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THE EFFECT OF POST-AND-HOLD LAWS ON ALCOHOL CONSUMPTION

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ABSTRACT

This paper estimates the effects of post-and-hold laws on alcohol consumption and price. Post-and-hold laws require alcohol wholesalers to provide a list of prices to the state, which can be reviewed by retailers, competitors and the public. These laws were generally enacted at the end of prohibition with the intention of limiting alcohol consumption by raising prices. The laws may also have the unintended consequence of protecting small retailers. Recently, several large retailers have argued in court that these laws are counter to the Sherman Act, which limits anti-competitive behavior. This paper follows the recent paper by Cooper and Wright (2012) and adds new data and new statistical tests. Both difference-in–difference models and synthetic control models are employed. The estimation results provide no persuasive evidence of an effect of post-and-hold laws on the consumption of either beer, wine, or spirits. There is also no persuasive evidence that the laws increase the prices of these products. One possible explanation of this null effect is that the wholesale markets for alcohol are so highly regulated that post-and-hold laws have no discernable marginal effect. The empirical results presented in this paper do support alcohol excise taxes as effective means of reducing alcohol consumption.

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1. Introduction

Alcohol is the third-leading cause of preventable mortality in the United States (Mokdad, 2004). This mortality includes deaths from liver cirrhosis and alcohol related fatal motor vehicle accidents. Heavy drinking is also a major risk factor for heart disease and various forms of cancer (Grønbæk et al., 2000). Alcohol has also been found to play a significant role in non-fatal accidents, violent crime, poor birth outcomes, marital instability, and unemployment (Wagenaar et al., 2010). Because much of these costs are borne by the state or by individuals who do not abuse alcohol, alcohol control is a justifiable goal of public policy.

Alcohol control policies include restrictions on the sale of alcohol, alcohol excise taxes and drunk driving laws. In the set of restrictions on the sale of alcohol, one group, which has been understudied, are laws governing the economic behavior of alcohol wholesalers. The modern history of laws affecting alcohol wholesalers begins with the enactment of the Twenty-First Amendment. At that time, many states adopted a system to regulate alcohol sales known as the License system.[1] Each License state has an elaborate bureaucracy, which enforces alcohol laws and violators can lose their license to operate. Under the License system, firms can be producers, distributors or retailers but vertical integration is prohibited.[2] Many of the states that chose the License system also enacted a set of laws, which govern the economic relationship between wholesalers and retailers of alcohol. Morgan (1988) cites the 1933 report by Fosdick and Scott, which provided the plan for the states to regulate the distribution of alcohol as prohibition was ended. The goals of the plan were to maximize tax revenues while promoting temperance.

The four key wholesaler laws are minimum mark-up laws, volume discount laws, limits on credit to retailers, and post-and-hold laws. In theory, these wholesale laws have the effect of protecting smaller retailers. This has an ambiguous effect on public health because it may

[1] A smaller number of states chose state-run monopolies for the wholesale and/or retail sale of spirits and/or wine. All states except Utah and Alabama are License for wholesale beer.
[2] Recent changes in Washington State allow retailers to act as distributors.

increase average prices but it may also increase the number of retail outlets. Each of these laws is beverage specific. That is, the specific wholesale laws for beer, for wine and for spirits can all be different. Minimum mark-up requires that wholesalers establish a minimum markup for each product sold based on the producer's price. Volume discounting laws require wholesalers to charge the same price for products regardless of the amount purchased by retailers. Credit restriction laws limit the wholesalers' options to provide credit to retailers and thus raise the cost of doing business to retailers. Post-and-hold laws require wholesalers to provide a list of prices to the state, which can be reviewed by retailers, competitors and the public. The hold component requires that these prices be held for a set amount of time (usually 30 days), which allows all retailers the opportunity to make purchases at the same price. The post-and-hold laws are typically tied to minimum pricing and volume discounting laws. Under post-and-hold laws, quantity discounts are prohibited and wholesalers are required to provide the same price schedule to all retailers. Some states also have a formula that maps posted wholesale prices into minimum retail prices, which prevents retailers from pricing below cost. Post-and-hold laws reduce price competition among both retailers and wholesalers because the posted prices are locked in for a set amount of time.

One reason that the effects of the state wholesaler laws are an important research subject is that several large alcohol retailers have argued that the state wholesaler laws are in conflict with the Sherman Act, which limits anti-competitive behavior. This is also a state-federal conflict since the authority to regulate alcohol is a state prerogative while the Sherman act is a federal law. A series of court challenges brought by retailers against state governments have addressed this conflict without any overall resolution to date. In Granholm v. Heald (2005), the Supreme Court struck down laws in New York and Michigan that allowed for within-state direct shipments from wineries to consumers, but banned out-of-state shipments. This ruling established that state alcohol regulations could be in violation of federal antitrust laws. In Costco v. Hoen (2009), the state of Washington's liquor laws were subjected

to scrutiny under the Sherman Act. Costco failed to win a court victory but subsequently succeeded in changing the laws through a voter initiative. In Maryland, a large retailer successfully sued the state to end post-and-hold pricing system and the prohibition of volume discounts (TFWS v. Schaefer et al., 2004, final appeal 2009).[3] Also, governor Malloy of Connecticut has argued for repeal of Connecticut's post and hold law because he believes it creates excessive restrictions on competition and pricing (Hartford Courant, Feb 13, 2015). In Michigan, the Mackinac Center for Public Policy, has lobbied the Michigan Alcohol Control Commission to rescind the state's post-and-hold law as anticompetitive.

The courts have noted that there is very little research to date on the effect of the wholesaler laws on alcoholrelated public health. Two reasons for the limited prior research on alcohol wholesale laws are the difficulty of collecting data on these laws and the limited number of changes in the laws over time. A study by Ornstein and Hanssens (1985) using data from 1974-1978 finds that post-and-hold laws and minimum markups increased the price of spirits. Jaeger and Storchmann (2011) conclude that the state alcohol price laws more or less effectively abolish competition between wine retail outlets, which should increase prices. The most recent and comprehensive study was by Cooper and Wright (2012) who show that the post-and-hold laws reduce consumption by 2–8%. However, they find no relationship between post-and-hold laws and drunk driving accidents nor with underage drinking.

This paper specifically examines the empirical inconsistency between consumption and the other outcomes found by Cooper and Wright (2012). Our paper resolves these inconsistencies and expands the work by Cooper and Wright in several respects. We first recreate the empirical work on alcohol consumption presented by Cooper and Wright (2012) and get the same results as they did. Next, we add alcohol consumption data from 2005 to 2012. We also analyze data on beer, wine and spirits prices. Finally, we extend the statistical work to also include synthetic control models and fix a coding error in the post-and-hold status

[3] http://www.ca4.uscourts.gov/Opinions/Published/072108.P.pdf

of Massachusetts. For alcohol consumption, adding additional years leads to a critical change in results. We no longer find a significant effect of post-and-hold laws on alcohol consumption. On the one hand, it is positive that our findings for consumption align with Cooper and Wright's (2012) findings for drunk driving and underage drinking. On the other hand, the lack of robustness with respect to different time windows is troubling. Thus, additional analyses using price data and the synthetic controls method were added to ensure our finding is not just an anomaly. All of these new results confirm Cooper and Wright's (2012) conclusion that post-and-hold laws do not reduce alcohol consumption or affect alcohol prices. This new evidence on the ineffectiveness of these laws is important to both the courts and to the states with these laws because of the increasing pressure to eliminate them. Our research is also important to public health in that efforts to support these laws are not likely to reduce problems with excessive alcohol consumption.

2. Data

The study of wholesaler laws is complicated by both the limited time variation in state wholesaler laws and the limited availability of historical data. States, which employ a state-owned monopoly for the wholesaling of alcohol, by beverage type, are not included because the wholesaler laws relate only to private wholesalers. Two states are monopoly for wholesale beer, three states are monopoly for wholesale wine and 18 states are monopoly for wholesale spirits. Data on post-and-hold laws for beer, wine and spirits from 1983 to 2010 were published by Cooper and Wright (2012) and checked for consistency with the newly published wholesaler laws in the Alcohol Policy Information System (APIS).[4] We used the APIS to extend the sample period provided by Cooper and Wright (2012) to 2012.

[4] The data are from: http://www.alcoholpolicy.niaaa.nih.gov. The only discrepancy was for Massachusetts, which has a post-and-hold law. Cooper and Wright (2012) did not include Washington State in their regressions, but did present Washington State data in a descriptive table. Washington State temporarily dropped their post-and-hold law in 2008 but the court required that it be reinstated.

The wholesaler law data were merged with alcohol consumption data, alcohol demand variables and alcohol tax and alcohol price data. Data on beer, wine and spirits and? per capita consumption of alcohol was obtained from the National Institute on Alcohol Abuse and Alcoholism.[5] Data is currently available up until 2012. Consumption is reported on the state level in ethanol equivalent gallons and is divided by the state population that is 14 years of age and older. The independent variables include measures related to alcohol demand. Data on the percentage of the population, by year-state aggregate, who are white, married and age 18 or older were included. Also, data on median household income per capita was included. These data are available from the US Census. Data on the percentage of the population, by year-state aggregate, that are members of Evangelical or Catholic religious institutions comes from the Association of Religious Data Archives.[6] These surveys are done every 10 years and thus the percentages between survey dates were interpolated. Finally, information on zero tolerance laws, blood alcohol concentration laws and the minimum legal drinking age come from the National Highway Traffic Administration.[7] The beer excise tax, wine excise tax and spirits tax come from the Brewers Almanac, the National Tax Foundation and state-specific sources.[8]

Average state beer and wine prices were calculated from American Chamber of Commerce Research Association (ACCRA, now known as C2ER) data. The ACCRA records the price of a few standardized items in at least one store in most metropolitan areas across the U.S. In terms of alcoholic beverages, the ACCRA data collects the price of a six-pack of Budweiser, a 1.5-liter bottle of Paul Masson/Livingston/Gallo Chablis or Chenin Blanc, and of 750ml J&B scotch. The collection of spirits prices has been stopped in 2004. The ACCRA data are reported by city and by quarter. Minor adjustments were made to the data to correct for

[5] http://pubs.niaaa.nih.gov/publications/surveillance98 /CONS12.pdf. These data are currently available only to 2012.
[6] http://www.thearda.com/
[7] http://www.nrd.nhtsa.dot.gov/Pubs/810942.pdf
[8] http://taxfoundation.org

changes in the survey brands.[9] The ACCRA data have been criticized for small sample sizes and reliance on only one beer product and one wine product (Ruhm, 2012). The sample size problem was corrected to some degree by computing population weighted year-state average prices. Sample means and standard deviations are provided in Table 1.

[9] ACCRA switched beer brand from Budweiser to Heineken in 2000. A state specific correction factor equal to the 1999 price of Budweiser divided by the 2000 price of Heineken was calculated and used to adjust the Heineken prices to approximate Budweiser prices. A minor adjustment was made in the wine price to correct for changing brands in a single year and for bottle size.

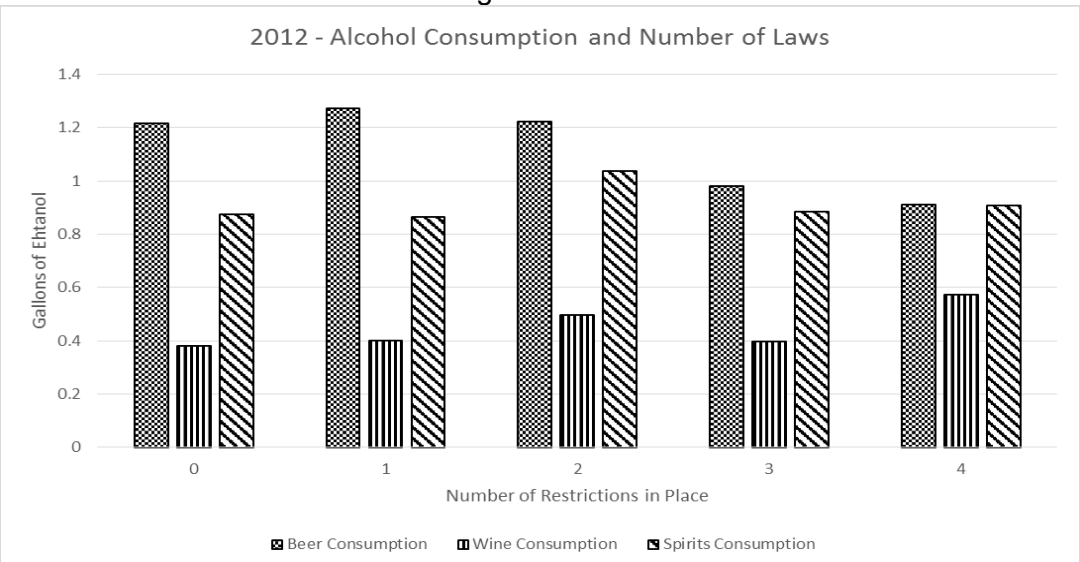
Table 1: Summary Statistics

Variable Name	Definition	Mean	SD
Per Capita Beer Consumption	Beer consumption in gallons of ethanol divided by population over 14.	1.29	0.22
Per Capita Wine Consumption	Wine consumption in gallons of ethanol divided by population over 14.	0.33	0.18
Per Capita Spirits Consumption	Spirits consumption in gallons of ethanol divided by population over 14.	0.79	0.31
ACCRA Beer Price	Dollar price of a six-pack of Budweiser, from ACCRA.	$4.29	1.01
ACCRA Wine Price	Dollar price of a 1.5-liter bottle of Gallo Sauvignon Blanc.	$5.80	1.14
ACCRA Spirits Price	Dollar price of a 1-liter bottle of J&B scotch.	$17.57	2.78
Post-and-Hold Law for Beer	A dichotomous variable that equals one if a post-and-hold law for beer was in place in a state at a given time.	0.23	0.42
Post-and-Hold Law for Wine	A dichotomous variable that equals one if a post-and-hold law for time wine was in place in a state at a given time.	0.26	0.44
Post-and-Hold Law for Spirits	A dichotomous variable that equals one if a post-and-hold law for spirits was in place in a state at a given time.	0.27	0.45
Beer Tax (per Gallon)	The sum of federal and state excise taxes per gallon of beer	$0.74	0.25
Wine Tax (per Gallon)	The sum of federal and state excise taxes per gallon of wine	$1.52	0.69
Spirits Tax (per Gallon)	The sum of federal and state excise taxes per gallon of spirits	$16.63	3.54
Income	Median nominal household income in $1000.	$37.43	11.39
Married	Percentage of the population that is married	0.54	0.05
White	percentage of the population that is white	0.81	0.14
Age less than 18	Percentage of the population that is younger than 18 years old	0.26	0.03
Evangelical	State's percentage of Evangelicals	0.14	0.11
Catholic	State's percentage of Catholics	0.21	0.14
Law Requiring BAC less than .08 to drive	A dichotomous variable that equals one a legal BAC limit of .08	0.45	0.50
Minimum Legal Drinking Age of 21	A dichotomous variable that equals one if the state minimum drinking age is 21.	0.93	0.26
Zero Tolerance Laws	A dichotomous variable that equals one for states with zero tolerance laws for underage drunk driving.	0.58	0.49

A regression analysis of the volume discount, minimum price and credit restriction laws is not possible because we only have data on these laws from 2003 to 2014 and over this time period there is no time variation in these laws. However, a descriptive analysis provides some evidence on the effects of these laws. Figure 1 uses data from 2012 and shows annual gallons

of ethanol consumption per capita for states with zero to four laws. Beer, wine and spirits consumption data are presented. Typically, states have one or two laws and very few states have three or four laws. Figure 1 suggests that there is very little correlation between the number of laws and per capita ethanol consumption.

Figure 1



3. The Empirical Approach

3.1 Introduction

The empirical goal is to estimate the effect of post-and-hold laws on alcohol consumption and prices. Policy endogeneity can be a concern when estimating the effects of public policy. Endogeneity would be a concern if states with heavy social costs of alcohol enacted post-and-hold laws to reduce this problem. However, the enactment of the post-and-hold laws reflects alcohol sentiment in the distant past and the recent revocation of these laws in some states reflects the successful or threatened court cases brought by large alcohol retailers in the state. Thus, endogeneity of post-and-hold laws does not seem likely to be an important concern.

Two empirical approaches are employed. The first approach is a difference-in-difference model (DD). The intuition behind a DD model is to employ the change over time in states that

have not rescinded their post-and-hold laws as the counterfactual for the change experienced by states that did abolish their laws. The DD model isolates the effect of the policy change from the effect of both time-invariant unobservables and from the effect of other events that occur over the time period by estimating the difference over time between the control states and the treatment state. One concern with this method is that the choice of control states is arbitrary. The second empirical approach, the Synthetic Control (SC) method, mitigates this concern. The key advantage of SC is the choice of the comparison group (Abadie et al., 2010). Instead of using all available comparison states as the control group for a treatment state, SC constructs a counterfactual as a weighted combination of this "donor pool" of states. The weights are chosen to minimize the difference in pre-intervention characteristics between the synthetic control group and the outcome in the treatment state in the pre-treatment period. Thus, the control group is selected to provide the best match for the treatment state. To ensure that the synthetic versions of the treatment state resembles the actual treatment state, both in terms of the pre-treatment characteristics and in terms of the outcome of interest, Abadie et al. (2010) recommend that lagged values of the outcome variable should be used as matching variables. Following this recommendation, 1-year and 2-year lags in alcohol consumption and prices were employed as predictors. A disadvantage of SC is that only one policy change can be evaluated at a time and in most cases there are a limited number of donor states which impacts inference.

3.2 Difference-in-Difference Results

The following DD model is estimated, following Angrist and Pischke (2009):

$$Y_{stj} = \theta_1 PH_{stj} + \theta_2 EX_{stj} + \theta_3 X_{st} + \eta_s + \eta_t + \eta_{st} + \mu_{stj} \qquad (1)$$

Y_{stj} is the outcome of interest, i.e. either alcohol consumption or alcohol prices, in state s, at time t, for beverage type j (beer, wine, spirits). PH_{stj} indicates the presence of a post-and-hold law for beverage j in a state s, at time t. EX_{stj} is the sum of federal and state excise taxes, X_{st} represent

other alcohol demand variables, η_s are state fixed effects, η_t are time fixed effects, η_{st} are linear state specific time trends and μ_{stj} is an idiosyncratic error.

The key identifying assumption in the DD models is the common-time trend assumption. That is, trends in alcohol consumption and prices would have been the same in both treatment and control states had the post-and-hold laws never been rescinded in the treatment states. Obviously, the counterfactual scenario of no treatment in the treatment state cannot be observed. However, the time trend in states with and without a post-end-hold law can be observed. If these time trends are similar, the assumption that without the treatment, treatment states would have behaved similar to control states is believable. These data for alcohol consumption and price are presented in Figures 2-7 and suggest that this is indeed the case. The solid lines represent consumption and prices in states which have post-and-hold laws in place, the dashed line shows the same time trends for states without post-and-hold laws. Within the graphs, states are shifted from the treatment into the control group based on changes in their laws. For example, Delaware rescinded its post-and-hold law for wine and spirits in 1999 and thus is in the post-and-hold group up until 1999 and subsequently in the no post-and-hold group.

In Figure 3, which shows the data for per-capita beer consumption, the difference between the two lines is virtually constant. In Figures 4 and 6, for wine and spirits consumption, respectively, the time pattern is very similar for states with and without post-and-hold laws. Figure 2 and figure 6 show that beer and spirits consumption in states that have post-and-hold laws is higher than in states without the laws although the reverse is true for wine consumption. Figures 3, 5 and 7 show the time trends for beer, wine and spirits prices, respectively. Again, it is clear from these figures that there is a common time trend in prices for both the states with post-and-hold laws and without post-and-hold laws. It is important to note that differences in levels between what are essentially the treatment and control groups are *not* a threat to the identification strategy. The key identifying assumption is that the *trends* in alcohol consumption,

not the levels, are the same in both types of states. The raw data suggests that this is indeed the case for both alcohol consumption and prices.

Figure 2: Beer Consumption (Gallons of Ethanol) - 1983-2012

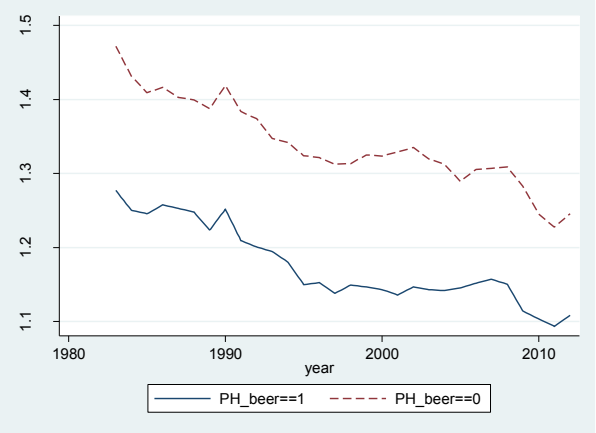


Figure 3: Beer Prices (Six-pack Budweiser) -1983-2012

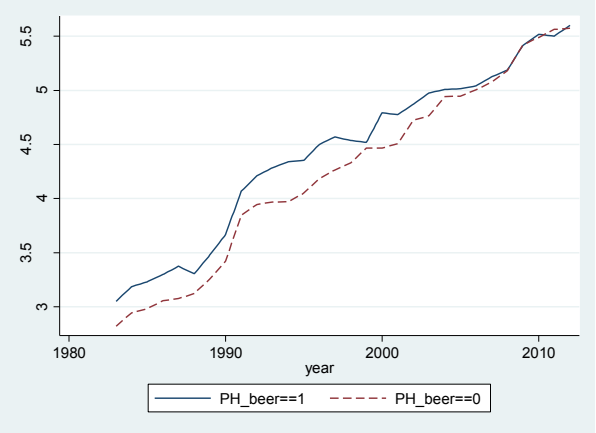


Figure 4: Wine Consumption (Gallons of Ethanol) - 1983-2012

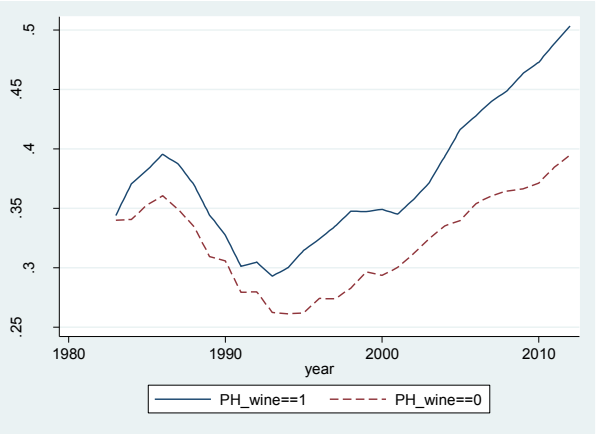


Figure 5: Wine Prices (1.5 liter Gallo Sauvignon Blanc) - 1983-2012

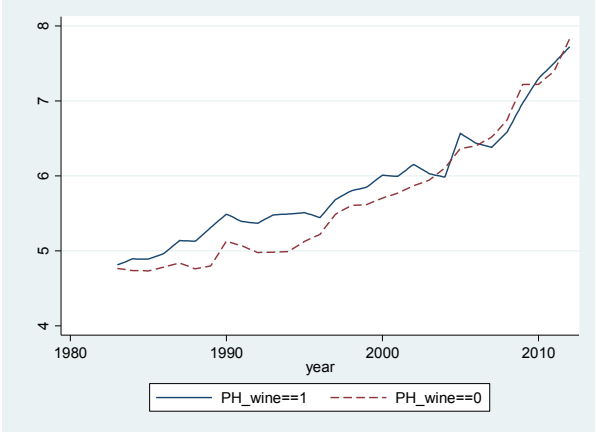


Figure 6: Spirits Consumption (Gallons of Ethanol) - 1983-2012

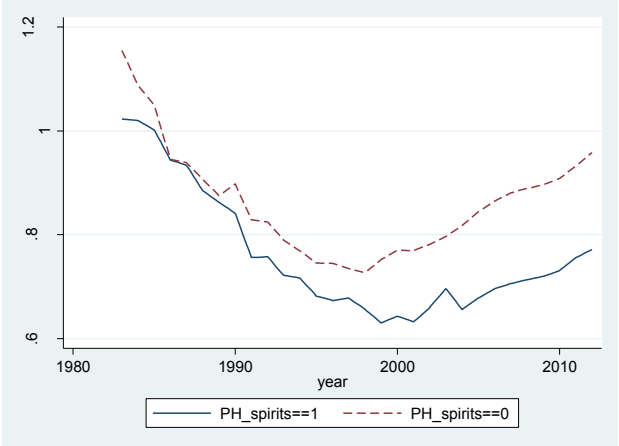
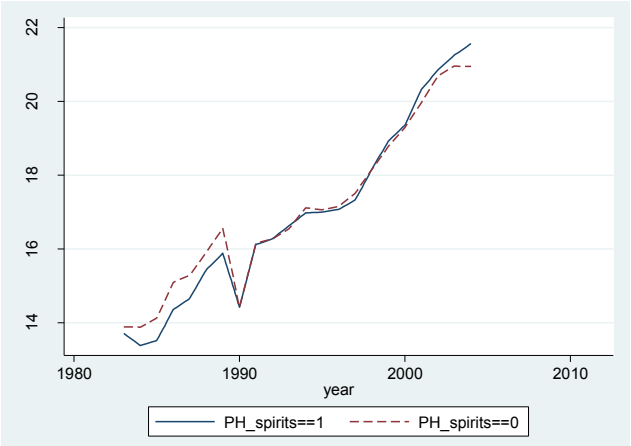


Figure 7: Spirits Prices (1liter J&B Scotch) - 1983-2004



The DD results for the effects of post-and-hold laws on beer, wine and spirits consumption are presented in Table 2 and for prices in Table 3. The specifications are based on equation (1). All regression models were estimated with state level clustered standard errors, and all specifications included state and year fixed effects. There are three specifications for each of the three beverages for a total of nine regressions in each table. The first specification in each set includes only the post-and-hold law, the excise tax and the state and time fixed effects. The second specification in each set adds demographic variables, religion variables, drunk driving laws. The third specification in each set adds a state-specific time linear trend variable. State-specific linear trend variables can help control any correlation between a change in the post-and-hold law and other trends affecting state-level alcohol consumption. These specifications parallel those employed by Cooper and Wright (2012).

The results in Table 2 show that the coefficient of the post-and-hold law is negative in all specifications although statistically significant in only four out of nine specifications. It is standard practice in DD settings to test the result of robustness to an inclusion of linear state-specific time trends. The post-and-hold law coefficients do not hold up to this robustness check, and are rendered insignificant. These models represent the preferred specification, as it is conceivable that there are idiosyncrasies that change within states over time. Such heterogeneity in trends is then accounted for by including state-specific time trends. Problems associated with including linear state-specific trends, such as endpoint bias or extreme state-specific one-time events associated with alcohol consumption/prices, appear to not play an important role in the data at hand.[10]

In the preferred models with state-specific time trends, the effect of post-and-hold is negative for wine and spirits and marginally statistically significant. Cooper and Wright (2012) reported highly significant effects that are about twice the size but only employed data from 1983-2004. To examine the discrepancy between their results and our results more carefully, a

[10] Wolfers (2006) describes the problems with state-specific linear time trends in detail.

set of regressions using the same data, but with the sample period limited to 1983 to 2004 were also estimated. These regressions produced the same results as reported by Cooper and Wright (2012). Thus, the results are not robust with respect to the length of the post-change sample period. Overall, the DD results provide some evidence for the notion that post-and-hold laws result in lower alcohol consumption.

The results presented in Table 2 for beer and spirits indicate that taxes have a significant and negative effect on consumption. The average tax per gallon of beer is 74 cents per gallon and the estimated tax elasticity for beer is about -0.15, which is consistent with past studies (Dave and Saffer, 2008). The average spirits tax is $16.63 per gallon and the estimated spirits tax elasticity is thus about -0.32.[11]

Table 3 presents the results for the effects of post-and-hold laws and excise taxes on beer, wine and spirits prices. Post-and-hold laws should raise prices but all of the coefficients for post-and-hold are negative and three even are marginally significant. However, in the specification including state-specific time trends, none of the post-and-hold coefficients is significant. There is, therefore, little evidence for the notion that post-and-hold laws increase prices. On the other hand, excise taxes are positively associated with prices in Table 3. The point estimates are significant in seven out of nine specifications and generally robust to the inclusion of time-specific trends. The estimated sizes of the pass-throughs for beer, wine and spirits, respectively are 0.6, 1.4 and 1.5. These values as consistent with previous studies and indicate limited competition in the wine and spirits markets. This consistency of the tax results across studies also add credibility to these models and suggest that the results for post-and-hold laws are also valid.

[11] The limited published data on the spirits tax elasticity suggests that it is larger in absolute value than the beer tax elasticity.

Table 2: 1983-2012 DD Ln per capita Alcohol Consumption (in Gallons of Ethanol)

VARIABLES	(1) Beer Cons.	(2) Beer Cons.	(3) Beer Cons.	(4) Wine Cons.	(5) Wine Cons.	(6) Wine Cons.	(7) Spirits Cons.	(8) Spirits Cons.	(9) Spirits Cons.
PH-law	-0.044***	-0.044**	-0.006	-0.069	-0.083	-0.034*	-0.056	-0.075	-0.037*
	(0.006)	(0.017)	(0.005)	(0.070)	(0.064)	(0.017)	(0.083)	(0.072)	(0.019)
Tax	-0.174***	-0.197***	-0.064***	-0.033	-0.042	0.059	-0.022***	-0.028***	-0.016**
	(0.033)	(0.057)	(0.020)	(0.045)	(0.053)	(0.041)	(0.007)	(0.007)	(0.006)
Observations	1,445	1,445	1,445	1,355	1,355	1,355	957	957	957
R-squared	0.874	0.903	0.966	0.961	0.964	0.983	0.932	0.949	0.978
State-Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demo/Demand Factors	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Religion	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Alcohol Laws	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
State-Specific Trends	No	No	Yes	No	No	Yes	No	No	Yes

Robust standard errors in parentheses; standard errors are clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. The dependent variables are the log of beer, wine, and spirits consumption respectively. Consumption is measured in gallons of ethanol. Post-and-hold law is a dummy that equals one if a post-and-hold law for the respective beverage was in place in a state at a given time. The tax refers to the sum of federal and state excise taxes per gallon of beer, wine, and spirits respectively. Demographic controls and demand factors include a state's median household income, percentage of the population that is white, percentage of the population that is younger than 18 years old, percentage of the population that is married. Religion controls are a state's percentage of Catholics and a state's percentage of Evangelicals. Controls for alcohol laws consist of three dummies, indicating the presence of minimum drinking age laws for age 21, a legal BAC limit of .08, and zero tolerance laws for underage drunk driving.

Table 3: 1983-2012: DD in Alcohol Prices (per Gallon)

VARIABLES	(1) Beer Price	(2) Beer Price	(3) Beer Price	(4) Wine Price	(5) Wine Price	(6) Wine Price	(7) Spirits Price	(8) Spirits Price	(9) Spirits Price
PH-law	-0.308	-0.290	-0.281	-0.800*	-0.892*	-0.061	-1.467**	-0.559	-2.719
	(0.404)	(0.402)	(0.351)	(0.399)	(0.518)	(0.613)	(0.718)	(0.760)	(1.736)
Tax	0.405*	0.418	0.635*	1.364*	1.434**	1.150	1.666***	1.636***	1.506***
	(0.237)	(0.282)	(0.330)	(0.725)	(0.707)	(0.763)	(0.444)	(0.489)	(0.363)
Observations	1,377	1,377	1,377	1,293	1,293	1,293	656	656	656
R-squared	0.911	0.915	0.970	0.838	0.847	0.900	0.942	0.947	0.967
State-Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time-Fixed-Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demo/Demand Factors	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Religion	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Alcohol Laws	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
State-Specific Trends	No	No	Yes	No	No	Yes	No	No	Yes

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. The dependent variables are the per gallon dollar prices of a six-pack of Budweiser, 1.5 liters of Gallo Sauvignon Blanc, and a 1 liter bottle of J&B scotch, respectively. Post-and-hold law is a dummy that equals one if a post-and-hold law for the respective beverage was in place in a state at a given time. The tax refers to the sum of federal and state excise taxes per gallon of beer, wine, and spirits respectively. Demographic controls and demand factors include a state's median household income, percentage of the population that is white, percentage of the population that is younger than 18 years old, percentage of the population that is married. Religion controls are a state's percentage of Catholics and a state's percentage of Evangelicals. Controls for alcohol laws consist of three dummies, indicating the presence of minimum drinking age laws for age 21, a legal BAC limit of .08, and zero tolerance laws for underage drunk driving.

3.3 Synthetic Control Results

Additional statistical testing for an effect of the post-and-hold laws is warranted partially because the DD results were not robust with respect to the length of the post-change sample period. SC can be employed when there is a single policy change and a sufficient amount of pre-intervention data to create a good control group. There is sufficient pre-intervention consumption data available and with some exceptions sufficient price data. In order to construct as good a match as possible, we always use all available pre-treatment years, as is common practice. If the post-and-hold law has an effect, there should be substantial post-treatment differences between the treatment and the synthetic control group. These differences are measured as the mean square prediction error (MSPE) or, in order to better account for outliers, the square root of the mean squared prediction error (RMSPE). The effect of the treatment is evaluated by the ratio of the post-treatment RMSPE to the pre-treatment RMSPE. The pre-treatment RMSPE tends to be relatively small since the synthetic control state is designed to resemble the treatment state during that time period. A relatively large RMSPE in the post-treatment period, which is defined as the three years following the law change, is evidence that the intervention had an effect.

The significance of the estimated treatment effect can be gauged through a set of falsification tests, termed placebo tests. Each state in the donor pool is tested as if it were the state with the treatment. Because the intervention never actually occurred in donor pool states, the RMSPE-ratios should be much smaller than the true treatment state ratio. If, however, the RMSPE ratios instead resemble those obtained from the true treatment state, then this is a strong indication that the intervention had no effect. Thus, the placebo tests provide a distribution of RMSPE ratios, and the RMSPE ratio of the true treatment should be located in the upper tail of this distribution to conclude that the intervention had an actual effect.

Abadie et al. (2010) argue that a p-value can be constructed by calculating the percent of placebo ratios that are greater than or equal to the treatment state ratio. This value can be

interpreted as the probability of obtaining an estimate at least as large as the estimate obtained for the actual treatment state when the intervention is assigned at random. However, when there are only a small number of placebo tests for a given treatment, the calculated p-value will be artificially large, biasing the inference towards no effect. Dube and Zipperer (2015) argue that when there are multiple SC case studies, the data from each study can be employed to construct a p-value for the set of studies. They provide a table of critical values based on alternative significance levels and number of case studies. For post-and-hold laws there are distributional assumptions, which may limit the validity of a group p-value. The graphical presentation of this significance criterion can be seen in figures 8-13. When the ratios for a set of SC cases show that treatment state falls within the range of the placebo states, it can be interpreted as no effect of the treatment.

Given the data and the requirements of the SC test, there are nine sets of results for consumption and six sets of results for price. To provide a concise presentation, the results from the SC tests are grouped into six figures. Figures 8-10 present the results for beer, wine and spirits consumption, respectively and figures 11-13 present the results for beer, wine and spirits prices, respectively. In each figure, the lowest horizontal line provides a numeric scale for the ratio of the post-treatment RMSPE to the pre-treatment RMSPE for all of the tests in the figure. Each of the other horizontal lines presents the results for a state-specific change in the post-and-hold law and the results for all the related placebos. The data points on each line are the ratios for the placebo states and the actual treatment state. Only the treatment state is labeled and is represented by a square rather than a point.

Figure 8 shows that for beer consumption all of the treatment states fall within the range of their own placebos and fall within the range of the set of all placebos. The calculated p-value is .466, which indicates that changes in the beer post-and-hold laws had no effect on beer consumption. Figure 9 shows that for wine consumption, all but one of the treatment states fall within the range of their own placebos. However, all treatment states fall within the range of the

set of all placebos. The calculated p-value is .403. This indicates that changes in the wine post-and-hold laws also had no effect on wine consumption. Figure 10 shows that for spirits consumption both treatment states fall within the range of their own placebos. The estimated p-value is .095. These results generally confirm the DD results. That is, improving the choice of control groups by means of SC, still results in no effect of post-and-hold laws on alcohol consumption.

Figure 11 displays the SC results for beer prices.[12] For beer, Washington introduced post-and-hold laws in 1995 and has a higher RMSPE-ratio than its placebos. Pennsylvania, which revoked its post-and-hold law in 1999, also has a relatively large RMSPE-ratio. The estimated aggregate p-value for this series is .022. Figure 12 shows that for wine, all states fall within the range of their own placebos. The p-value is .200. In Figure 13, only Delaware is included and it falls within the range of its placebos with a p-value of .333.[13]

Generally, for price, the treatment state RMSPE-ratios fall within the range of the set of all placebos, indicating that changes in the post-and-hold laws have had no effect. The single exception is Washington State for beer. However, Washington State is not a large outlier. For instance, the treatment country in Abadie et al. (2012) had a RMSEP-ratio that was 50% larger than the RMSPE-ratio for the nearest placebo. This is clear evidence for a treatment effect. For the largest outlier in this study, this difference is just 12.5%, which is not nearly as conclusive. Collectively, the evidence suggests that post-and-hold laws have not reduced consumption and have not raised prices.

[12] Oregon was not included because the required price data was not available.
[13] Maryland, which changed its post-and-hold laws for spirits in 2004, could not be included as the ACCRA ceased to collect price data on spirits in the same year.

Figure 8: RMSPE-Ratios Synthetic Control Method: Beer Consumption

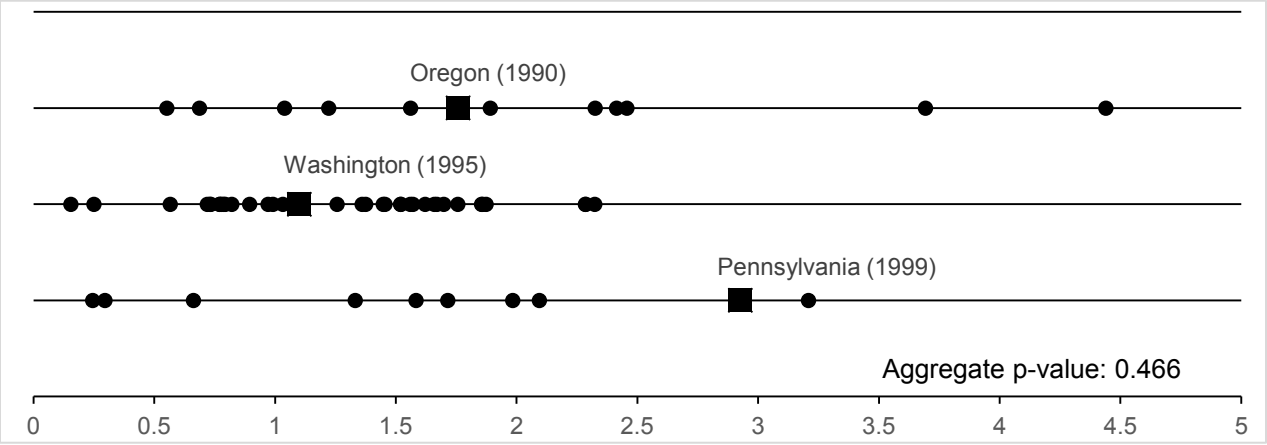


Figure 9: RMSPE-Ratios Synthetic Control Method: Wine Consumption

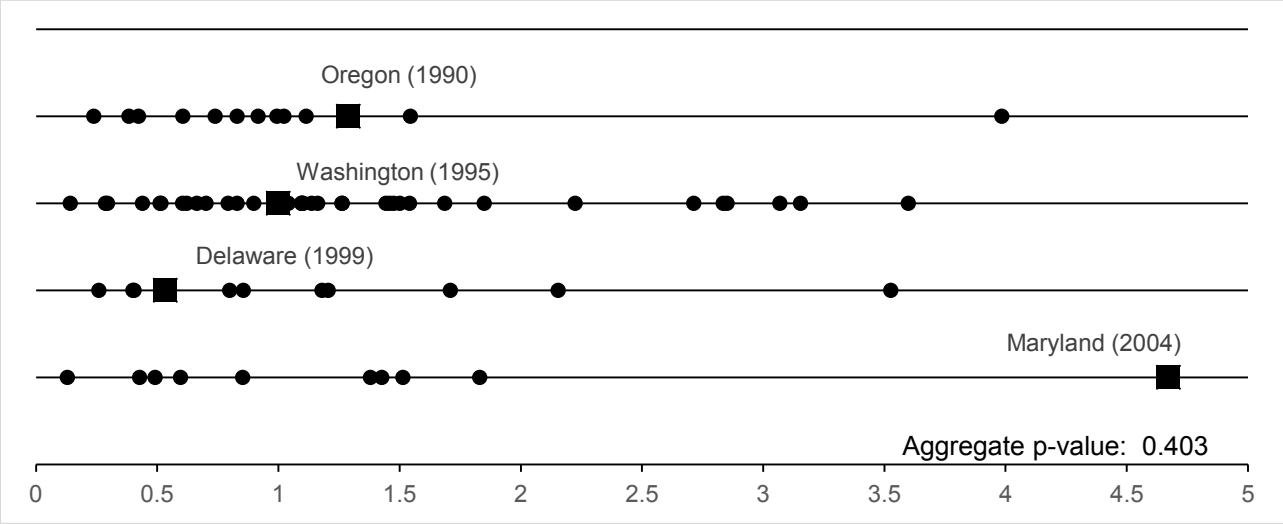
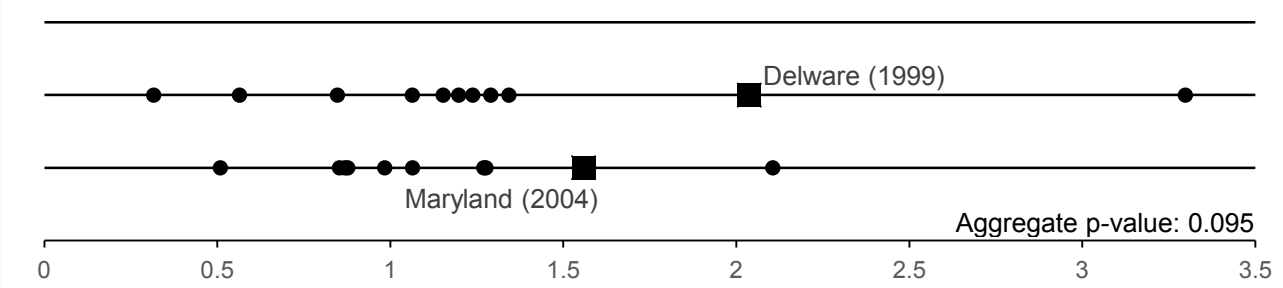


Figure 10: RMSPE-Ratios Synthetic Control Method: Spirits Consumption



Figures 7-9 show the ratios of the post-treatment root mean squared prediction error (RMSPE) to the pre-treatment RMSPE. Squares denote states in which a post-and-hold law change actually occurred. Circles denote the RMSPE-ratio for placebo states, i.e. states in which the laws actually never changed. If the intervention had an effect, one would expect the squares to be outliers. The p-values correspond to the null hypothesis of no difference between actual and placebo interventions.

Figure 11: RMSPE-Ratios - Synthetic Control Method: Beer Prices

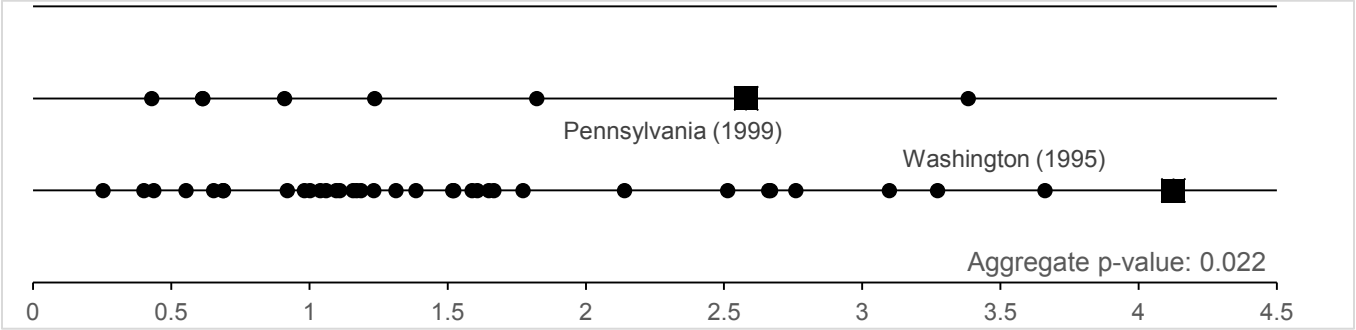


Figure 12: RMSPE-Ratios - Synthetic Control Method: Wine Prices

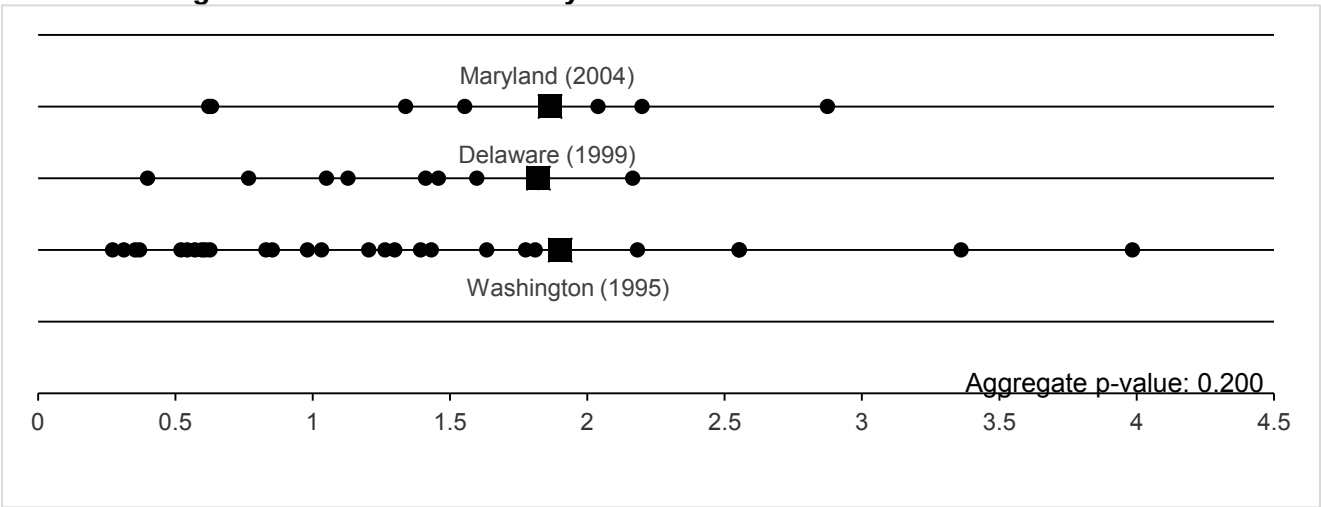
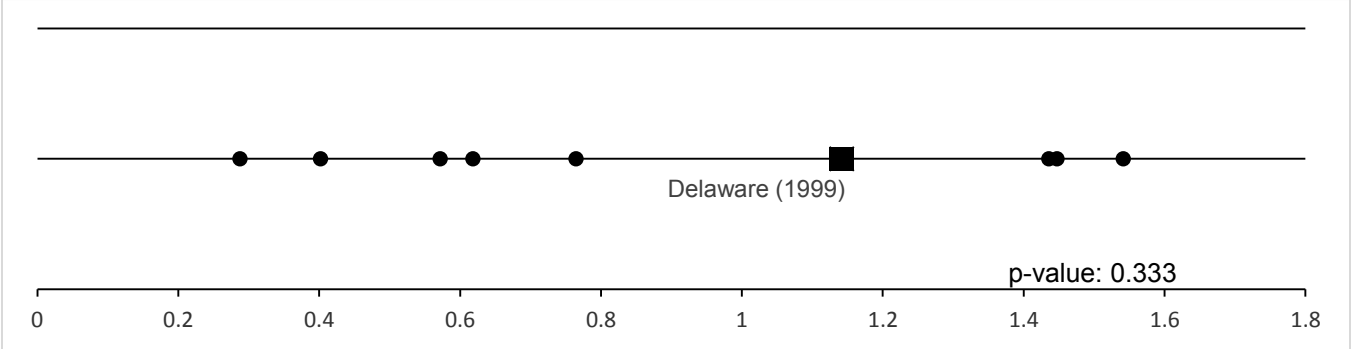


Figure 13: RMSPE-Ratios - Synthetic Control Method: Spirits Prices



Figures 10-12 show the ratios of the post-treatment root mean squared prediction error (RMSPE) to the pre-treatment RMSPE. Squares denote states in which a post-and-hold law change actually occurred. Circles denote the RMSPE-ratio for placebo states, i.e. states in which the laws actually never changed. If the intervention had an effect, one would expect the squares to be outliers. The p-values correspond to the null hypothesis of no difference between actual and placebo interventions.

4. Conclusion

The primary purpose of this paper is to evaluate the effectiveness of post-and-hold laws on alcohol consumption and price. Both DD models and SC models were employed with a 30-year panel of state level data. The estimation results provide no persuasive evidence of an effect of post-and-hold laws on the consumption of either beer, wine, or spirits. There is also no conclusive evidence that the laws increase the prices of these products. These results show that post-and-hold laws are ineffective in discouraging alcohol consumption. One possible explanation of these results is that the wholesale markets for alcohol are so highly regulated that post-and hold laws have no discernable marginal effect. For example, many states use mandated exclusive territories, which make wholesalers monopolists for specific products in specific areas.

The alcohol wholesaler laws, in theory, protect small alcohol retailers. This is difficult to empirically test because almost all states allow the sale of beer in grocery stores and many states allow the sale of wine and spirits in grocery stores. Comparisons of grocery stores are not useful because these stores sell a wide variety of other products. However, a comparison can be made by limiting the data to wine and spirits and to states that do not allow the sale of these products in grocery stores. There are only 10 states that fit these criteria. Figure 14 presents the number stores with five or less employees as a percent of all stores by the number of wholesale restriction in the included states. The number of small stores is about the same for zero, one and two restrictions. There are no states with three restrictions in this sample and only Connecticut has four restrictions. Figure 14 shows Connecticut has relatively more small alcohol retailers than the other states in this limited sample. These results could also be due to some other unobserved factors in Connecticut.

Figure 14
Small retailers as a percent of all retailers by number of restrictions

The empirical results for alcohol excise taxes are found to be associated with lower consumption and higher prices, which is consistent with the previous literature. Economic theory predicts that compared to regulation, taxation is often a more efficient way of internalizing negative externalities. Regulation can result in income for certain favored groups such as small retailers while taxes generate revenue for the state. In addition, the price mechanism has proven to be powerful at changing undesirable behavior. The empirical evidence in this paper and in other papers confirms these predictions. Taxes are more effective in driving up alcohol prices and reducing consumption than the post-and-hold laws. Of course, higher prices may not necessarily be welfare enhancing since most individuals drink moderately and do not cause any negative externalities.

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