, 2012), and gasoline sales (Chan, Padmanabhan and Seetharaman, 2007; Doyle and Samphantharak, 2008). Overall, this literature finds that price elasticities for commodities vary with the distances consumers travel to markets with lower prices and the density of populations in areas along the border. In the case of online shopping, consumers in high sales tax areas are significantly more likely to buy online, and tax elasticities are higher in states with higher Internet penetration.

The paper proceeds as follows. Section 2 describes the retail alcohol market in Washington that led to privatization and examines the price differential with Oregon. A description of the Oregon sales data is presented in Section 3. The empirical strategy is presented in Section 4. The main empirical findings are covered in Section 5; in Section 5.1, I present several robustness checks. Finally, Section 6 concludes.

1 Institutional Background

On Nov. 8, 2011, Washington residents voted to end the state's nearly 80-year monopoly over the retail sale and distribution of liquor within the state.

Before the initiative passed, Washington had been one of 19 "control" states in the U.S., all of which strictly regulate the sale and/or distribution of alcoholic beverages within their borders. The Washington State Liquor Control Board (WSLCB) had been the sole distributor and primary retailer of liquor in Washington since the end of Prohibition.[1] Distribution

[1] Formed in 1933 by the Steele Act.

for the entire state was overseen by one entity, the Seattle Distribution Center. Consumer sales were met through a system of approximately 167 state-run liquor stores and 161 specially licensed "contract" stores, which were operated by independent contractors who earned a flat commission on all liquor sales.

1.1 Liquor pricing

Under Washington's publicly run system, uniform pricing had been imposed on all liquor sold by the state —prices for any given product were the same from store to store. The average price for a 750 ml bottle of liquor in the year prior to privatization was $16.36.[2] According to the WSLCB, the final price on a bottle of spirits under the public system consisted of the distiller's wholesale price to the board, federal taxes (excise taxes on all liquor, plus custom duty rates on imported liquor), average freight or transportation costs, the state's markup, and state sales taxes. Washington had imposed a markup of 51.9 percent on the wholesale liquor price, which covered operating costs of the state system. Any residual profit from the markup was shared by state and local governments. Consumers also paid a spirits sales tax (SST) of 20.5 percent on all liquor, as well as an excise tax of $3.7708 a liter (spirits liter tax, or SLT).

Washington liquor prices increased approximately 11 percent in the year following privatization. I find that the average price for a 750 ml bottle of liquor increased to $18.23.[3] Under the private system, consumers pay the same rates on the SST and SLT, but private distributors and retailers set their own markup. In addition to excise taxes and new markups,

[2] June 2011 through May 2012. Figure 1 shows average monthly consumer liquor prices in Washington the year before and after privatization.

[3] June 2012 through May 2013. Figure 1 shows average monthly consumer liquor prices in Washington the year before and after privatization.

the state imposed new retailer and distributor licensing fees. I-1183 mandated that private distributors pay 10 percent of all gross spirit revenue to the state for the first two years of privatization, and 5 percent of revenue thereafter. Private retailers pay 17 percent of all gross spirit revenue to the state.[4]

According to the liquor board, the state had expected a private sector mark-up of between 52 percent and 72 percent on spirits. The state also estimated I-1183 would result in 1,428 total retail liquor outlets. Combined with the SST, the SLT, new markups, and the new licensing fees, average prices have substantially increased for consumers. Figure 1 shows monthly average per liter consumer liquor prices in Washington the year before and after privatization. The graph depicts a sharp increase in average prices after June 1, 2012. Overall, the figure shows higher average prices in each month after privatization, compared to the previous year's month under the state-run system.

Oregon and Idaho are both alcohol "control" states. In Oregon, retail sales are overseen by the Oregon Liquor Control Commission (OLCC) and regulated through a system of 250 retail outlets. The state owns all distilled spirits in the state liquor stores, while independent contractors (the liquor store operators) are appointed by the commission and are responsible for the stores' daily operations. Liquor store operators and personnel are not considered state employees; operators are compensated via a commission on store sales.

Liquor prices in Oregon are set uniformly each month by the OLCC. From June 2011 through May 2012, the average price for a 750 ml bottle of liquor in Oregon was $15.70. Oregon prices were already lower than Washington's before privatization, which suggests the presence of tax avoidance in the pre-period. To the extent that Washington consumers took advantage of price differentials ahead of privatization, my findings in the post-period

[4]Retailers and distributors must also pay an annual license renewal fee.

represent a lower bound on the amount of cross-border shopping. I observe only the increase in avoidance behavior from the new tax environment in Washington, not the total amount of avoidance from price differentials.

After privatization, there was no significant change in Oregon liquor prices. The average price for a 750 ml bottle of liquor in Oregon from June 2012 through May 2013 was $15.93. Figure 2 shows the average monthly prices in Oregon one year before and after the market structure change in Washington. While the figure does exhibit some seasonality, there is no significant change in Oregon price levels. Additional evidence is presented in Figure 3. This figure shows the average price charged for a 750 ml bottle of 80-proof liquor broken down by category in the year before and after privatization. The series in Figure 3 is relatively flat, which supports the hypothesis that prices in Oregon did not change appreciably during the timing of the intervention in Washington.

The average price differential between Oregon and Washington for a 750 ml bottle of liquor a year after privatization was 14.4 percent. I find that the closest liquor stores in Oregon are located 10 driving miles from the nearest border crossing. A 20-mile round-trip between the border and an Oregon liquor store would cost approximately $2.26 to $2.68 and take 27 minutes in driving time.[5] The average Washington consumer would have to buy at least two bottles of liquor in order to recoup the cost of the trip.

2 Data

Monthly consumer liquor revenues in dollars are tabulated for each store in Oregon from January 2005 through September 2015. I construct a panel for all 250 stores licensed to

[5]Calculated with a fuel efficiency of 28 mpg and a gas price of $3.00 to $3.75 a gallon.

sell liquor in Oregon across 129 months, for a total of 32,176 observations in the pooled sample.[6] Second, monthly brand sales by internal OLCC item number and store are obtained for each Oregon store from October 2010 through September 2015. Item numbers are matched to general characteristics for each brand, including the spirits category, size in milliliters and proof. According to the OLCC, bottles sales are not disaggregated by consumer sales and "dispenser" sales, or sales to restaurants and bars. In Oregon, establishments are required to purchase liquor from an OLCC agent (i.e., a state liquor store), and they receive a discount of 5 percent off the retail price of their purchases. Monthly bottle sales are calculated by taking the ending inventory reported in the prior month from each store and calculating the total plus any shipments, less claims for damaged merchandise the latest month reported ending inventory. The data comprises approximately 11.4 million observations across items (i.e., branded bottles of liquor), stores and months in the pooled sample. For ease of computation, I convert bottle sales into total liters sold and then aggregate sales to the store-by-month level by spirits category[7]for a total of 14,576 observations in the pooled sample.

Given the time series and cross-sectional components in the data, my analysis relies on changes in the magnitude of liquor prices in Washington following privatization. The analysis is simplified by the fact that neighboring states did not experience significant changes in tax rates on liquor or market structure during the period of analysis.

Estimation of the pooled data includes market and demographic characteristics from two sources. Market-level data from the 2011 Zip Code Business Patterns (ZCBP) and demographic characteristics from the 2011 American Community Survey at the Zip Code

[6]One store located in Birkenfield, OR, closed in September 2012 and another store located in Grass Valley, OR, closed in July 2012.

[7]The categories are whiskey, vodka, rum and cachaca, brandy and cognac, vermouth, gin, cordials and liqueurs, tequila and mezcal, and neutral grain spirits.

Tabulation Area (ZCTA) level supplement the data set. Data on the total number of firms, groceries, schools, churches, hospitals, and convenience stores were matched at the zip code level to each store. Demographic characteristics such as population density, median age, gender, race, and mean household income were matched at the ZCTA level to each store's zip code via crosswalks.

Geographic coordinates in longitude and latitude for each Oregon store were generated via hand-coding from addresses provided by the OLCC. I also obtain geographic coordinates for the center points of 12 bridges that span the Columbia River and the population center of Walla Walla, Wash.[8]

3 Empirical Specification

For consumer revenues, I estimate the following equation using a difference-in-differences (D-in-D) methodology with store-level and month fixed effects and standard errors clustered at the county level:

$$\begin{aligned} \ln S_{it} = \beta_0 + \beta_1 Post + \beta_2 Border\ store\ + \\ \beta_3 (Post \times Border\ store) + \beta_4 \cdot X_{it} + \gamma C_i + \rho T_t + \varepsilon_{it} \end{aligned} \tag{1}$$

The dependent variable is the log of monthly consumer liquor revenues in Oregon for store i at time t. *Post* is an indicator variable equal to 1 if the observation occurred after June

[8]The Columbia River spans the Washington-Oregon border for 309 miles. Travel between the two states requires crossing a bridge or the Oregon-Washington Highway outside Walla Walla, Wash.

1, 2012, and zero otherwise.[9] *Border store* is an indicator variable equal to 1 if the store is located near the Washington border, and zero otherwise. I define border proximity in several ways. In the main analysis, crossing the border entails traversing one of 12 bridges spanning the Columbia River or the Oregon-Washington Highway near Walla Walla, Wash. First, I create a dummy variable equal to one if the Oregon store is one of the three closest stores to each border crossing, and zero otherwise. These stores are denoted *Proximity 1* stores, as consumers crossing the border to buy cheaper liquor would encounter these stores first. Driving distances in miles between each Oregon liquor store and each WA-OR border crossing are also obtained via hand-coding. Table 2 lists the minimum average distance between stores and border crossings. On average, *Proximity 1* stores are located 10 miles from any WA-OR border crossing, with the closest store 0.7 miles away and the farthest store 33.8 miles away. *Proximity 1* stores are on average 13.5 driving minutes from the nearest crossing. Theory suggests that if higher prices in Washington are motivating sales in Oregon, the effect should be more pronounced in stores closest to border crossing points. I also create a dummy variable equal to one if the Oregon liquor store is located in a county bordering Washington state, and zero otherwise. To separate out effects of the closest stores to the WA-OR border, I define *Proximity 2* stores as any store in a WA-OR border county that is not a *Proximity 1* store. Figure 4 maps border crossings in relation to interior, *Proximity 1* and *Proximity 2* stores across Oregon.

C_i represents store-level fixed effects and control for omitted variables that differ across stores but are constant over time. T_t are month fixed effects and control for unobserved variables that vary across time. X_{it} represents demand and profit shifters at the zip code

[9] June 1, 2012, refers to the beginning of liquor privatization in Washington state. Higher prices followed the market change from the introduction of two new ad-valorem taxes.

and ZCTA levels.[10] Then β_0 represents the baseline average of the dependent variable, β_1 is the overall change in time, and β_2 is the difference between border and interior stores in Oregon. Finally, β_3 is the coefficient of interest, the difference-in-differences estimator, and can be defined as the difference in average sales in border stores before and after June 1, 2012, minus the difference in average sales in interior stores before and after June 1, 2012.

Unlike consumer revenues, total liters are not logged due to the presence of zeros sales or negative values. According to the OLCC, there are at least four possible explanations for negative values. At the product level, a negative "sale" may result if a store sold an item in January that was later returned for a refund in February and no other sales were recorded for that item in the later month. A store could have also undercounted a particular item in January, sold none the following month, and then reported the corrected sales count in February, resulting in a negative value sold. A store may also not have been able to submit its month-end inventory for some reason, resulting in the replication of brand sales in the previous month as a placeholder. The correction of this action may result in negative values across observations. Last, negative values may be the result of input errors due to unfamiliarity with the Oregon's online reporting system or mistyping. Errors that result in negative values are generally corrected within a month, according to the OLCC.

I estimate the effect of Washington's privatization on Oregon liquor sales using fixed effects across time and stores. Standard errors are clustered at the county level. This approach is preferred if individual store or county fixed-effects are correlated with other exogenous variables. Also, a fixed-effects technique is more appropriate because the data

[10] Such as the log of total population, log of total area, log of mean household income, log of the total male population 21 and over, log of the total number of firms, and the number of Oregon state stores in the same zip code.

includes all liquor stores in Oregon, not a sampling of stores across the state. Fixed-effect analysis supports inference when a sample exhausts the population, as fixed effects arise when the levels of an effect constitute the entire population of interest.

The D-in-D approach uses changes in the control group to estimate what would have been the change in the treatment group had that group not received the intervention in order to produce an estimate of the counterfactual. An assumption this approach uses is that the trajectories of the treatment and control groups would be the same in the absence of the treatment. Any difference between treatment and control groups observed in the post-period would then be an unbiased estimate of the intervention effect. Figures 6 and 7 suggest the common trends assumption is clearly met. Both figures indicate that liquor sales for *Proximity 1*, *Proximity 2*, and interior stores ran parallel until the timing of the intervention.

Figure 6 plots the time series of the log of average monthly liquor consumer revenues and total liters sold in Oregon by border proximity. In each panel, the top line plots the time series for the three closest stores to each of the 13 WA-OR border crossings, again denoted *Proximity 1* stores. The middle line plots the time series for all Oregon liquor stores in counties along the WA-OR border net of the three closest stores to border crossings, again denoted *Proximity 2* stores. The bottom line plots the time series for interior stores. A vertical red line corresponds to the data point May 2012, so that all post-treatment observations appear to the right of this line.

Overall, Figure 6 shows *Proximity 1*, *Proximity 2* and interior stores follow the same general trend until privatization in Washington. The figure also reveals that most of the increase in sales is being driven by those stores closest to the border. The main result translates into a significant increase in sales for *Proximity 1* stores, relative to interior and *Prox-*

imity 2 stores, in the post-period. For completeness, Table 1 provides summary statistics for border and interior stores in Oregon. The table indicates that border and interior stores are similar along many observable characteristics. While border stores in Oregon appear to have higher consumer revenues, on average, than interior stores in the pre-period, this difference is not statistically significant. However, border stores do appear to have higher sales as measured in total liters sold, a difference that is statistically significant across most spirits categories. Below, I estimate an event study to verify the assumption of parallel trends between border and interior stores in the pre-period.

Figure 7 uses methodology approximating an event study to estimate the aggregate effect of Washington's privatization on Oregon liquor sales. Panel (a) corresponds to total consumer revenues, while Panel (b) corresponds to total spirits volume by liters. I obtain fitted values from separate regressions of monthly liquor sales on three different proximity measures: interior Oregon liquor stores; *Proximity 1* stores; and *Proximity 2* stores. The dependent variable in Panel (a) is the log of monthly consumer revenues; for Panel (b) the dependent variable is total liters sold. Each specification is a standard linear regression with a dummy variable for each month in the time series —the excluded category corresponds to the May 2012 observation for ease of interpretation. Specifications include standard errors clustered at the county level.

Figure 7 plots the residuals of the fitted model. Following general practice in event study methodology, the plots in Figure 7 delivers sales value net of covariates and seasonal effects for *Proximity 1* stores that is compared to the counterfactual groups. A vertical red line again corresponds to May 2012, such that all observations to the right of this line are in the post-intervention period. The plots provide substantial evidence of cross-border shopping effects following privatization in Washington for those Oregon stores closest to

the WA-OR border. From the figure, interior and *Proximity 2* liquor stores in Oregon followed roughly the same pattern before and after the change, while *Proximity 1* stores experienced a significant increase in sales. Consistent with my hypothesis, revenues and liter sales for *Proximity 1* stores show a discrete jump in sales relative to other stores after June 1, 2012. Overall, Figure 7 provides compelling evidence for cross-border substitution effects due to differential tax rates, reinforcing evidence of significant border effects relative to the counterfactual groups.

The time series shows significant seasonality in liquor sales and a positive time trend. Therefore, the main empirical analysis includes and month and store-level fixed effects to correct for any small but significant differences between border and interior stores (Heckman and Hotz, 1989). Separately, D-in-D estimations with many time periods have been criticized for focusing on serially correlated outcomes while ignoring the possibility of inconsistent standard errors (Bertrand, Duflo and Mullainathan, 2004). Conventional D-in-D standard errors have been found to severely understate the standard deviation of the estimators, thereby overstating the significance of interventions. Marianne Bertrand, Esther Duflo and Sendhil Mullainathan (2004) propose several econometric corrections that I employ here. Block bootstrapping techniques, which take into account the auto-correlation of the data, have been found to give consistent errors provided the number of entities is large enough. I modify my model to include block-bootstrapping techniques with standard errors clustered at the county level.

Fundamentally, any alternative explanation of the paper's main results must be based on the idea that the increase in Oregon liquor sales in border stores following privatization is driven by some other unobserved factor. The D-in-D specification is only valid under the assumption that changes in liquor sales over time would have been similar in border

and interior stores in the absence of Washington's privatization. One solution I employ is a more highly refined definition of the treatment and control groups. I use driving distances to border crossings to identify which stores are most likely to be affected by higher prices from privatization. The analysis is aided by the fact that there are few crossing points between Washington and Oregon, ensuring a more accurate estimate of the treatment effect. I also use the precise timing of the treatment to identify the impact of cross-state tax differentials on liquor sales in Oregon.

4 Results

In Table 3 I report the results from estimating Equation 1. My regressions include month and store-level fixed effects to account for static differences between stores and seasonal changes in liquor demand. Coefficients for each dependent variable are reported by store location in relation to the WA-OR border. These coefficients are estimates of the degree of consumer avoidance that followed higher liquor prices in Washington after privatization. As such, they provide evidence supporting the main hypothesis that cross-state tax differentials increased liquor sales in Oregon, particularly for stores closest to border crossings. These coefficients correspond to the results shown in both panels of Figure 7.

The dependent variable in Column 1 is the log of monthly consumer liquor revenues; Column 2 reports results for total liter sales and Column 3 reports results for the log of monthly dispenser sales. All specifications employ block-bootstrapped standard errors clustered at the county level.

In Column 1, I find that *Proximity 1* stores experienced an additional 20 percent increase in revenues, relative to interior stores, following privatization. *Proximity 2* stores experi-

enced an additional 9 percent increase in consumer revenues, relative to interior stores. These results are quite robust: I have tried a number of different specifications, changing the dependent variable in the regression as well as changing the distance measures over which I estimate it.

Column 2 estimates the effect of privatization using store-level data on total liquor sales by liter volume. To maintain comparability across all liquor products sold across state stores, I first restrict the analysis to products for standard bottle sizes of 750 ml or greater, then use the same D-in-D framework to estimate the effect of privatization on total volume sold in liters. The coefficients correspond to the bottom panel of Figure 7. The dependent variable in all specifications is total monthly liquor sales in liters for standard bottles sizes 750 ml or greater. All specifications employ block-bootstrapped standard errors clustered at the county level.

Column 2 indicates that *Proximity 1* stores sold an additional 1,665 liters relative to interior stores. The coefficient on *Post* $\times$ *Proximity 2 store* is smaller, positive and statistically significant at conventional levels. Proximity 2 stores sold an additional 892.35 liters following privatization, relative to interior stores.

Column 3 estimates the effects of privatization on a third outcome variable of *dispenser* revenues. As enumerated previously, dispenser revenues denote "licensee" sales, or revenues from liquor sales to restaurants and bars. In Oregon, licensees are required to purchase liquor from an OLCC agent (state liquor store), and they receive a discount of 5 percent off the retail price of their purchases. The monthly dispenser revenues data provided the OLCC are tallied at full retail price, and are kept separate from consumer revenues for compensation purposes.

My findings indicate that higher prices in Washington are driving consumers to seek

cheaper liquor in Oregon for consumption at home. However, it may be less likely that consumers are also taking advantage of lower prices in Oregon for consumption in bars and restaurants. Examining the effect of privatization on dispenser sales serves as a useful counterfactual and helps to rule out demand shocks for alcohol that may be correlated with the law change. According to the Washington State Department of Revenue, the spirits sales tax for consumption in bars and restaurants (on-premise) is 13.7 percent, compared to 20.5 percent for purchases for consumption at home; the spirits liter tax for on-premise consumption is $2.4408 per liter, compared to $3.7708 a liter for consumption at home. It is conceivable that cross-border substitution effects from privatization might benefit restaurants and bars, and that the total loss in revenues for Washington might not be confined to newly licensed liquor stores, but to all businesses that serve liquor.

The coefficients on the D-in-D estimators for both *Proximity 1* and *Proximity 2* stores are not significant. This result is consistent with the prediction that bars and restaurants in Oregon stores along the WA-OR border did not experience significant cross-border shopping effects. The findings also indicate that demand shocks for liquor in border counties are an unlikely explanation for my main results.

Figures **??** and **??** examine the dynamics of the impact of privatization on avoidance behavior over time. The results in Table 3 are the average effect of privatization on Oregon liquor sales but do not illustrate whether the growth rate accelerates over time, stabilizes or mean reverts. To explore these patterns, I generate an indicator variable for each month in the time series following privatization then plot the coefficients on consumer revenues and liter sales over time relative to June 1, 2012. The plots indicate that consumer avoidance behavior was strongest in the first 12 months after privatization. However, for both consumer revenues and liter sales, there is a sustained increase in the level of liquor sales due

to the law change.

I also estimate the effect of privatization by proximity to population-weighted centroids in Washington counties bordering Oregon (see Figure 5). While I find consumer tax avoidance behavior to be concentrated at stores located closest to the border, one might expect the effect to be even stronger among those stores located closest to population centers.

In Table 4, I report the results from estimating Equation 1 with the alternative proximity specification. Coefficients for each dependent variable are reported by store location in relation to a Washington state population-weighted county centroid. *Proximity 1* stores are defined as one of the three closest stores to a centroid, while *Proximity 2* stores are all other stores in an Oregon county that borders Washington but is not a *Proximity 1* store. All regressions again include month and store-level fixed effects and block-bootstrapped errors clustered at the county level. The dependent variables are the same as in Table 3.

In Column 1, I find that *Proximity 1* stores experienced an additional 21 percent increase in revenues, relative to interior stores, following privatization. *Proximity 2* stores experienced an additional 7 percent increase in consumer revenues, relative to interior stores, although the effect is only significant at the 10 percent level. Column 2 indicates that the closest stores to Washington county centroids sold an additional 1,689 liters relative to interior stores. The coefficient on *Post* $\times$ *Proximity 2 store* is smaller, positive, but not statistically significant at conventional levels. Column 3 estimates the effects of privatization by centroid proximity on dispenser revenues. Overall, I find no significant effect of privatization on dispenser sales for stores closest to Washington population centers.

These findings are extremely similar to those from the main proximity model. As the geocoding in Figures 4 and 5 suggests, the closest stores to WA-OR border crossings are substantially the same stores that are closest to population-weighted county centroids in

Washington. Because Washington consumers have to cross a bridge to visit an Oregon liquor store, the shopping location decision is narrowly defined by geography.

Overall, the results indicate that *Proximity 1* stores experienced an additional increase in consumer revenues of approximately 20 to 21 percent. Stores closest to the WA-OR border sold an additional 1,665 to 1689 liters following privatization, relative to interior stores. While *Proximity 2* stores also experienced an additional increase in sales relative to interior stores, cross-border shopping effects appear to be driven primarily by *Proximity 1* stores. These results are consistent with both theory and previous work on cross-border sales. The presence of significant cross-border shopping effects for liquor are consistent with results from Ye and Kerr (2015), Winfree and Watson (2015), Asplund, Friberg and Wilander (2007), Stehr (2007), but differ from Beard, Grant and Saba (1997), as they found a border effect for beer but not for liquor. The results are also consistent with previous empirical work on cross-border shopping in other contexts; Lovenheim (2008) finds that price elasticities for cigarettes vary with the distances consumers travel to markets with lower prices. Table 3 supports the key prediction that Oregon border stores gained significantly from Washington consumers taking advantage of cross-state tax differentials.

4.1 Alternative Specifications

Tables 5 and 6 examine dissipation patterns in consumer avoidance behavior and further tests the hypothesis that stores located closest to the WA-OR border experienced the largest sales increases. In addition to a dummy variable which takes a value of one if the Oregon liquor store is located within a county that borders Washington and zero otherwise, I include a variable that corresponds to the log of the minimum driving distance (in miles) to the nearest crossing. I also create dummy variables corresponding to three different and

mutually exclusive distance bands from border crossings. The closest band takes a value of one if the Oregon liquor store is 10 or fewer miles from the nearest crossing, and zero otherwise; the second band takes a value of one if the Oregon liquor store is between 11 and 25 miles from the nearest crossing, and zero otherwise; the last band takes a value of one if the store is between 26 and 35 miles of the nearest border crossing, and zero otherwise.

In Table 5, the dependent variable in all specifications is the log of monthly consumer revenues. In Table 6, the dependent variable in all specifications is total spirits volume in liters for bottles of standard size 750 ml or greater. Each specification uses fixed effects at the month and store levels with block-bootstrapped standard errors clustered at the county level. The coefficients of interest represent the interaction between the geospatial or distance measure and the *Post* indicator variable for whether the observation occurred after June 1, 2012.

The geospatial measure in Column 1 of both tables is whether an Oregon liquor store is located within a border county. The point estimate for consumer revenues in Table 5 is approximate 12 percent and the coefficient for total liter sales in Table **??** is 1,104.74; both are significant at the 1 percent level. Column 1 in both tables can be interpreted as the average effect of the tax differential between Washington and Oregon on border stores. However, as the results in Table 3 and shortly Tables 5 and 6 indicate, consumer tax avoidance is concentrated among those stores closest to WA-OR border crossings.

The distance measure in Column 2 is the log of the minimum driving distance (in miles) to the nearest border crossing. The coefficient is negative, as expected, as theory predicts that increased distance from a border crossing will be associated with lower sales.

The rest of the results support the main hypothesis. The coefficient of interest for stores between 26 to 35 driving miles of the nearest border crossing is insignificant and

indistinguishable from zero for revenues and total liters sold. Column 4 also shows the effect for stores between 11 and 26 driving miles from the nearest crossing to insignificant and indistinguishable from zero for both consumer revenues and total liters sales. Column 5 in both tables shows that the increase is being driven by stores closest to the WA-OR border. Stores 10 or fewer driving miles from the nearest crossing experienced an additional 19 percent increase in revenues, or an additional 1,507.83 total liters sold, relative to interior stores. The coefficient approximates the effect found among *Proximity 1* stores in Table 3, and is significant at conventional levels.

Column 6 in both tables tests the effect of cross-state tax differentials for all exclusive distance bands. The specification includes a variable = 1 if the store in between 26 and 35 driving miles from any border crossing, a variable = 1 if the store is between 11 and 25 miles of any border crossing, and a dummy variable = 1 if the store is 10 or fewer driving miles from any crossing. As expected, most of the revenues and liter sales increases are experienced for stores within 10 driving miles of any border crossing. I find that the closest stores experienced an additional increase of approximately 20 percent for consumer revenues, and 1,677.18 liters sold, a result significant at conventional levels. While the coefficients for whether a store is between 11 and 25 miles and between 26 and 35 miles of the nearest crossing are also positive and significant, the effects are much smaller and decline in increasing distance from the nearest stores. The results support the main hypothesis that cross-border shopping effects following privatization dissipate by border proximity.

I further disaggregate total liter sales for standard bottles size 750 ml or greater into eight distinct spirit categories to examine the effect of consumer preferences on the pattern of displacement. The categories are whiskey (includes American, Canadian, Scotch, Irish, and other imported whiskey spirits), vodka, brandy (includes brandy and cognac), rum

(includes rum and cachaca), tequila (includes tequila and mezcal), gin, cordials (includes cordials, liqueurs, and cocktails), and neutral grain spirits. For parsimony, I do not include the wine-based spirit of vermouth. Table **??** should more starkly trace the pattern of consumer demand for liquor by Washington consumers crossing the border. The coefficients correspond to the panels in Figures 8 and 9. I find that the bulk of the increase in total liter sales are driven by purchases of whiskey, vodka, and cordials. The point estimates for *Post* $\times$ *Proximity 1 store* and for *Post* $\times$ *Proximity 2 store* are comparable to previous results. While there is some variability in the significance of *Post* $\times$ *Proximity 2 store*, the effect of Washington privatization on Oregon liquor stores is dominated by those stores closest to the border.

As an additional robustness check on the main results, I estimate the effect of Washington's privatization on Oregon liquor stores while correcting for possible spatial correlation in the data. The nature of panel data may mask patterns of mutual dependence between stores that may overstate the amount of information in the data, producing biased and inconsistent estimates. These results, which are effectively unchanged from the main results, are available upon request.

5 Conclusion and Policy Implications

Commodity tax avoidance along the WA-OR border significantly reduces state revenue. Aggregating the dollar value of the sales increases in Oregon after privatization provides a useful approximation of the loss to government coffers. The caveat is that the estimated amount is only an approximation, not a dollar-to-dollar transfer. In Section 2, I find that consumers taking advantage of tax differentials would have to buy at least two bottles of

liquor in order to make border crossing worthwhile. Consumers may purchase more liquor than they would have in the absence of tax differentials.

My analysis finds that avoidance in Oregon translates into significant monthly losses for Washington state in the form of foregone revenue. The evidence presented in the main analysis is consistent with previous work on the prevalence of cross-border sales of alcohol. The implication is that border crossing is a significant determinant of state-level demand for alcohol. My estimates suggest that state tax policies designed to raise revenue and lower excessive consumption are less effective when consumers are able to take advantage of lower tax environments across state borders. From a policy standpoint, cross-border shopping can significantly affect state tax revenues, and there may be incentives for home states to unilaterally lower tax rates to deter avoidance. In the case of Washington, a more aggressive approach could also be taken, such as stopping and searching cars at border crossings.

This paper explores the effect that higher liquor prices has on consumer behavior. Using store-level data on consumer liquor revenues in Oregon from January 2005 to September 2015 and total liter sales from October 2010 through September 2015, I estimate the effect of cross-state tax differentials on consumer demand. Unlike previous studies, I use variation in tax rates instead of variation in price levels to identify the impact of policy changes in nearby Washington on Oregon liquor sales. I obtain the driving distances between each Oregon store and the WA-OR border. Therefore, I am able to employ a quasi-experimental approach in estimating the effect of cross-state tax differentials on Oregon liquor sales by proximity to Washington. I find that the closest Oregon liquor stores to the WA-OR border experienced an additional 20 percent increase in sales relative to interior stores.

My findings suggest that the consequences for tax revenues and lost sales are non-

trivial. More work is needed to evaluate state-level alcohol taxation as a policy instrument to limit excessive consumption and increase revenue in the presence of cross-state tax differentials and avoidance opportunities.

Figure 1: Washington State: Average Liquor Prices By Market Structure

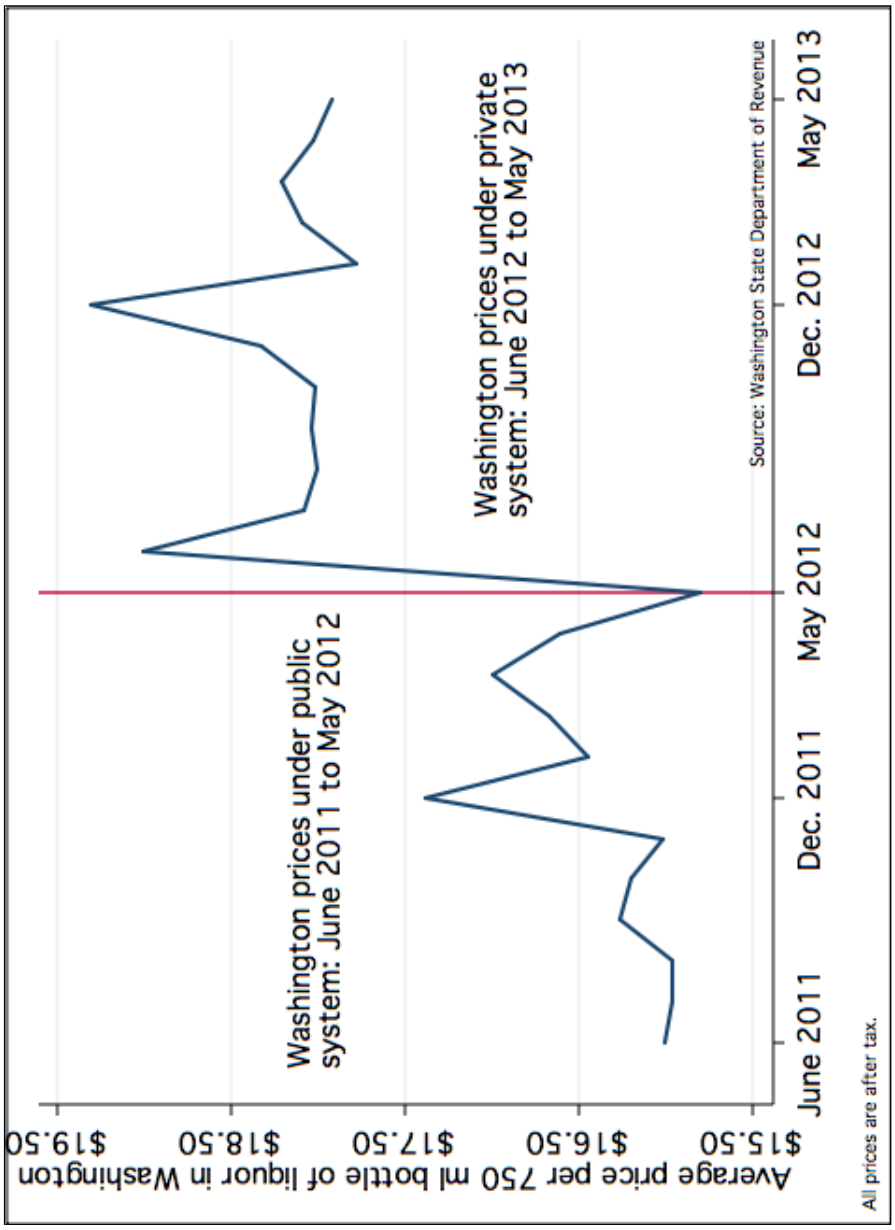


Figure 2: Oregon State: Average Liquor Prices

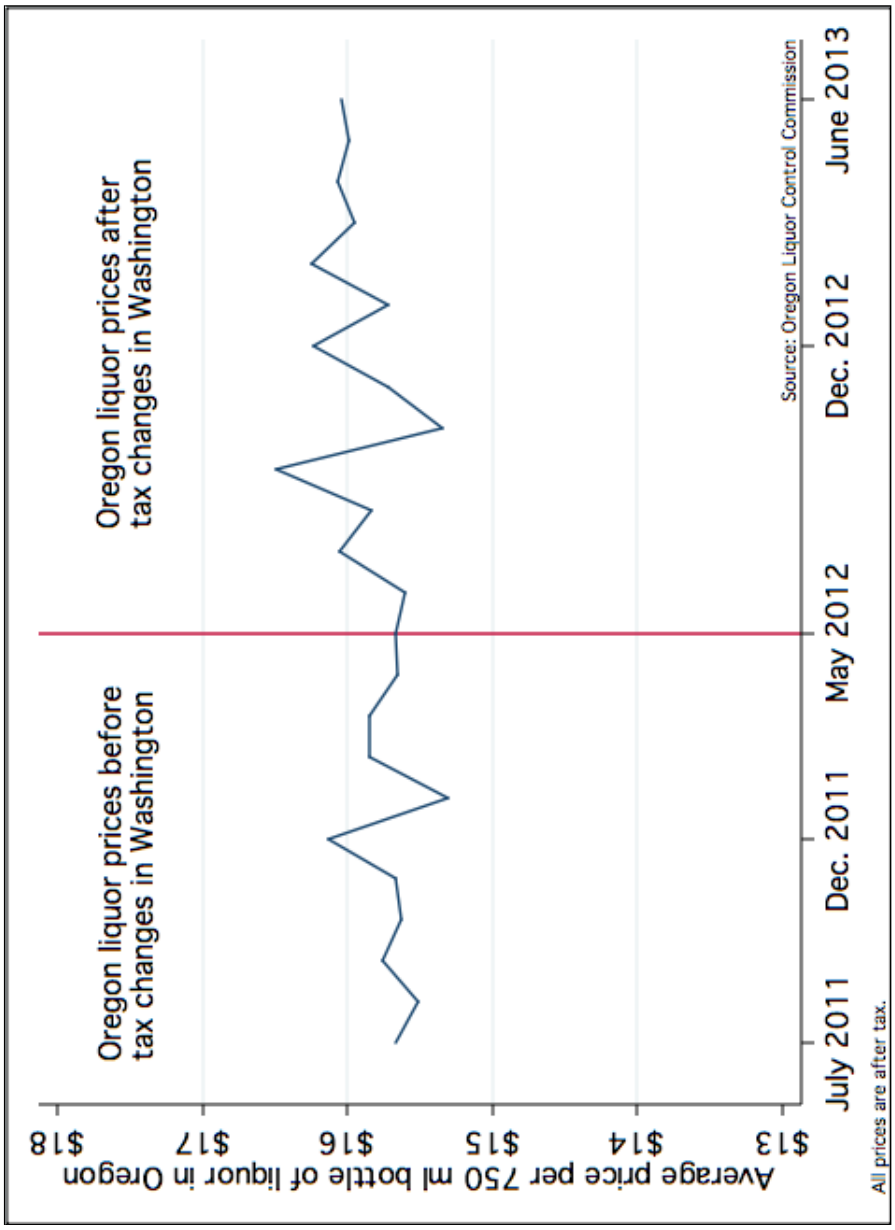


Figure 3: Oregon State: Consumer Price Series By Liquor Type

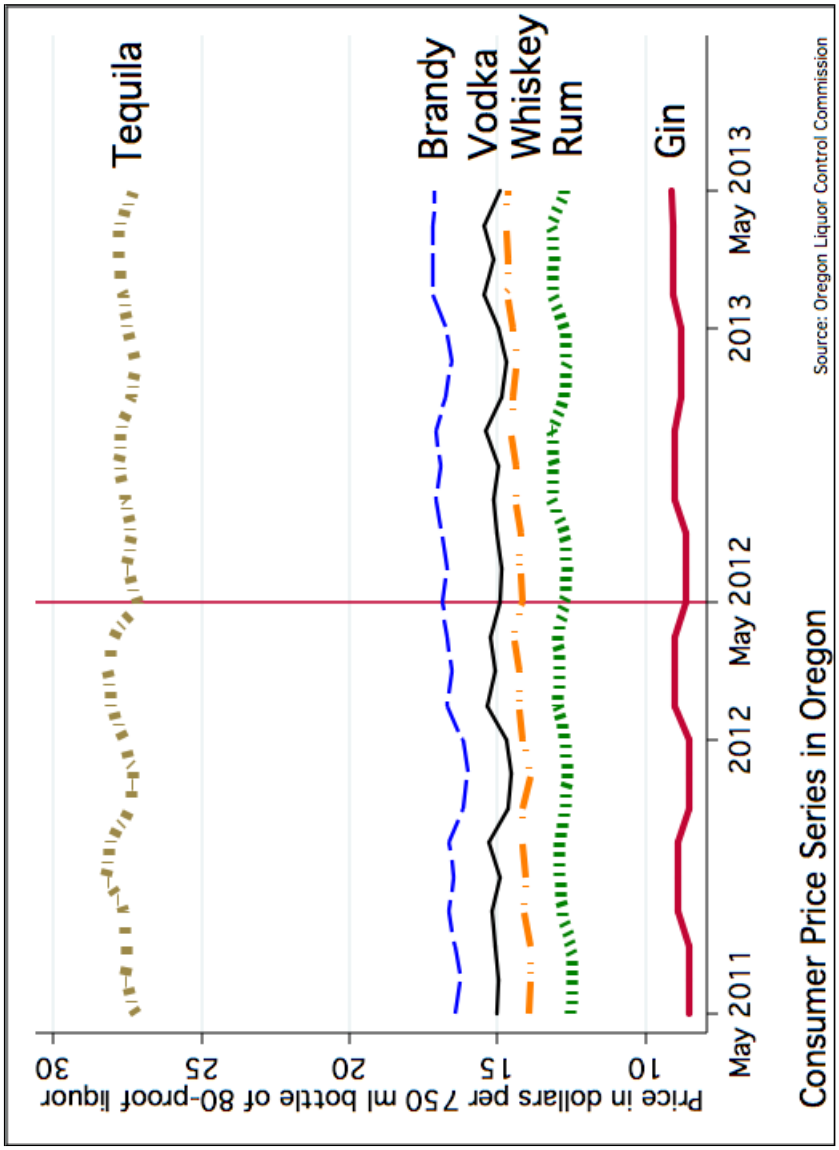
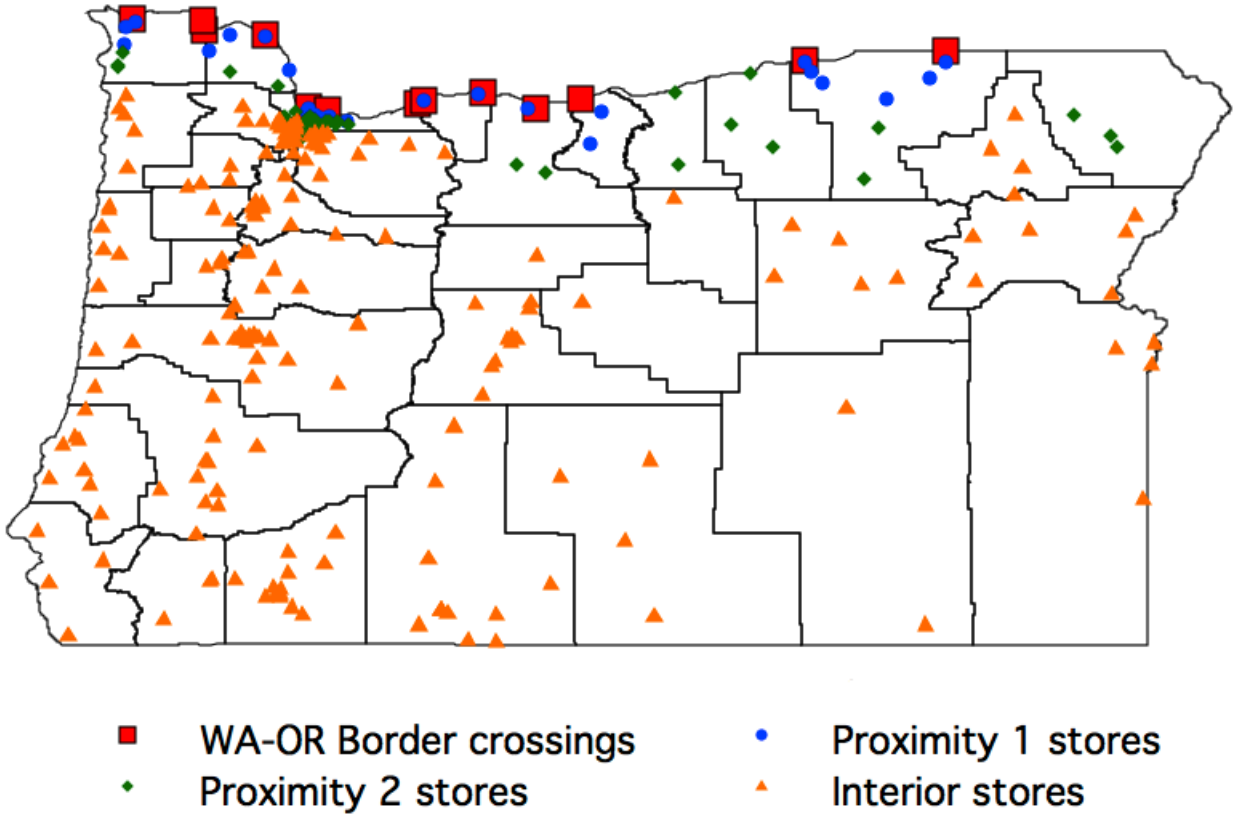
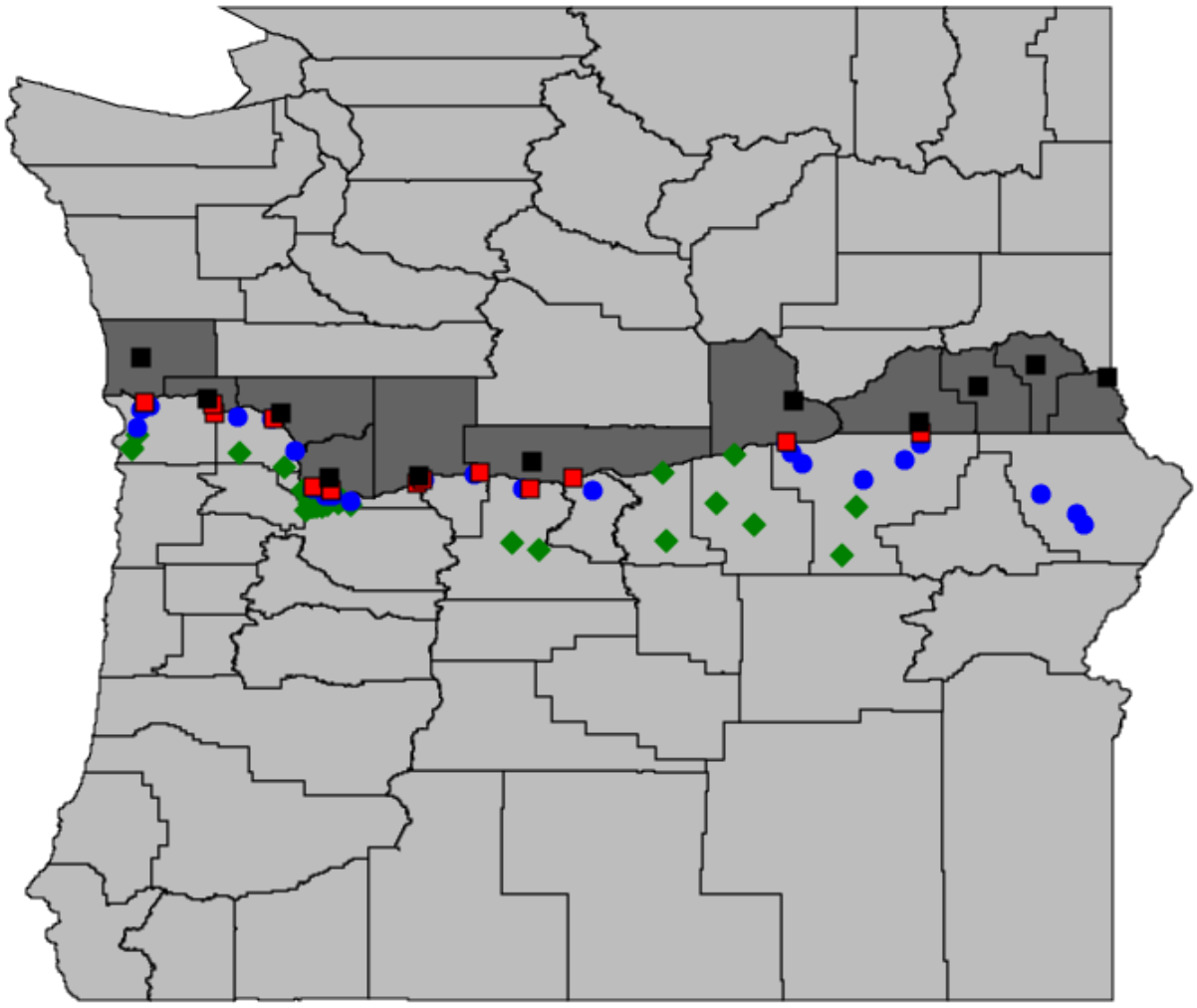


Figure 4: Oregon Liquor Store Locations by Washington Border Proximity



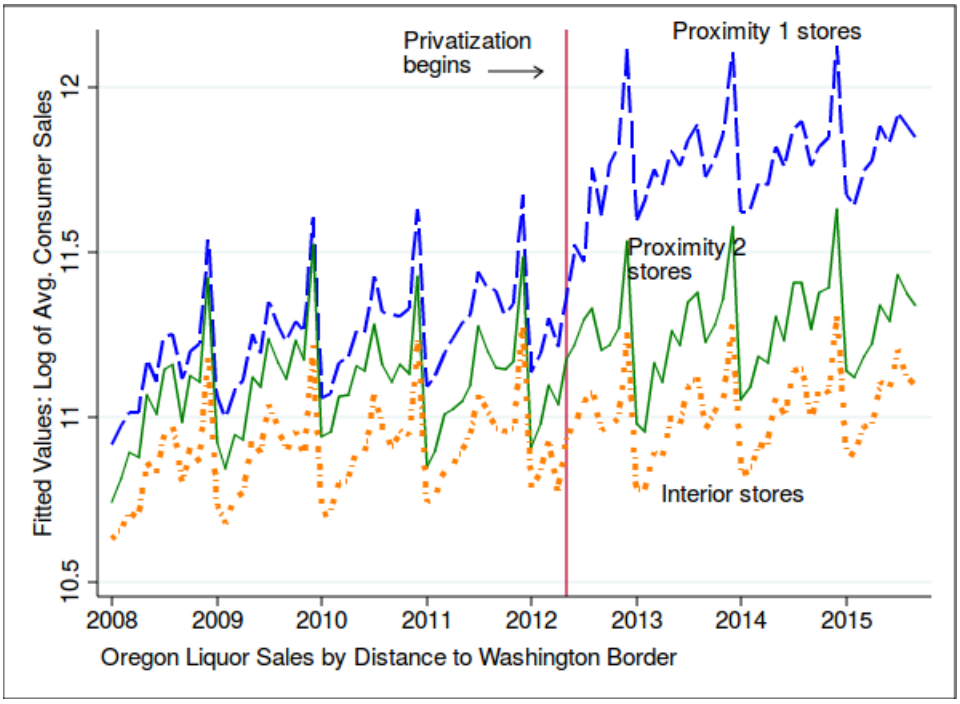
Proximity 1 stores in Oregon defined as the three closest stores to the 13 designated WA-OR border crossings. *Proximity 2* stores defined as any store in a county bordering Washington that is not a *Proximity 1* store. Interior stores are all other stores.

Figure 5: Oregon Store Proximity to County Centroids

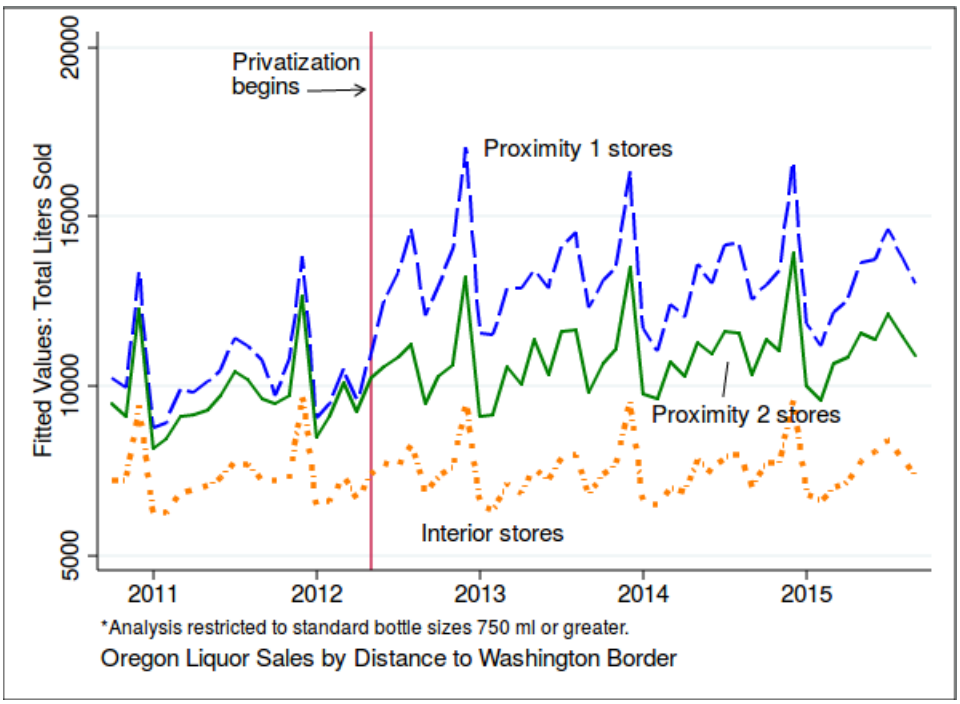


Oregon liquor store locations by proximity to population-weighted county centroids in Washington state (given by black squares). Border crossings also shown (red squares).

Figure 6: Time Series: Oregon Liquor Sales by Border Proximity

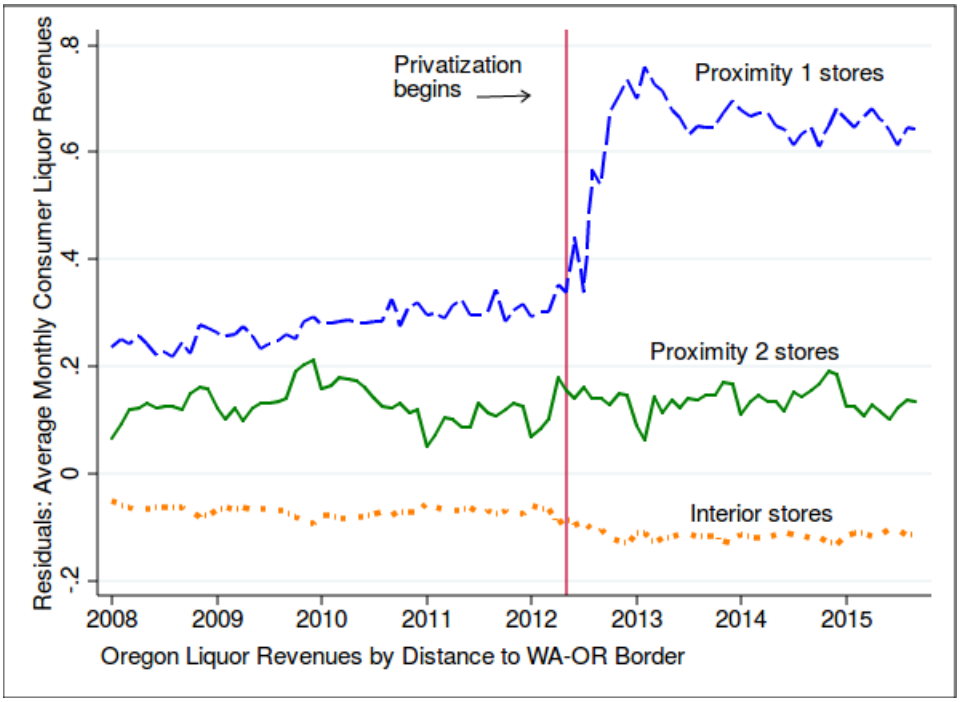


(a) Consumer Revenues

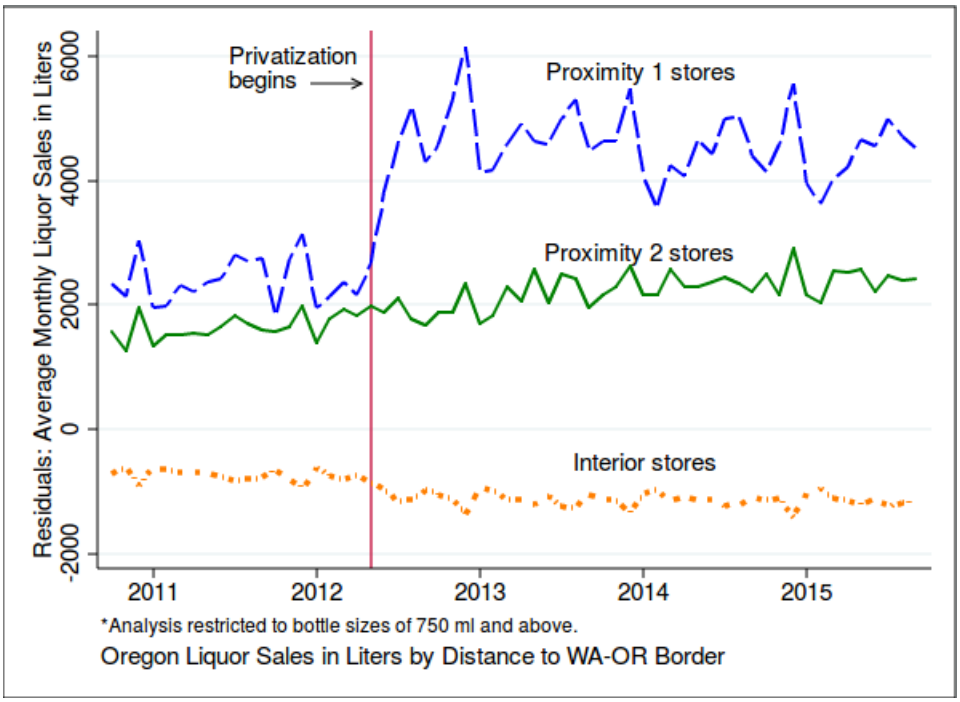


(b) Total Liters Sold

Figure 7: Effect of Washington's Liquor Privatization on Oregon Liquor Revenues

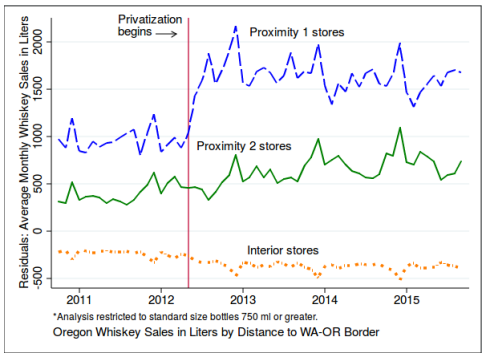


(a) Consumer Revenues

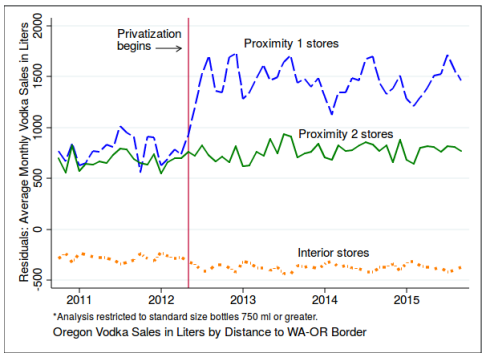


(b) Total Liters Sold

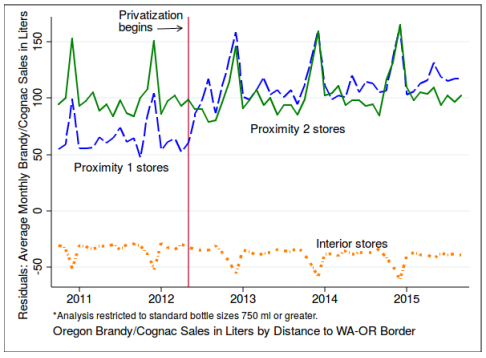
Figure 8: Washington Liquor Privatization on Oregon Liquor Sales by Type



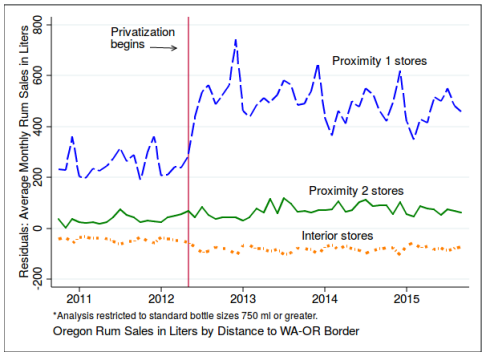
(a) Whiskey



(b) Vodka

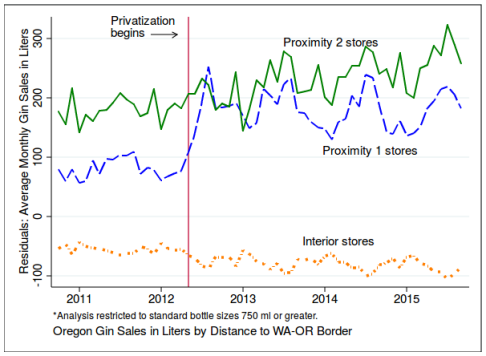


(c) Brandy

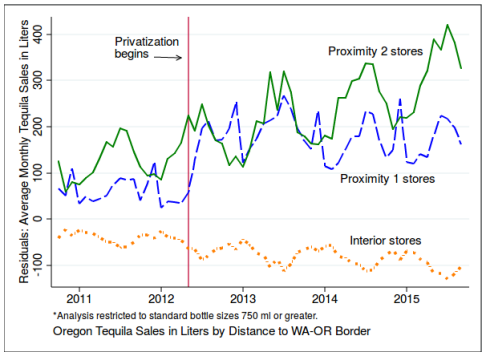


(d) Rum

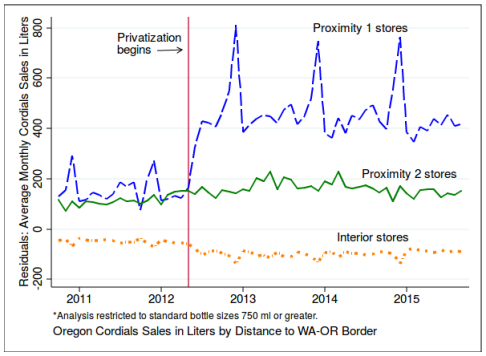
Figure 9: Washington Liquor Privatization on Oregon Liquor Sales by Type



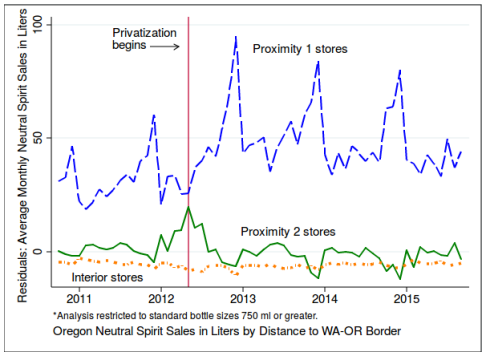
(a) Gin



(b) Tequila



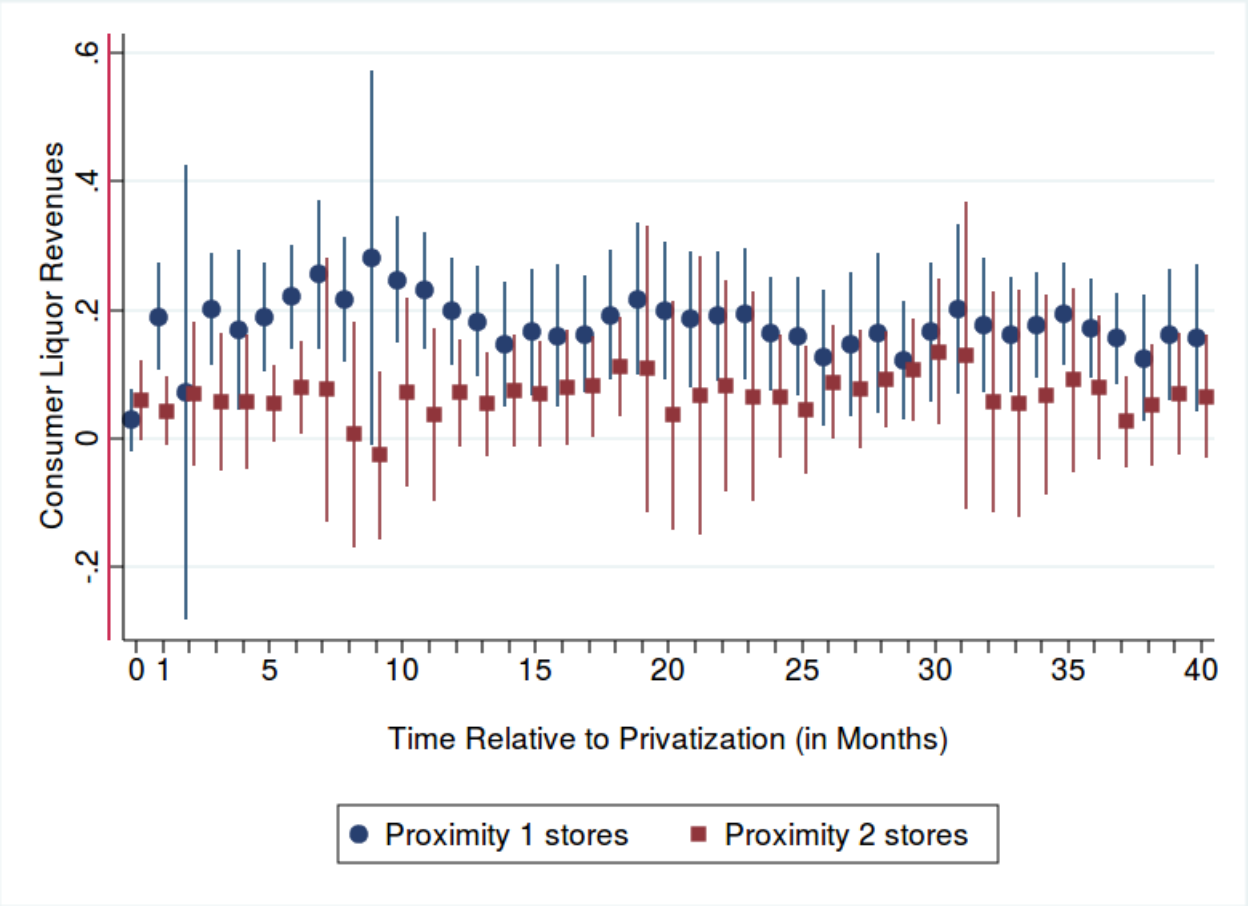
(c) Cordials



(d) Neutral Spirits

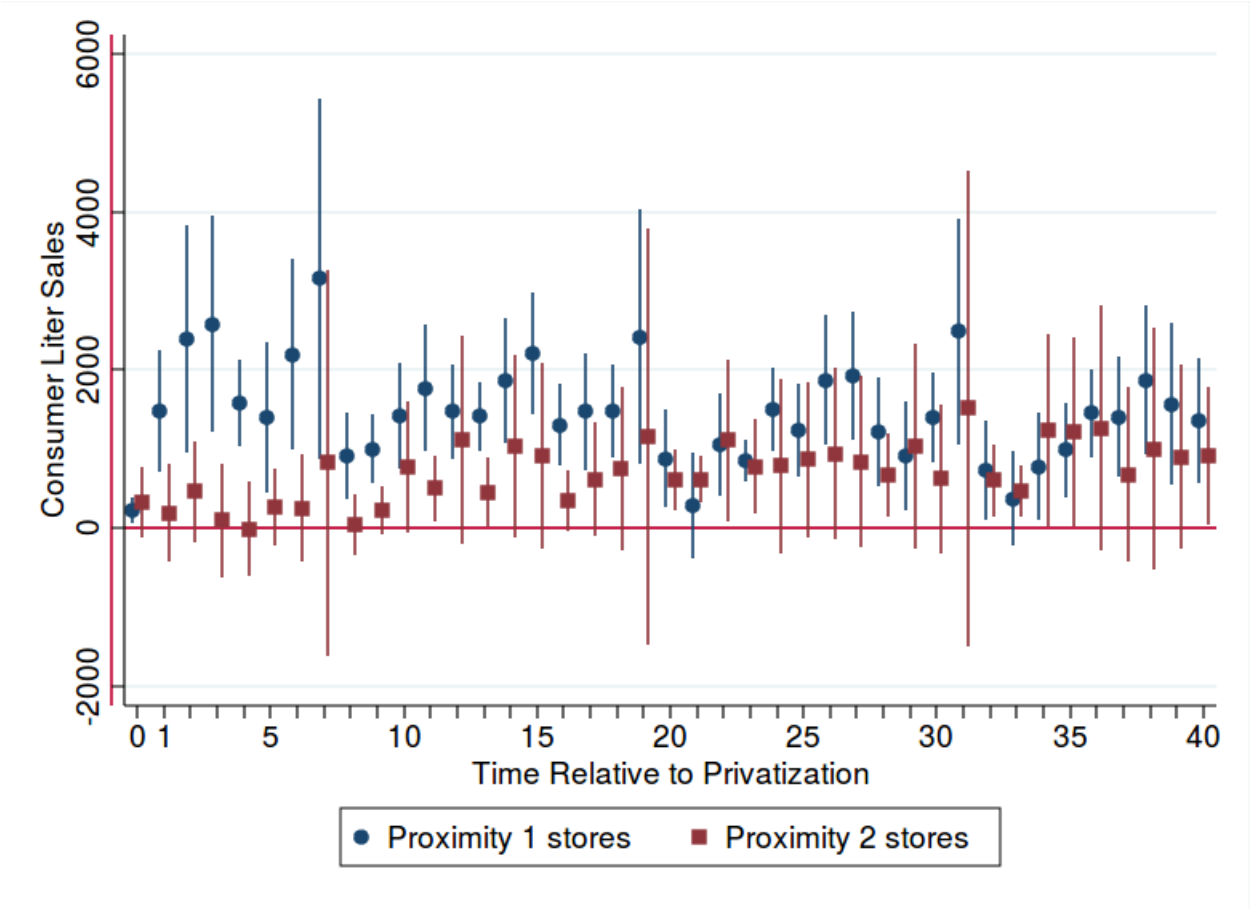
Proximity 1 stores in Oregon defined as the three closest stores to the 13 designated WA-OR border crossings. *Proximity 2* stores defined as any store in a county bordering Washington that is not a *Proximity 1* store. Interior stores are all other stores. Privatization in Washington began June 1, 2012, and was accompanied by higher liquor prices from new taxes.

Figure 10: Dynamics of the Effect of Privatization on Revenue Sales



Proximity 1 stores in Oregon defined as the three closest stores to the 13 designated WA-OR border crossings. *Proximity 2* stores defined as any store in a county bordering Washington that is not a *Proximity 1* store. Interior stores are all other stores. Privatization in Washington began June 1, 2012, and was accompanied by higher liquor prices from new taxes.

Figure 11: Dynamics of the Effect of Privatization for Liter Sales



Proximity 1 stores in Oregon defined as the three closest stores to the 13 designated WA-OR border crossings. *Proximity 2* stores defined as any store in a county bordering Washington that is not a *Proximity 1* store. Interior stores are all other stores. Privatization in Washington began June 1, 2012, and was accompanied by higher liquor prices from new taxes.

Table 1: Descriptive Statistics for Oregon Liquor Stores

	(1) Interior stores	(2) Border stores	(3) *t*-stat	(4) Interior *N*	(5) Border *N*
Average monthly consumer revenue ($)	95,910.7	110,967.7	-1.218	184	66
Total spirits volume in liters for all bottle sizes	7,650.6	10,401.9	-2.565	184	66
Average monthly number of bottles sold	8,740.5	12,148.8	-2.758*	184	66
Total spirits volume in liters for bottles 750 ml or greater	7,242.2	9,931.9	-2.615*	184	66
Average monthly whiskey volume in liters for bottles 750 ml or greater	2,081.7	2,951.0	-3.151*	184	66
Average monthly vodka volume in liters for bottles 750 ml or greater	2,475.5	3,458.1	-2.650*	184	66
Average monthly brandy volume in liters for bottles 750 ml or greater	129.3	253.8	-4.918**	184	66
Average monthly rum volume in liters for bottles 750 ml or greater	858.7	1030.0	-1.385	184	66
Average monthly tequila volume in liters for bottles 750 ml or greater	445.0	592.1	-2.025	184	66
Average monthly gin volume in liters for bottles 750 ml or greater	326.0	510.3	-3.310*	184	66
Average monthly cordials volume in liters for bottles 750 ml or greater	886.3	1,068.2	-1.438	184	66
Average monthly neutral spirits volume in liters for bottles 750 ml or greater	22.68	42.41	-3.962**	184	66
Average monthly vermouth volume in liters for bottles 750 ml or greater	17.09	26.00	-2.840*	184	66
Total population (overall) by ZCTA	17759.2	15842.5	0.816	184	66
Total population age 21 and over by ZCTA	12,923.4	12,011.1	0.537	184	66
Total male population by ZCTA	8,750.6	7,874.7	0.758	184	66
Total population of African-Americans by ZCTA	184.8	750.7	-5.618**	184	66
Average number of state liquor stores in same zip code	1.290	1.303	-0.184	184	66

Average monthly consumer liquor revenues calculated in the pre-treatment period only, from January 2005 through May 2012. Liter sales calculated from October 2010 through May 2012. An Oregon border store is located in a county that borders Washington state only. *ZCTA* refers to the U.S. Census Zip Code Tabulation Area. The ZCTA designation was matched to each store's zip code via crosswalks. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 2: Distance Statistics for Oregon Liquor Stores

	Mean	Min	Max
Distance to nearest crossing in miles			
Proximity 1 stores in Oregon	10.1 (8.7)	0.7	33.8
Proximity 2 stores in Oregon	25.8 (25.2)	5.9	104
Interior stores in Oregon	138.4 (93.1)	10.5	355
	Mean	Min	Max
Distance to nearest Washington county centroid in miles			
Proximity 1 stores in Oregon	31.9 (23.3)	4.9	89.8
Proximity 2 stores in Oregon	32.4 (23.2)	11.2	90.2
Interior stores in Oregon	149.8 (95.9)	17.9	361.0
	Mean	Min	Max
Time to nearest crossing in minutes			
Proximity 1 stores in Oregon	13.5 (10.7)	2.0	41.2
Proximity 2 stores in Oregon	32.0 (28.8)	9.4	127.4
Interior stores in Oregon	144.6 (93.1)	16.6	405.3

Driving distances to WA-OR border crossings and WA county centroids from Oregon liquor stores. Standard deviation in parentheses.

Table 3: Effect of Liquor Privatization on Oregon Liquor Sales (Border Crossings)

	(1) Log of monthly consumer revenues	(2) Monthly liter sales	(3) Log of monthly dispenser revenues
Post × Oregon liquor store is a *Proximity 1* store	0.1950***	1,665.42***	0.0231
	(0.0364)	(298.86)	(0.0854)
Post × Oregon liquor store is a *Proximity 2* store	0.0890***	892.35**	0.2653
	(0.0329)	(434.60)	(0.1721)
Store Fixed Effects?	Yes	Yes	Yes
Time Fixed Effects?	Yes	Yes	Yes
Observations	31,496	14,841	28,990
R-squared	0.9801	0.97	0.9258

Observations at the store-month level. *Proximity 1* store is a dummy variable = 1 if the Oregon liquor store is one of the three closest stores to each of the 13 designated WA-OR border crossings. *Proximity 2* store is a dummy variable = 1 if the Oregon liquor is located in a WA-OR border county but is not a *Proximity 1* store. June 1, 2012, refers to the date privatization began in Washington state. Bootstrap methods with standard errors clustered at the county level employed in all specifications and given in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 4: Effect of Liquor Privatization on Oregon Liquor Sales (County Centroids)

	(1) Log of monthly consumer revenues	(2) Monthly liter sales	(3) Log of monthly dispenser revenues
Post × Oregon liquor store is a *Proximity 1* store	0.2114***	1,689.24***	-0.0295
	(0.0380)	(561.17)	(0.0749)
Post × Oregon liquor store is a *Proximity 2* store	0.0669*	774.18	0.2543
	(0.0404)	(515.89)	(0.1884)
Store Fixed Effects?	Yes	Yes	Yes
Time Fixed Effects?	Yes	Yes	Yes
Observations	31,496	14,841	28,990
R-squared	0.9801	0.96	0.9257

Observations at the store-month level. *Proximity 1* store is a dummy variable = 1 if the Oregon store is one of the three closest stores to a Washington state population-weighted county centroid. *Proximity 2* store is a dummy variable = 1 if the Oregon liquor is located in a WA-OR border county but is not a *Proximity 1* store. June 1, 2012, refers to the date privatization began in Washington state. Bootstrap methods with standard errors clustered at the county level employed in all specifications and given in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 5: Effect of Washington Liquor Privatization on Oregon Liquor Revenues

	(1) Monthly consumer revenues	(2) Monthly consumer revenues	(3) Monthly consumer revenues	(4) Monthly consumer revenues	(5) Monthly consumer revenues	(6) Monthly consumer revenues
Post x Store in Washington border county	0.1196***					
	(0.0231)					
Post x Log of min. distance to any crossing		-0.0541***				
		(0.0118)				
Post × Store between 26 and 35 miles from crossing			-0.0026			0.0363
			(0.0254)			(0.0226)
Post × Store between 11 and 25 miles from crossing				0.0243		0.0586**
				(0.0245)		(0.0248)
Post × Store 10 or fewer miles from crossing					0.1930**	0.2073**
					(0.0778)	(0.0807)
Constant	10.4166***	10.4165***	10.4166***	10.4166***	10.4166***	10.4166***
	(0.2375)	(0.2551)	(0.2227)	(0.2398)	(0.2496)	(0.2413)
Store Fixed Effects?	Yes	Yes	Yes	Yes	Yes	Yes
Month Fixed Effects?	Yes	Yes	Yes	Yes	Yes	Yes
Observations	31,496	31,496	31,496	31,496	31,496	31,496
	0.9799	0.9802	0.9796	0.9797	0.9801	0.9801

Dependent variable is logged in all specifications. Observations at the store-month level. *Border county* is a dummy variable = 1 if the Oregon liquor store is located in a county that borders Washington state. Dependent variable in all specifications is the log of monthly consumer liquor revenues. Bootstrap methods with standard errors clustered at the county level employed in all specifications and given in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 6: Effect of Washington Liquor Privatization on Oregon Spirit Liter Sales

	(1) Monthly liter sales	(2) Monthly liter sales	(3) Monthly liter sales	(4) Monthly liter sales	(5) Monthly liter sales	(6) Monthly liter sales
Post x Store in Washington border county	1,104.74***					
	(361.81)					
Post x Log of min. distance to any crossing		-463.33***				
		(105.04)				
Post × Store between 26 and 35 miles from crossing			-239.93			133.10
			(225.42)			(138.79)
Post × Store between 11 and 25 miles from crossing				516.27		783.50
				(504.71)		(543.42)
Post × Store 10 or fewer miles from crossing					1,507.83***	1,677.18***
					(478.53)	(391.27)
Constant	7,882.18***	7,882.02***	7,878.45***	7,878.51***	7,880.64***	7,880.69***
	(1,182.72)	(1,246.38)	(1,221.67)	(1,156.47)	(1,221.66)	(1,249.72)
Observations	14,841	14,841	14,841	14,841	14,841	14,841
R-squared	0.9648	0.9653	0.9639	0.9641	0.9648	0.9651

Observations at the store-month level. *Border county* is a dummy variable = 1 if the Oregon liquor store is located in a county that borders Washington state. Dependent variable in all specifications is the monthly spirits volumes in liters for bottles 750 ml or greater. Bootstrap methods with standard errors clustered at the county level employed in all specifications and given in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 7: Effect of Washington Liquor Privatization on Oregon Spirit Liter Sales

	(1) Monthly liter sales of whiskey	(2) Monthly liter sales of vodka	(3) Monthly liter sales of brandy	(4) Monthly sales of rum spirits
Post × *Proximity 1* store	529.30***	455.97***	35.73***	175.96***
	(82.61)	(89.40)	(9.29)	(20.45)
Post × *Proximity 2* store	358.70**	155.44*	8.28**	62.41***
	(174.26)	(94.09)	(3.79)	(16.93)
Constant	2,324.26***	2,749.48***	155.22***	906.33***
	(324.20)	(460.65)	(35.50)	(121.78)
Store Fixed Effects?	Yes	Yes	Yes	Yes
Time Fixed Effects?	Yes	Yes	Yes	Yes
Observations	14,841	14,841	14,841	14,841
R-squared	0.9598	0.9695	0.9242	0.9566

	(1) Monthly liter sales of tequila	(2) Monthly liter sales of gin	(3) Monthly liter sales of cordials	(4) Monthly sales of neutral spirits
Post × *Proximity 1* store	111.89**	83.61***	252.08***	12.87***
	(49.89)	(16.24)	(59.41)	(4.53)
Post × *Proximity 2* store	152.60*	74.10*	84.01	-3.23
	(86.81)	(39.29)	(63.06)	(2.08)
Constant	446.13***	376.63***	874.68***	30.13***
	(72.00)	(70.76)	(115.07)	(4.60)
Store Fixed Effects?	Yes	Yes	Yes	Yes
Time Fixed Effects?	Yes	Yes	Yes	Yes
Observations	14,841	14,841	14,841	14,841
R-squared	0.9209	0.9496	0.9304	0.7896

Observations at the store-month level. *Proximity 1* store is a dummy variable = 1 if the Oregon liquor store is one of the three closest stores to each of the 13 designated WA-OR border crossings. *Proximity 2* store is a dummy variable = 1 if the Oregon liquor is located in a WA-OR border county but is not a *Proximity 1* store. Dependent variable is monthly spirit liter sales by volume and liquor type for all bottles 750 ml and greater. June 1, 2012, refers to the date privatization began in Washington state. Bootstrap methods with standard errors clustered at the county level employed in all specifications and given in parentheses. *** p<0.01, ** p<0.05, * p<0.1

References

Alm, James, and Mikhail I. Melnik. 2012. "Does Online Cross-Border Shopping Affect State Use Tax Liabilities?" Tulane University Tulane Economics Working Paper Series 1206.

Asplund, Marcus, Richard Friberg, and Frederik Wilander. 2007. "Demand and Distance: Evidence on Cross-Border Shopping." *Journal of Public Economics*, 91(1–2): 141–157.

Beard, T. Randolph, Paula A. Grant, and Richard P. Saba. 1997. "Border-Crossing Sales, Tax Avoidance, and State Tax Policies." *Southern Economic Journal*, 64: 293–306.

Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan. 2004. "How Much Should We Trust Difference-in-Differences Estimates?" *The Quarterly Journal of Economics*, 119: 249–275.

Chan, Tat Y., V. Padmanabhan, and P. B. Seetharaman. 2007. "An Econometric Model of Location and Pricing in the Gasoline Market." *Journal of Marketing Research*, 44(4): 622–635.

Doyle, Joseph J. Jr., and Krislert Samphantharak. 2008. "$2.00 Gas!: Studying the Effects of a Gas Tax Moratorium." *Journal of Public Economics*, 92: 869–884.

Fox, William F. 1986. "Tax Structure and the Location of Economic Activity Along State Borders." *National Tax Journal*, 39(4): 387–401.

Garrett, Thomas A., and Thomas L. Marsh. 2002. "The revenue impacts of cross-border lottery shopping in the presence of spatial autocorrelation." *Regional Science and Urban Economics*, 32: 501–519.

Goolsbee, Austan. 2000. "In a World Without Borders: The Impact of Taxes on Internet Commerce." *Quarterly Journal of Economics*, 115: 561–576.

Goolsbee, Austan, Michael F. Lovenheim, and Joel Slemrod. 2010. "Playing with Fire: Cigarettes, Taxes, and Competition from the Internet." *American Economic Journal: Economic Policy*, 2(1): 131–154.

Heckman, James J., and Joseph Hotz. 1989. "Choosing Among Alternative Nonexperimental Methods for Estimating the Impact of Social Programs: The Case of Manpower Training." *Journal of the American Statistical Association*, 84: 862–874.

Knight, Brian, and Nathan Schiff. 2012. "Spatial Competition and Cross-Border Shopping: Evidence from State Lotteries." *American Economic Journal: Economic Policy*, 4: 199–229.

Lovely, Mary E. 1994. "Crossing the Border: Does Commodity Tax Evasion Reduce Welfare and Can Enforcement Improve It?" *The Canadian Journal of Economics*, 27(1): 157–174.

Lovenheim, Michael F. 2008. "How Far to the Border?: The Extent and Impact of Cross-Border Casual Cigarette Smuggling." *National Tax Journal*, 58: 281–302.

Merriman, David. 2010. "The Micro-Geography of Tax Avoidance: Evidence from Littered Cigarette Packs in Chicago." *American Economic Journal: Economic Policy*, 2(2): 61–84.

Slemrod, Joel, and Shlomo Yitzhaki. 2002. "Tax Avoidance, Evasion, and Administration." *Handbook of Public Economics*, 3(1): 1423–1470.

Stehr, Mark. 2007. "The Effect of Sunday Sales Bans and Excise Taxes on Drinking and Cross-Border Shopping for Alcoholic Beverages." *National Tax Association*, 60(1): 85–105.

Thompson, Jeffrey P., and Shawn M. Rohlin. 2013. "The Effect of State and Local Sales Taxes on Employment at State Borders." Federal Reserve Board, Division of Research and Statistics and Monetary Affairs Working Paper.

Tosun, Mehmet S., and Mark L. Skidmore. 2007. "Cross-Border Shopping and the Sales Tax: An Examination of Food Purchases in West Virginia." *The B.E. Journal of Economic Analysis and Policy*, 7(1): 1–20.

Walsh, Michael J., and Jonathan D. Jones. 1988. "More evidence on the 'border tax' effect: The case of West Virginia, 1979-84." *National Tax Journal*, 41(2): 261–265.

Winfree, J. A., and P. Watson. 2015. "Substitution of liquor sales across states." *Applied Economic Letters*, , (22): 891–894.

Ye, Yu, and William C. Kerr. 2015. "Estimated increase in cross-border liquor purchases by Washington following the privatization of liquor sales." Alcohol Research Group, Public Health Institute Working Paper.