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Effects of state cigarette excise taxes and smoke-free air policies on state per capita alcohol consumption in the U.S., 1980–2009

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Abstract

Background—Increasing state cigarette excise taxes and strengthening smoke-free air laws are known to reduce smoking prevalence. Some studies suggest that such policies may also reduce alcohol use, but results for cigarette taxes have been mixed and associations with smoke-free air policies have been limited to some demographic subgroups. To shed further light on the potential secondary effects of tobacco control policy, we examined whether increases in cigarette taxes and strengthening of smoke-free air laws were associated with reductions of per capita alcohol consumption and whether any reductions were specific to certain beverage types.

Methods—State per capita alcohol consumption from 1980–2009 was modeled as a function of state price per pack of cigarettes and smoke-free air policy scores while controlling for secular trends and salient state covariates. Both policy measures also accounted for local policies. Total alcohol, beer, wine, and spirits consumption per capita were modeled separately. For each type of beverage, we used a nested models approach to determine whether the two policies together were associated with reduced consumption.

Results—For total alcohol consumption, and for beer or spirits (but not wine), one or both tobacco policies were associated with reductions in consumption. A one percent increase in cigarette price per pack was associated with a 0.083% decrease in per capita total alcohol consumption (95% confidence interval [CI] 0.0002% to 0.166%, p=.0495), and a one point increase in SFA policy score, measured on a 6-point scale, was associated with a 1.1% decrease in per capita total alcohol consumption (95% CI 0.4% to 1.7%, p=.001; p<.001 for the hypothesis that the two policies are jointly associated with reduced alcohol consumption).

Conclusions—The public health benefits of increasing cigarette taxes and smoke-free policies may go beyond the reduction of smoking and extend to alcohol consumption, specifically beer and spirits.

Keywords

cigarette price; smoke-free air policy; alcohol sales; alcohol consumption

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Introduction

Cigarette smoking and alcohol consumption are often complementary behaviors (Room, 2004). Smokers are more likely than non-smokers to drink alcohol, and heavy smokers are more likely to be heavy drinkers (Johnson et al., 2000; Weitzman & Chen, 2005). Alcohol and tobacco contribute to a wide range of acute and chronic illnesses, and are among the top causes of preventable deaths in the U.S. (Danaei et al., 2009; Mokdad et al., 2004). Their combined use has multiplicative effects on cancers of the upper digestive and respiratory tract (Castellsague et al. 1999; Hashibe et al., 2009; Pelucchi et al., 2008; Saracci, 1987).

Increasing taxes on cigarettes and strengthening smoke-free air (SFA) policies are two of the most effective population-based methods to prevent smoking initiation and induce smokers to quit or reduce their cigarette consumption (Bader et al., 2011; Hahn, 2010; Hopkins et al., 2010; Liang et al., 2003; Peterson et al., 1992; Task Force on Community Preventive Services, 2005). Because co-use of tobacco and alcohol is so common, strengthening tobacco policies might not only decrease cigarette smoking but also reduce alcohol use. Studies on the cross-price effects of alcohol and tobacco in Sweden, Australia, Taiwan, and Italy found that increasing cigarette prices, through excise taxes or other means, leads to decreases in alcohol demand (Aristei & Pieroni, 2010; Bask & Melkersson, 2004; Cameron & Williams, 2001; Lee, 2007; Lee et al., 2010; Pierani & Tiezzi, 2008). Studies in the U.S., however, have yielded mixed results. Three studies found an increase in cigarette price/tax associated with an *increase* in alcohol use; though one of these focused only on spirits and another focused on adults age 51 years and above (Decker & Schwartz, 2000; Goel & Morey, 1995; Picone et al., 2004). Another study found that effects of increases in cigarette prices on alcohol use differ by age, with increases in prevalence of current drinking but decreases in binge drinking among adults aged 65 and older, and decreases in drinking among adults age 18–20 years (McLellan et al., 2012). Most recently, Young-Wolff *et al.* (2014) examined data from a U.S. longitudinal U.S. study and found greater reductions in typical quantity of alcohol consumption and frequency of binge drinking among smokers in states that increased cigarette taxes compared to states that did not.

Few studies have examined the association between SFA policies and alcohol consumption; results suggest that there is a negative association, but in some cases this has been observed only among subgroups. Two studies reported no differences in overall alcohol consumption associated with SFA policies, but suggested that such policies may influence the behavior of heavier drinkers. Results from a multi-country cohort study showed small reductions in alcohol consumed by hazardous drinkers and small reductions in frequency of alcohol consumption among heavy smokers (Kasza et al., 2012). Similarly, McKee et al. (2009) found no overall differences in drinking between Scotland and the rest of the United Kingdom after a smoke-free policy was implemented in Scotland, but did find a reduction in drinking in pubs and bars among moderate and heavy-drinking smokers in Scotland. Picone et al. (2004) found that smoking bans are associated with reduced alcohol consumption in females age ≥51 years. Young-Wolff et al. (2013) examined longitudinal U.S. survey data; SFA laws increased the likelihood of alcohol use disorder remission among current drinkers, with pronounced effects among smokers, men and younger adults .

Because results of existing studies are conflicting, and sometimes not generalizable to the full population, further clarification is needed on the role of tobacco policies on alcohol consumption in the U.S. Prior U.S. studies have not always focused on the general population, have not accounted for local city or county tobacco policies, and have primarily examined data over a relatively short time period. Only one study has considered the effects of both SFA policies and cigarette taxes, with contradictory effects of the two policies (Picone et al., 2004). Finally, studies have not attempted to distinguish tobacco policy effects on consumption of different types of alcoholic beverages; an important consideration given that smokers may have different beverage preferences than non-smokers (Barefoot et al., 2002; Klatsky et al., 1990; Klatsky & Armstrong, 1993; Tjønneland et al., 1999). To further elucidate the relationship between tobacco policies and alcohol consumption in the U.S., we used state alcohol sales data from 1980–2009 to examine the effects of state cigarette prices and SFA policies on state per capita total alcohol, beer, wine, and spirits consumption. Specifically, our objectives were to 1) examine whether changes in tobacco policies are associated with changes in alcohol consumption, and 2) examine whether any potential effects differed among the types of alcohol (beer, wine, and spirits) that are affected by the tobacco policies.

Methods

Overview

Our objective was to examine the hypothesis that strengthening of tobacco policies is associated with decreased alcohol consumption. We employed a “differences-in-differences” quasi-experimental approach (Angrist & Pischke, 2008), and used data on U.S. state-level per capita alcohol consumption, derived from sales, tax and shipments data, from 1980–2009. The differences-in-differences approach exploits policy changes over time, and differences between states with different policies at any given time, to estimate the policy effect independently of stable state characteristics and national secular trends. To achieve this, state and year indicators were included as unordered categorical fixed effect covariates in all analytical models. As a result, associations are expected to be observed only if the magnitudes of within-state changes in policy correlate with within-state changes in risk of our outcomes.

Dependent variables

State per capita consumption of alcohol—Per capita consumption of alcohol for each state from 1980–2009 was obtained from a report of the National Institute on Alcohol Abuse and Alcoholism (Lavallee et al., 2011). The Alcohol Epidemiologic Data System (AEDS) collects alcohol beverage sales and/or tax receipts data from states. For states where that data is not available, AEDS collects shipments data from beverage industry sources. To calculate alcohol consumption per capita, AEDS uses state population of persons ages 14 and older in the state obtained from the U.S. Census as the denominator. AEDS chose 14 even though it is much below the legal age for drinking because many adolescents report drinking alcohol. Before calculating per capita consumption estimates, the gallons of sold or shipped beer, wine and spirits are converted into gallons of ethanol (Lavallee et al., 2011).

We examined per capita consumption of all alcoholic beverages combined, and per capita consumption of each type of alcoholic beverage separately.

Primary independent variable

State price per pack of cigarettes—We used price per pack of cigarettes as a primary independent variable, as most of the variance in price within states over time is due to taxation (R-squared 0.98). Annual state cigarette price per pack data were adjusted for inflation to reflect 2012 dollars using the consumer price index obtained from the Bureau of Labor Statistics. We adjusted the state price per pack to account for local cigarette taxes. For each state and year, we calculated the ratio of gross state cigarette tax revenue, including local collections, to gross revenue due to state taxes alone. We multiplied this ratio by the state tax to arrive at the adjusted tax. Finally, we subtracted the unadjusted tax from the price per pack and replaced it with the adjusted cigarette tax. All price per pack, tax, and tax revenue data were obtained from "The Tax Burden on Tobacco" historical compilation (Orzechowski & Walker, 2011).

State smoke-free air (SFA) policies—SFA policy scores were retrieved from the ImpacTeen State-Level Tobacco Legislative Database (http://www.impacteen.org). Three key policies were included: bars, restaurants, and private worksites (International Agency for Research on Cancer, 2009). Scores were a three point scale for each site: 0 for no policy, 1 for a non-comprehensive ban (i.e., restrictions on smoking that fall short of an outright ban), and 2 for a comprehensive ban. For years in which state policy scores were not included in the ImpacTeen database, we searched the State Cancer Legislative Database (http://www.scld-nci.net) for SFA policies and coded scores accordingly.

To account for local SFA laws, we obtained data on the percent of the state population protected by comprehensive smoke-free state or local laws in workplaces, restaurants, and bars from the American Nonsmokers' Rights Foundation (Americans for Nonsmokers' Rights Foundation, 2014). We combined this data with the 0–2 state scale described above for each state and year. For each site (restaurant, worksite, bar), if there was a comprehensive statewide ban, the score was 2. If there was a non-comprehensive statewide ban, the score was 1 plus the proportion of the state population covered by comprehensive local bans. If there was no statewide policy, the score was twice the percent of the population covered by comprehensive local bans. This was to be consistent with the 0–2 coding described above where a comprehensive statewide ban=2. Thus, for example, if half the state is under a comprehensive ban and half is under no ban, then the score = 50%*0 + 50%*2 = 1. Finally, the values for each site were summed to obtain a scale ranging from 0 to 6.

Covariates

In addition to state and year fixed effects, we controlled for selected time-varying state economic and demographic variables that could influence both tobacco control policy and alcohol consumption rates. We considered state beer excise tax per barrel, wine and spirits excise taxes per gallon (obtained from W. Ponicki, Statewide Availability Data System II: 1933–2003, Pacifica Institute for Research and Evaluation), state per capita income (from

the Bureau of Economic Analysis), annual unemployment rate (from the Bureau of Labor Statistics), proportion of population in rural areas (from the U.S. Census Bureau), percent of the population that was African American, Hispanic, or Other (not Caucasian) race (calculated from U.S. Census population estimates), age distribution (14–17 years, 30–49 years, 50–64 years, and 65 years or older, calculated from U.S. Census population estimates), and percent of population affiliated with primarily Judeo-Christian denominations, including Mainline Protestant, Evangelical Protestant, Catholic, Orthodox, and Other denominations (church membership data from the Association of Religion Data Archives). Beer excise tax and per capita income were adjusted for inflation to reflect 2012 dollars. For rural population and religious adherents, data were not available for all years; data for missing years were imputed via linear interpolation.

We used the variance inflation factor (VIF) to test for collinearity among our potential covariates. Due to the high VIFs (approximately 100–300), race/ethnicity distribution, religious adherents distribution, and percent living in rural areas were not included in the models. Their collinearity with state fixed effects is not surprising, as many of these covariates may be relatively constant over time. Age distribution, per capita income, and the alcohol excise tax variables also had relatively high VIFs (range 13 to 54). However, their VIFs were much less than the other covariates and were included in the models because they were significant for at least one alcoholic beverage type. The final models adjusted for state unemployment rate, per capita income, age distributions, and alcohol excise taxes in addition to state and year fixed effects.

Statistical analysis

We used linear regression to model state per capita alcohol consumption as a function of cigarette prices (log-transformed) and SFA score. All models included state and year fixed effects and the covariates described above. We used natural log-transformed per capita alcohol and beverage-specific consumption as our dependent variables. Thus, the beta coefficient for cigarette price can be interpreted as the price elasticity of demand for alcohol with respect to cigarette prices (percent change in alcohol consumption associated with a 1% increase in cigarette price per pack). The beta coefficient for SFA policy score, multiplied by 100, can be interpreted as the percent change in alcohol consumption associated with a one point increase in the SFA policy score. The joint effect of both tobacco policies was examined using a 2 degree-of-freedom F-test to evaluate the change in explained variance upon simultaneous addition of both policy variables compared to a more restricted model including only the other covariates. In each model, all three alcohol excise tax variables (beer, wine, and spirits) were included as covariates. Some states have state-run retail and/or wholesale systems for wine/spirits (3 states for wine and 18 states for spirits). The status of these states does not change over time in our data and is collinear with state fixed effects; thus the effects of these states are accounted for by the state fixed effects in the models. Analyses were weighted by population estimates for each state in a given year, using the U.S. Census intercensal estimates. Models were run for the full time period (1980–2009), and then for each half of the time period (1980–1994 and 1995–2009). Parameter estimates and standard errors were calculated using the SAS (Version 9.2, SAS Institute, Cary, NC) procedure “surveyreg”, employing state as the clustering unit to account for correlation of

residuals within states in estimating standard errors (Angrist & Pischke, 2008; Arellano, 1987; Bertrand et al., 2004). Hawaii was excluded from analyses as alcohol excise tax data was not available for all years.

Results

Table 1 includes a summary of each state included in the analysis along with policy data and alcohol consumption data in 1980 and 2009. The median state price per pack (in 2012 dollars and adjusted for local taxes) in 1980 was $1.76 (inter-quartile range [IQR] $1.70 to $1.83); in 2009 the median was $5.68 (IQR $4.97 to $6.65). The median increase in cigarette price per pack during this time period was $3.86 (IQR $3.41 to $4.90). State SFA scores (adjusted for local SFA 100% smoke-free policies) increased from a median of 0 in 1980 to a median of 4.0 (IQR 2.29 to 6.0) in 2009; a median increase in SFA score of 4.0 (IQR 2.23 to 6.0). Median total alcohol consumption per capita (in gallons of ethanol) was 2.76 (IQR 2.33 to 3.14) in 1980 and 2.35 (IQR 2.06 to 2.63) in 2009. The median change in state-level alcohol consumption per capita was −0.31 (IQR −0.65 to −0.03).

As a preliminary examination of the data, we assessed overall changes in total alcohol consumption from 1980–2009 among the states who ranked in the highest quartile of changes in tobacco policies versus the states who ranked in the lowest quartile during the same time period. Figure 1a depicts the levels of per capita alcohol consumption over time in states ranking in the highest (n=12) and lowest (n=13) quartile of cigarette price per pack changes; Figure 1b shows the same data from states with the highest (n=16) and lowest (n=12) changes in SFA policies. Overall changes in natural log-transformed per capita alcohol sales from 1980 to 2009 were compared. States with the highest increases in price per pack ($4.90 to $7.13) had an overall 26% reduction in per-capita total alcohol consumption from 1980 to 2009 compared to a 5% reduction in total alcohol consumption in states with the lowest change in cigarette price per pack ($2.60 to $3.41) (p<.001). States that increased the SFA score from 0 (no bans) to 6 (total bans in private worksites, restaurants and bars) had a 24% reduction in total alcohol consumption, compared to a 10% reduction in states with the lowest quartile change in SFA policy score (0 to 2.2) (p=.007).

Formal examination of the relationship between state price per pack and SFA policy scores with state per capita alcohol consumption over time was performed using linear regression with state and year fixed effects, adjusting for state unemployment rate, per capita income, age distributions, and alcohol excise taxes (Table 2). For total per capita alcohol consumption, the addition of both tobacco policies significantly improved the model compared to a model that included only the other covariates ($R^2_{reduced}$ =0.9481, R^2_{full}=0.9532, F(2,49)=9.24, p<.001). A one percent increase in price per pack was associated with a 0.083% reduction in per capita total alcohol consumption (95% confidence interval [CI] 0.0002% to 0.166%, p=.050). A one point increase in SFA score (on a 6 point scale) was associated with a 1.1% reduction in total alcohol consumption (95% CI 0.4% to 1.7%, p=.001).

Similarly, the joint effects of the tobacco policies significantly improved the model predicting per capita beer consumption ($R^2_{reduced}$ =0.9290, R^2_{full}=0.9334, F(2,49)=6.65, p=.

003). A one percent increase in price per pack was associated with a 0.106% reduction in per capita beer consumption (95% CI 0.027% to 0.186%, p=.010) and a one point increase in SFA score was associated with a 0.7% reduction in per capita beer consumption, (95% CI 0.1% to 1.2%, p=.019). For per capita wine consumption, the addition of the two tobacco policies did not significantly improved the variance explained by the model ($R^2_{reduced}$ =0.9689, R^2_{full}=0.9695, F(2,49)=2.19, df 2, p=.124). Estimates for the individual policies were not significant, though both were in the expected direction. Finally, the joint effect of the tobacco policies significantly improved the model predicting per capita spirits consumption ($R^2_{reduced}$ =0.9534, R^2_{full}=0.9580, F(2,49)=18.97, p<.001). A one point increase in SFA score was associated with a 1.9% reduction in per capita spirits consumption (95% CI 1.1% to 2.6%, p<.001), while the estimate for price per pack was non-significant (−0.083%; 95% CI –0.197% to 0.031%; p=.152).

Because changes in smoke-free policies were relatively modest prior to the mid-1990s, we estimated models splitting the time period of observation in half: 1980–1994, and 1995–2009 (Table 3). During 1980–1994, a 1% increase in cigarette price per pack was associated with a 0.237% decrease in per capita total alcohol consumption (95% CI 0.158% to 0.317%, p<.001), a 0.187% decrease in per capita beer consumption (95% CI 0.089% to 0.284%, p<.001), and a 0.233% reduction in per capita spirits consumption (95% CI 0.077% to 0.388%, p=.004). No significant cigarette price effects were observed for wine. Strengthening SFA scores did not have significant effects on most types of alcohol consumption (total, beer, and spirits), but appeared be associated with an increase in wine consumption (a one point increase in SFA score was associated with a 3.2% *increase* in per capita wine consumption, 95% CI 0.4% to 5.9%, p=.024) . During 1995–2009, price per pack of cigarettes did not have significant effects on any type of alcohol consumption, while a one point increase in SFA scores was significantly associated with a 0.6% reduction in per capita total alcohol consumption (95% CI 0.1% to 1.0%, p=.014) and with a 1.0% reduction in per capita spirits consumption (95% CI 0.4% to 1.7%, p=.003). Effects of SFA score on beer and wine consumption were not statistically significant but were in the expected direction.

Discussion

Increases in state cigarette prices and restrictions on indoor smoking (SFA policies) were significantly associated with decreases in state per capita alcohol consumption during 1980–2009. The joint effects of the policies were significantly associated with reductions in consumption of total alcohol and of beer and spirits, but not wine. A 10% increase in cigarette price was associated with a 0.83% decrease in per capita total alcohol consumption and a 1.06% decrease in beer consumption. A one point increase in SFA policy score was associated with a 1.1% decrease in per capita total alcohol consumption, a 0.7% decrease in beer consumption, a 1.9% reduction in per capita spirits consumption.

Cigarette price changes had significant effects on decreasing alcohol consumption in 1980–1994, while, in general, SFA policy scores did not. Conversely, during 1995–2009 SFA policy changes were significantly associated with reductions in alcohol consumption, while cigarette prices were not. Effects of cigarette prices were likely more important during the first half of the study period because the 1980s marked the time during which cigarette

prices started to increase due to state cigarette taxes. While some states adopted SFA policies during this period, changes in scores were not dramatic and did not yet result in comprehensive statewide bans across all three areas (worksites, restaurants, and bars). Cigarette prices increased more sharply in the mid-1990s and 2000s, but in the 2000s stronger SFA policies were adopted at a dramatically increased rate. Although the relative importance of the two policies changed over time, results suggest that policies that decrease cigarette consumption are likely to decrease alcohol consumption as well.

Strengthening of tobacco policies was associated with reductions in beer and spirits consumption, but not wine. This suggests that smoking and drinking beer are more strongly related than smoking and drinking wine. In fact, people who prefer wine are less likely to smoke, more educated, and more likely to have healthier lifestyle habits than those who prefer other types of alcohol (Barefoot et al., 2002; Klatsky et al., 1990; Klatsky & Armstrong, 1993; Tjønneland et al., 1999). The significant positive effect of SFA policy score on wine consumption during 1980–1994 could be a reflection of health consciousness among states that started strengthening SFA policies in earlier years. Wine is often perceived as a relatively healthy alcoholic beverage, and epidemiologic studies have shown the health benefits of moderate wine consumption, including decreased risk of cardiovascular disease related mortality (O'Keefe et al., 2014).

Our results suggest that a 20% increase in cigarette price would be associated with a nearly 2% reduction in per capita alcohol consumption, or that the adoption of a complete statewide ban on smoking in bars, restaurants and worksites, relative to no restrictions, would reduce per capita alcohol consumption by about 6–7%. It is important to note that these estimates are averaged across the entire population—not just smokers. Tobacco policies might limit alcohol consumption primarily among smokers and "would-be" smokers, that is, those who were prevented from initiation as a result of tobacco control policies (Young-Wolff et al., 2013; Young-Wolff et al., 2014). If this is the case, then effects of tobacco policies on individual-level alcohol consumption among the population at risk for smoking would be substantially larger than those estimated for the population as a whole.

Our results corroborate several prior studies showing that higher cigarette taxes/prices or stricter SFA policies are associated with a reduction in alcohol consumption (Bask & Melkersson, 2004; Cameron & Williams 2001; Kasza et al., 2012; Lee, 2007; Lee et al., 2010; McKee et al., 2009; Pierani & Tiezzi, 2008; Young-Wolff et al., 2013; Young-Wolff et al., 2014). However, at first glance our findings seem to contradict those of some prior U.S. studies that suggested an increase in cigarette taxes is associated with an increase in alcohol consumption (Decker & Schwartz, 2000; Goel & Morey, 1995; Picone et al., 2004). One study focused only on spirits consumption during the two decades prior to the time period of our study and therefore comparability may be limited (Goel & Morey, 1995). McLellan et al. (2012) and Picone et al. (2004) found higher cigarette prices to be associated with increased alcohol consumption among adults age ≥65 years and 51–61 years, respectively. Our findings suggest that the net effect of tobacco control policies is to reduce alcohol consumption in the full population; however the use of aggregated sales data prevented us from testing differential associations by age group.

Studies have found that SFA policies do not adversely affect restaurant/bar revenues or alcohol sales (Collins et al., 2010; Eriksen & Chaloupka, 2007), and this might seem to contradict findings by us and others that SFA policies are associated with reduced alcohol consumption. Smoke-free policies might affect alcohol consumption by reducing the prevalence and intensity of smoking more generally rather than in specific venues such as bars and restaurants. In other words, the degree of reduction of consumption in bars and restaurants due to smoke free policies may be negligible, but this does not preclude the possibility of reduction in total per capita consumption.

We did not examine the specific mechanism by which the tobacco policies affect drinking behavior. However, smoking cessation is negatively correlated with alcohol consumption or alcohol abuse/dependence (Cavazos-Rehg et al., 2014; Picone & Sloan, 2003). Given that smoking and alcohol consumption often occur together and that alcohol consumption triggers smoking among smokers (Epstein et al., 2007; King & Epstein, 2005; Sayette et al., 2005), for many drinkers, smoking might serve as a 'trigger' for drinking. Reducing or quitting smoking due to the stricter tobacco policies could, in turn, reduce alcohol consumption. Although decreasing alcohol consumption is a net public health benefit, reducing alcohol-related disease and injury rates (Wagenaar et al., 2010), decreased consumption among heavy drinkers would be most beneficial. The reductions in per-capita alcohol consumption in response to the tobacco policies likely occurred among heavy drinking smokers, as prior studies on individual drinking behaviors found the impact of tobacco policies on drinking to be pronounced among heavy or hazardous drinkers (Kasza et al., 2012; McKee et al., 2009; Young-Wolff et al., 2013).

The tobacco and alcohol industries have a similar agenda regarding taxes and other regulations on their products. The tobacco industry allied directly or indirectly with the alcohol industry in the 1980s and 1990s to oppose tobacco taxes, smoke-free air laws, and tobacco advertising/marketing restrictions (Jiang & Ling, 2013). This suggests that the alcohol industry believes that alcohol and cigarettes are economic complements (i.e., that decreased sales of one adversely effects sales of the other), which is consistent with results of our analyses. Our work and similar studies that describe the negative association between tobacco policies and alcohol consumption can help public health advocates better understand the link between the tobacco and alcohol industries in order to be better prepared to contest their opposition to strengthening tobacco policies.

Some limitations should be considered when interpreting our results. We were unable to examine the per capita consumption of alcohol among individuals with different levels of smoking or drinking, or among different demographic groups. State level estimates of per capita alcohol consumption are based on sales data collected directly by the Alcohol Epidemiology Data System and shipments data from beverage industry sources. There could be inaccuracies in estimates of per capita alcohol consumption due to reporting error, random fluctuation over time, estimation of ethanol conversion coefficients, cross-border sales, tourists' consumption, and variation in state reporting practices for sales (Lavallee et al., 2011). However, the use of alcohol sales data is also a strength, as it is not subject to self-report bias like survey data. Furthermore, the use of aggregated panel data based on sales allowed us to examine the consumption of different types of alcoholic beverages,

which is often not available in survey data, over a 30 year time period. This study was also the first to incorporate effects of local cigarette tax and smoke-free air policies.

In summary, our results from examination of state-level alcohol sales data from 1980–2009 suggest that higher cigarette prices and stricter SFA policies reduce alcohol consumption in addition to their known influences on smoking. We extend earlier work by demonstrating that these policies affect consumption of beer and spirits, but not wine. Our study helps inform the additional benefits associated with these tobacco policies beyond the well-documented smoking-related effects, underscoring the multiple public health benefits of tobacco control policies and the link between tobacco and alcohol consumption.

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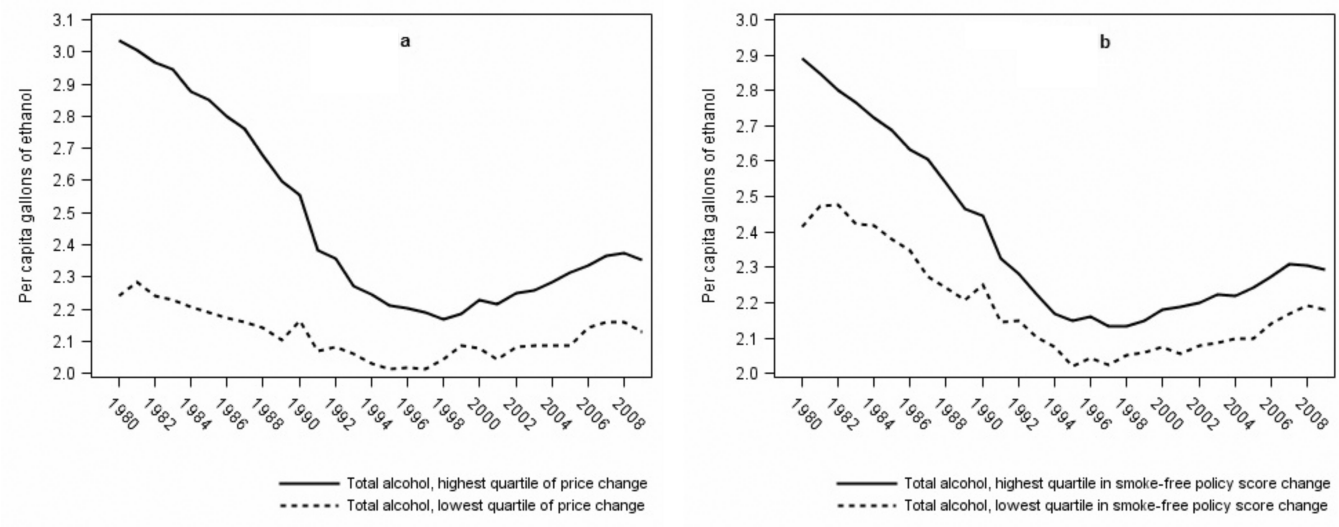

Figure 1.

Total alcohol consumption over time, stratified by states with the highest and lowest quartile of cigarette price per pack (Figure 1a) and smoke-free air policy (Figure 1b) changes over the same time period, 1980–2009

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Table 1

State tobacco policies and alcohol consumption in 1980 and 2009 [a]

State	Price per pack of cigarettes ($) [b]		Smoke-free air (SFA) score [c]		Alcohol consumption per capita (gallons of ethanol)	
	1980	2009	1980	2009	1980	2009
Alabama	1.987	4.937	0.00	1.46	1.86	2.01
Alaska	1.769	8.895	0.00	3.32	3.76	3.02
Arizona	1.764	6.714	0.00	6.00	3.03	2.31
Arkansas	1.803	5.659	0.00	3.05	1.81	1.83
California	1.850	5.444	0.00	5.27	3.38	2.33
Colorado	1.619	5.434	0.00	6.00	3.35	2.68
Connecticut	2.232	7.999	0.00	5.00	2.70	2.34
Delaware	1.839	5.727	0.00	6.00	3.12	3.13
District of Columbia	1.923	7.157	0.00	6.00	5.42	3.90
Florida	2.028	5.859	0.00	4.00	3.22	2.61
Georgia	1.744	4.849	0.00	3.18	2.35	1.97
Idaho	1.650	4.884	0.00	3.00	2.60	2.68
Illinois	1.795	6.345	0.00	6.00	3.00	2.33
Indiana	1.624	5.152	0.00	1.41	2.21	2.06
Iowa	1.711	5.701	0.00	6.00	2.25	2.31
Kansas	1.666	5.080	0.00	2.23	1.96	1.99
Kentucky	1.376	4.899	0.00	1.89	1.91	1.94
Louisiana	1.744	4.830	0.00	4.00	2.71	2.63
Maine	1.753	6.679	0.00	6.00	2.67	2.48
Maryland	1.750	6.651	0.00	6.00	3.09	2.21
Massachusetts	1.973	7.771	0.00	6.00	3.19	2.47
Michigan	1.722	6.570	1.00	1.49	2.65	2.22
Minnesota	1.833	6.069	2.00	6.00	2.85	2.59
Mississippi	1.755	4.854	0.00	0.88	2.09	2.24
Missouri	1.755	4.354	0.00	3.41	2.44	2.42
Montana	1.683	6.171	2.00	4.06	3.21	2.99
Nebraska	1.697	5.022	3.00	6.00	2.64	2.35

State	Price per pack of cigarettes ($) [b]		Smoke-free air (SFA) score [c]		Alcohol consumption per capita (gallons of ethanol)	
	1980	2009	1980	2009	1980	2009
Nevada	1.764	5.328	0.00	4.00	5.82	3.30
New Hampshire	1.627	6.291	0.00	5.00	5.76	4.38
New Jersey	1.915	7.649	0.00	6.00	2.83	2.35
New Mexico	1.755	5.460	0.00	6.00	2.99	2.42
New York	1.914	8.541	0.00	6.00	2.91	2.06
North Carolina	1.393	4.821	0.00	0.00	2.17	2.02
North Dakota	1.728	4.487	1.00	3.69	2.83	3.03
Ohio	1.711	5.780	0.00	6.00	2.33	2.01
Oklahoma	1.833	5.575	0.00	2.00	1.95	1.95
Oregon	1.585	5.457	0.00	6.00	2.82	2.59
Pennsylvania	1.806	5.844	0.00	4.00	2.39	2.19
Rhode Island	1.797	8.278	0.00	6.00	3.14	2.55
South Carolina	1.524	4.245	0.00	1.45	2.46	2.37
South Dakota	1.736	5.819	0.00	4.00	2.56	2.62
Tennessee	1.780	4.970	0.00	3.00	1.92	1.83
Texas	1.864	5.917	0.00	2.00	2.80	2.29
Utah	1.747	5.000	2.00	6.00	1.71	1.33
Vermont	1.700	7.124	0.00	5.00	3.30	2.69
Virginia	1.498	4.950	0.00	1.09	2.39	2.13
Washington	1.856	7.029	0.00	6.00	3.12	2.34
West Virginia	1.845	4.832	0.00	3.32	1.82	1.79
Wisconsin	1.808	7.407	0.00	2.29	3.46	2.96
Wyoming	1.558	5.010	0.00	0.75	3.42	2.77
Median (inter-quartile range)	1.755 (1.697–1.833)	5.680 (4.970–6.651)	0 (0 – 0)	4.0 (2.29–6.0)	2.76 (2.33–3.14)	2.35 (2.06–2.63)

[a] Hawaii was excluded from all analyses as alcohol excise tax data was not available for all years

[b] Adjusted for inflation. 2012 dollars. Also incorporates local taxes. See methods.

[c] Also incorporates local 100% smoke-free air laws. See methods.

Table 2

Associations between state tobacco policies and natural log-transformed per capita alcohol consumption (gallons of ethanol), 1980–2009

	----------Total alcohol[a]----------		----------Beer[b]----------		----------Wine[c]----------		----------Spirits[d]----------	
Independent variable	**β (95% CI)**	**P**	**β (95% CI)**	**P**	**β (95% CI)**	**P**	**β (95% CI)**	**P**
Price per pack of cigarettes (natural log-transformed)	−0.083 (−0.166, −0.0002)	.0495	−0.106 (−0.186, −0.027)	.010	−0.017 (−0.154, 0.121)	.809	−0.083 (−0.197, 0.031)	.152
Smoke-free air score	−0.011 (−0.017, −0.004)	.001	−0.007 (−0.012, −0.001)	.019	−0.012 (−0.024, 0.001)	.077	−0.019 (−0.026, −0.011)	<.001
R^2 Δ with addition of both policies above	*R^2Δ=0.0051, F(2,49)=9.24,*	*p<.001*	*R^2Δ=0.0044, F(2,49)=6.65,*	*p=.003*	*R^2Δ=0.0005, F(2,49)=2.19,*	*p=.124*	*R^2Δ=0.0046, F(2,49)=18.97,*	*p<.001*
Age distribution								
14–17 years (%)	−0.031 (−0.059, −0.003)	.030	−0.040 (−0.061, −0.019)	<.001	−0.059 (−0.115, −0.003)	.039	−0.030 (−0.071, 0.010)	.134
30–49 years (%)	−0.009 (−0.018, 0.001)	.074	−0.010 (−0.022, 0.002)	.102	0.025 (0.002, 0.048)	.036	−0.014 (−0.030, 0.002)	.090
50–64 years (%)	0.019 (0.003, 0.035)	.021	0.017 (0.002, 0.031)	.028	0.041 (0.012, 0.069)	.006	0.017 (−0.007, 0.041)	.165
≥ 65 years (%)	−0.020 (−0.037, −0.002)	.028	−0.019 (−0.038, 0.0002)	.052	−0.013 (−0.045, 0.019)	.426	−0.031 (−0.056, −0.006)	.015
Unemployment rate (%)	−0.014 (−0.021, −0.008)	<.001	−0.011 (−0.017, −0.004)	.003	0.006 (−0.011, 0.023)	.478	−0.024 (−0.031, −0.017)	<.001
Per capita income, per dollar	0.001 (−0.004, 0.005)	.736	−0.002 (−0.008, 0.003)	.373	0.010 (0.001, 0.019)	.035	−0.001 (−0.007, 0.005)	.812
Beer tax per barrel, per dollar	−0.005 (−0.008, −0.002)	.001	−0.007 (−0.011, −0.003)	<.001	−0.007 (−0.013, −0.001)	0.017	0.001 (−0.002, 0.003)	.724
Wine tax per gallon, per dollar	0.019 (−0.010, 0.048)	.195	0.016 (−0.031, 0.062)	.502	−0.015 (−0.092, 0.063)	.704	0.036 (0.007, 0.065)	.017
Spirits tax per gallon, per dollar	−0.002 (−0.010, 0.005)	.517	0.008 (−0.002, 0.019)	.115	−0.008 (−0.025, 0.010)	.392	−0.017 (−0.028, −0.007)	.002

Note: All models adjust for state and year fixed effects in addition to other covariates listed. Each model includes 1,500 observations (50 states, 30 years).

[a] R^2 for model without both policies=0.9481, R^2 for model including both policies=0.9532.

[b] R^2 for model without both policies=0.9290, R^2 for model including both policies=0.9334.

[c] R^2 for model without both policies=0.9689, R^2 for model including both policies=0.9695.

[d] R^2 for model without both policies=0.9534, R^2 for model including both policies=0.9580.

Table 3

Associations between state tobacco policies and natural log-transformed per capita alcohol consumption (gallons of ethanol), 1980–1994 and 1995–2009

	----------Total alcohol[a]----------		----------Beer[b]----------		----------Wine[c]----------		----------Spirits[d]----------	
Independent variable	**β (95% CI)**	**P**	**β (95% CI)**	**P**	**β (95% CI)**	**P**	**β (95% CI)**	**P**
1980–1994								
Price per pack of cigarettes (natural log-transformed)	−0.237 (−0.317, −0.158)	<.001	−0.187 (−0.284, −0.089)	<.001	−0.106 (−0.300, 0.087)	.275	−0.233 (−0.388, −0.077)	.004
Smoke-free air score	0.003 (−0.006, 0.011)	.534	0.001 (−0.010, 0.012)	.875	0.032 (0.004, 0.059)	.024	−0.003 (−0.021, 0.015)	.745
R^2 Δ with addition of both policies above	*R^2Δ=0.0029, F(2,49)=20.9,*	*p<.001*	*R^2Δ=0.0028, F(2,49)=8.06,*	*p=.001*	*R^2Δ=0.0007, F(2,49)=4.66,*	*p=.014*	*R^2Δ=0.0011, F(2,49)=4.93,*	*p=.011*
1995–2009								
Price per pack of cigarettes (natural log-transformed)	0.050 (−0.002, 0.102)	.057	0.039 (−0.010, 0.088)	.118	0.082 (−0.016, 0.180)	.098	0.040 (−0.050, 0.131)	.375
Smoke-free air score	−0.006 (−0.010, −0.001)	.014	−0.005 (−0.010, 0.0002)	.061	−0.005 (−0.014, 0.003)	.226	−0.010 (−0.017, −0.004)	.003
R^2 Δ with addition of both policies above	*R^2Δ=0.0015, F(2,49)=5.47,*	*p=.007*	*R^2Δ=0.0008, F(2,49)=2.35,*	*p=.106*	*R^2Δ=0.0002, F(2,49)=1.73,*	*p=.188*	*R^2Δ=0.0016, F(2,49)=6.70,*	*p=.003*

Note: All models adjust for state and year fixed effects, as well as age distribution, unemployment rate, per capita income, beer tax, wine tax, and spirits tax. Each model includes 750 observations (50 states, 15 years).