RAE REVIEW OF APPLIED ECONOMICS
Vol. 11, Nos. 1-2, (January-December 2015)

DO HIGHER CIGARETTE PRICES INCREASE ALCOHOL CONSUMPTION? EVIDENCE FROM THE U.S.

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Abstract: *This paper considers the effects of the large increases in cigarette prices after the Master Settlement Agreement (MSA) on alcohol consumption among smokers using the U.S. individual level data from the Panel Study of Income Dynamics (PSID). System Generalized Method of Moments (GMM) with time fixed effects is used to address the unobserved heterogeneity and the initial conditions problem in dynamic panel data models. The cross-price effects of cigarettes on alcohol consumption are positive and significant for females, indicating that female smokers drink more when facing higher cigarette prices. Smoke-free air laws do not appear to have significant effects on alcohol consumption.*

JEL Classification*: D10, I10*

Keywords: *Cross Price Effects, Dynamic Panel Model, GMM*

1. INTRODUCTION

Since the release of the Surgeon General's report on smoking and health in 1964, there has been a heightened public awareness about the harmful effects of smoking (including secondhand smoking), which is the single most preventable cause of death and disability in the United States—it is responsible for more than 480,000 deaths annually.[1] Among all the policy tools to reduce smoking, increasing cigarette excise taxes has been the most effective one. Smoking rate among adults in the United States has fallen from 50% in the 1990 (BREFFS 1990) to 20.9% in 2005 and to 18.1% in 2012.[2]

As the anti-smoking campaign goes on, one policy concern arises: will the reduction in smoking affect alcohol consumption? If cigarettes and alcohol are complements, then higher cigarette prices may have a health multiplier effect by also reducing drinking; if they are substitutes, raising cigarette prices may inadvertently increase alcohol consumption. Drinking, especially heavy drinking, causes health and social consequences such as cirrhosis of the liver and personal injuries from motor vehicle crashes, violence and crimes (Dave and Saffer 2008). This study explores how alcohol consumption is affected by the increases in cigarette prices among smokers only. Smokers are defined, in this article, as the individuals who have ever

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smoked over the sample period. Non-smokers are not considered because that are not likely to be affected by changes in cigarette prices. This paper adds to the literature by providing consistent estimates of the cross-price effects of cigarettes on alcohol consumption using the System Generalized Method of Moments (GMM), a dynamic panel method that solves the initial conditions problem in dynamic models.

2. BACKGROUND

In November 1998, 46 states and the four major tobacco companies reached the Master Settlement Agreement (MSA) which stipulated that the tobacco companies pay the states $206 billion over the next 25 years to compensate them for Medicaid expenses of treating tobacco-related illnesses. The other four states (Florida, Mississippi, Texas and Minnesota) settled with the tobacco companies individually. As a result, the cigarette prices went up by 45 cents per pack, or 19.5%, nationwide immediately after the settlement, and continued to rise over the next decade. By 2003, the national average of cigarette prices had nearly doubled since 1997. In addition, many states increased their excise taxes on cigarettes substantially, and the federal taxes on tobacco were increased to $1.01 per pack in 2009. Also during the same period, an increasing number of states have passed stronger smoke-free air laws. As of March 2011, 27 states had enacted statewide bans on smoking in all enclosed public places, including private workplaces, restaurants and bars. The MSA has generated much variation in cigarette prices to allow the identification of their effects on alcohol consumption. This paper utilizes prices rather than taxes because cigarette taxes fail to reflect all the actual variation in the monetary cost of cigarettes after the MSA.

3. LITERATURE

A huge body of the medical and psychological literature has documented the positive correlation between cigarette smoking and alcohol consumption under controlled experiments. Bobo *et al*. (1987) estimate, by examining inpatients in an alcohol treatment facility, that over 75% of the patients (most of them are heavy drinkers) also smoke cigarettes. Ritchey *et al*. (2001) find that, among high school students in the U.S., drinkers are three times more likely than non-drinkers to be smokers. Carmelli *et al*. (1993) and Swan *et al*. (1997) conduct twin studies and find interdependence between smoking and alcohol consumption. Batel *et al*. (1995) and King *et al*. (2005) both find that higher doses of alcohol intake induce increases in smoking urge.

A recent neurological study with rats advances the medical literature by providing some explanation for the mechanism of the interdependence between smoking and alcohol use. Sharma *et al*. (2015) find that nicotine weakens the sleep-inducing effects of alcohol by stimulating a response in an area of the brain known as the basal forebrain. As a result, when used in conjunction with alcohol, nicotine acts as a stimulant to ward off sleep. Therefore, if an individual smokes, he or she is much more likely to consume more alcohol, and vice-versa.

In the economic literature, there are relatively few studies that have focused on the complementarity and substitutability of smoking and drinking. The results are mixed.

Goel and Morey (1995) use US state level panel data from 1959 to 1982 to estimate demand equations for cigarettes and liquor allowing for cross-price effects. They find that cigarettes and liquor are substitutes in consumption.

In an effort to address endogeneity in the structural models of interdependence between alcohol and cigarettes consumption, Dee (1999) utilizes within-state variation in cigarette taxes and the movement away from a minimum legal drinking age of 18 to conduct reduced form and instrumental variable estimations for separate drinking and smoking equations. Using state-level rates of drinking and smoking for teenagers, Dee finds that participation in drinking and smoking by teens are complements.

Decker and Schwartz (2000) investigate cross-price effects in cigarettes and alcohol participation and consumption. Using a sample of nearly 500 000 observations drawn from the 1985-1993 Behavioral Risk Factor Surveillance System (BRFSS), the authors find that increases in the price of cigarettes increase drinking participation, suggesting that alcohol and cigarettes are substitutes, while increases in the price of alcohol decrease smoking participation, indicating that they are complements.

Cameron and Williams (2001) use Australian individual level data for adults (NDSHS) to estimate probit models of the price responsiveness of participation in cannabis, alcohol and cigarette use. They regress participation indicators for each of the drugs (cannabis, alcohol and cigarette) on their full prices, interactions between the different prices and socioeconomic and demographic variables. They find some evidence that alcohol and cigarettes are complements. In particular, the effect of the price of cigarettes on alcohol participation is negative and strongly significant while the price of alcohol is positive but insignificant in the cigarette equation.

In a similar study using more recent surveys of NDSHS, Zhao and Harris (2004) investigate the interrelations among participation decisions of marijuana, alcohol and tobacco. Extending Cameron and Williams (2001), the authors estimate a multivariate probit model to allow for correlations of an individual's unobserved heterogeneity across decisions about different drugs. They find stronger evidence for complementarity between alcohol and tobacco than that from Cameron and Williams (2001). Cross-price effects of tobacco and alcohol are both negative and significant at 5% in the alcohol and tobacco equations, respectively.

Picone *et al*. (2004) focus on older persons above 50 years of age. Using the panel data Health and Retirement Survey (HRS) between 1992 and 2002, they estimate dynamic panel models using GMM estimators to analyze the effects of smoking bans and cigarette prices on alcohol consumption, and symmetrically, the effects of the 0.08 BAC laws and alcohol prices on cigarette consumption. The positive effect of cigarette prices on alcohol consumption suggests that alcohol and cigarettes are substitutes, but the negative effect of smoking bans supports complementarity.

Also estimating with GMM, Bask and Melkersson (2004) find that alcohol and cigarettes are complements using Swedish aggregate annual time series on sales volumes of cigarettes and alcohol for the period of 1955-1999.

Markowitz and Tauras (2009) estimate separate teens' participation demand equations for alcohol, cigarettes and marijuana with region fixed effects and individual fixes effects. What distinguishes their work from others is that they consider the influence of the prices of goods commonly bought by teenagers such as gasoline, clothing, fast food and entertainment on the demand for the three substances. Using the first four waves of NLSY97 from 1997 to 2001 matched with the price variables from the American Chamber of Commerce Researchers'

Association (ACCRA), they find evidence that cigarettes and alcohol are substitutes when the probability of alcohol use is examined, but no symmetric cross-price effects of alcohol when the probability of smoking is examined.

Tauchmann *et al.* (2013), using German individual level data, employ an instrumental variables approach that statistically mimics an experimental study. They find that a reduction in tobacco consumption results in a moderate reduction in alcohol consumption, suggesting that alcohol and tobacco are complements.

4. THE MODEL AND ESTIMATION STRATEGY

The aim of this study is to test whether the increases in the prices of cigarettes after the MSA affect alcohol consumption when allowing for reinforcement effects. Reinforcement of an addictive good means that past consumption increases current consumption by raising the marginal utility of current consumption. Due to the addictive nature of alcohol and cigarettes, past consumption of alcohol will reinforce its current consumption, and past consumption of cigarettes may also reinforce current consumption of alcohol.

The model starts with an individual's utility in period t as a function of the consumption of alcohol (A_t), cigarettes (C_t) and the composite good (G_t) given consumption of alcohol and cigarettes from last period (A_{t-1}) and (C_{t-1}). The individual maximizes utility:

$$U = u(A_t, C_t, G_t \mid A_{t-1}, C_{t-1})$$

subject to a budget constraint:

$$Y_t = p_t^A A_t + p_t^C C_t + p_t^G G_t$$

where Y_t is income in period t, p_t^A, p_t^C and p_t^G are prices of alcohol, cigarettes and the composite good, respectively. Prices of alcohol and cigarettes are the full prices that include monetary prices and policies that regulate the consumption of alcohol and cigarettes.

Maximizing utility subject to the budget constraint yields the following empirical model of alcohol consumption for individual i in period

$$A_{i,t} = \alpha_1 A_{i,t-1} + \alpha_2 C_{i,t-1} + \beta_1 p_{i,t}^A + \beta_2 p_{i,t}^C + \beta_3 pol_{i,t}^A + \beta_4 pol_{i,t}^C + \beta_5 x_{i,t} + \varepsilon_{i,t} \quad (1)$$

where the error term $\varepsilon_{i,t}$ consists of the unobserved individual fixed effects u_i and the idiosyncratic disturbances $v_{i,t}$ ($\varepsilon_{i,t} = u_i + v_{i,t}$). $A_{i,t}$ is the amount of alcohol consumed, A_{it-1} and $C_{i,t-1}$ are alcohol and cigarettes consumed in the previous period, $p_{i,t}^A$ and $p_{i,t}^C$ are the monetary prices for alcohol and cigarettes, $pol_{i,t}^A$ and $pol_{i,t}^C$ are the policy variables for drinking and smoking, $x_{i,t}$ is a vector of exogenous social-demographic variables including family income, age, gender, race, ethnicity, education, employment and marital status. Due to the addictive nature of alcohol, past consumption of alcohol will reinforce its current consumption. α_1 measures the reinforcement effect of past alcohol consumption on current consumption, and it is expected to be positive.

Past consumption of cigarettes may also reinforce current consumption of alcohol. α_2 captures this reinforcement effect if any; a priori, its sign is unknown. β_1 and β_3, the coefficients on the own-price and policy of alcohol, should be negative based on the law of demand. Interest lies in the signs and significance of β_2 and β_4, the coefficients on the cross-price and cross-policy of alcohol. They can be negative or positive depending on whether alcohol is a complement good to cigarettes or a substitute for cigarettes.

It can be shown that the lagged consumption variables $A_{i,t-1}$ and $C_{i,t-1}$ are predetermined variables. $A_{i,t-1}$ is positively correlated with time invariant preferences for alcohol in the error term, and $C_{i,t-1}$ is also positively correlated with the error term if $A_{i,t-1}$ and $C_{i,t-1}$ are positively correlated. In that case, OLS estimator will yield upward biased and inconsistent estimates. Individual fixed effects (FE) estimates using within group transformation will be downward biased and inconsistent if serial correlation is present in the error term (Nickell 1981). Consistent estimation on these lagged variables is crucial in order to consistently recover other parameters (Bond 2002).

Equation 1 will be estimated as a linear dynamic panel data model with time fixed effects using the two-step system Generalized Method of Moments (GMM) as the following:

$$\Delta A_{i,t} = \alpha_1 \Delta A_{i,t-1} + \alpha_2 \Delta C_{i,t-1} + \beta_1 \Delta p^A_{i,t} + \beta_2 \Delta p^C_{i,t} + \beta_3 \Delta pol^A_{i,t} + \beta_4 \Delta pol^C_{i,t} + \beta_5 \Delta x_{i,t} + \Delta v_{i,t} \tag{2}$$

$$A_{i,t} = \alpha_1 A_{i,t-1} + \alpha_2 C_{i,t-1} + \beta_1 p^A_{i,t} + \beta_2 p^C_{i,t} + \beta_3 pol^A_{i,t} + \beta_4 pol^C_{i,t} + \beta_5 x_{i,t} + \varepsilon_{i,t}$$

System GMM uses the lagged levels of the predetermined variables as instruments for their first-differenced form and uses the first differenced predetermined variables (now exogenous to the fixed effects) to instrument them in levels. Let $\Delta X_{i,t}$ be a vector of all exogenous variables in first differences $\Delta X_{i,t} = (\Delta p^A_{i,t}, \Delta p^C_{i,t}, \Delta pol^A_{i,t}, \Delta pol^C_{i,t}, \Delta x_{i,t})$. $X_{i,t}$ is used to instrument $\Delta X_{i,t}$ in the difference equation and to instrument themselves in the level equation. One period lagged price and policy variables can serve as the additional instruments for the predetermined variables.[3] Define $LP_{i,t} = (p^A_{i,t-1}, p^C_{i,t-1}, pol^A_{i,t-1}, pol^C_{i,t-1})$. Instrument matrices are given by[4]

$$Z_{di} = \begin{pmatrix} A_{i1}C_{i1} & 0 & 0 & 0 & X_{i3}\Delta LP_{i3} \\ 0 & A_{i1}A_{i2}C_{i1}C_{i2} & 0 & 0 & X_{i4}\Delta LP_{i4} \\ 0 & 0 & A_{i1}A_{i2}A_{i3}C_{i1}C_{i2}C_{i3} & 0 & X_{i5}\Delta LP_{i5} \\ 0 & 0 & 0 & A_{i1}A_{i2}A_{i3}A_{i4}C_{i1}C_{i2}C_{i3}C_{i4} & X_{i6}\Delta LP_{i6} \end{pmatrix} \tag{3}$$

$$Z_{li} = \begin{pmatrix} \Delta A_{i1}\Delta C_{i1} & 0 & 0 & 0 & X_{i3}LP_{i3} \\ 0 & \Delta A_{i1}\Delta A_{i2}\Delta C_{i1}\Delta C_{i2} & 0 & 0 & X_{i4}LP_{i4} \\ 0 & 0 & \Delta A_{i1}\Delta A_{i2}\Delta A_{i3}\Delta C_{i1}\Delta C_{i2}\Delta C_{i3} & 0 & X_{i5}LP_{i5} \\ 0 & 0 & 0 & \Delta A_{i1}\Delta A_{i2}\Delta A_{i3}\Delta A_{i4}\Delta C_{i1}\Delta C_{i2}\Delta C_{i3}\Delta C_{i4} & X_{i6}LP_{i6} \end{pmatrix}$$

(4)

$$Z_{si} = \begin{pmatrix} Z_{di} & 0 \\ 0 & Z_{li} \end{pmatrix} \tag{5}$$

The moment conditions are[5]

$$E(Z_s' Q) = 0 \tag{6}$$

where $Q = \begin{pmatrix} \Delta U \\ U \end{pmatrix}$, $\Delta U_i = \begin{bmatrix} \Delta v_{i3} \\ \Delta v_{i4} \\ \vdots \\ \Delta v_{iT} \end{bmatrix}$ and $U_i = \begin{bmatrix} v_{i3} \\ v_{i4} \\ \vdots \\ v_{iT} \end{bmatrix}$

5. DATA

The data are from the 1999, 2001, 2003, 2005, 2007 and 2009 waves of the Panel Study of Income Dynamics (PSID). Conducted by the Survey Research Center, Institute for Social Research, University of Michigan, the PSID is a longitudinal study of a nationally representative sample of U.S. individuals and the family units in which they reside. The initial wave of the PSID was administered in 1968. Follow-up interviews were conducted annually until 1996 and biennially thereafter. Health behavior measures, such as alcohol and cigarette consumption, have been collected since 1999.

The dependent variable is the average number of drinks per day the individual consumes.

To control for the reinforcement effects of past drinking and past smoking on current alcohol consumption, variables for lagged alcohol consumption and lagged cigarette consumption are included. Cigarette consumption is the number of cigarettes smoked per day by the respondent. Figures 1 and 2 present the trends in average alcohol and cigarette consumptions by smokers over the sample period, respectively.

The key independent variables are the costs of consuming cigarettes, including monetary costs[6] and nonmonetary costs. The monetary costs (cigarette prices) come from the state level weighted average prices per pack in the Tax Burden on Tobacco (Orzechowski and Walker 2009). Figure 3 shows the increasing trend in cigarette prices during the sample period. The nonmonetary costs refer to policies and regulations that increase the degree of inconvenience for consuming cigarettes, and are measured with a smoking ban index. It is constructed based on the smoking restriction decisions of the smoke-free air laws in the following 12 locations: Government worksites, private worksites, child care centers, health care facilities, restaurants, recreational facilities, cultural facilities, public transit, shopping malls, public schools, private schools, and free standing bars. Smoking restrictions are coded 0, 1, 2, 3, 4 and 5, with 0 being no restrictions against smoking and 5 being smoking banned at all times. The smoking ban index for each state of each year is the sum of the numerical codes. For alcohol prices, State level prices of a six-pack of beer constructed from the American Chamber of Commerce Researchers' Association (ACCRA) are used as proxies for the monetary prices of alcohol: the

Figure 1: Trends in Average Alcohol Consumption per day by Smokers

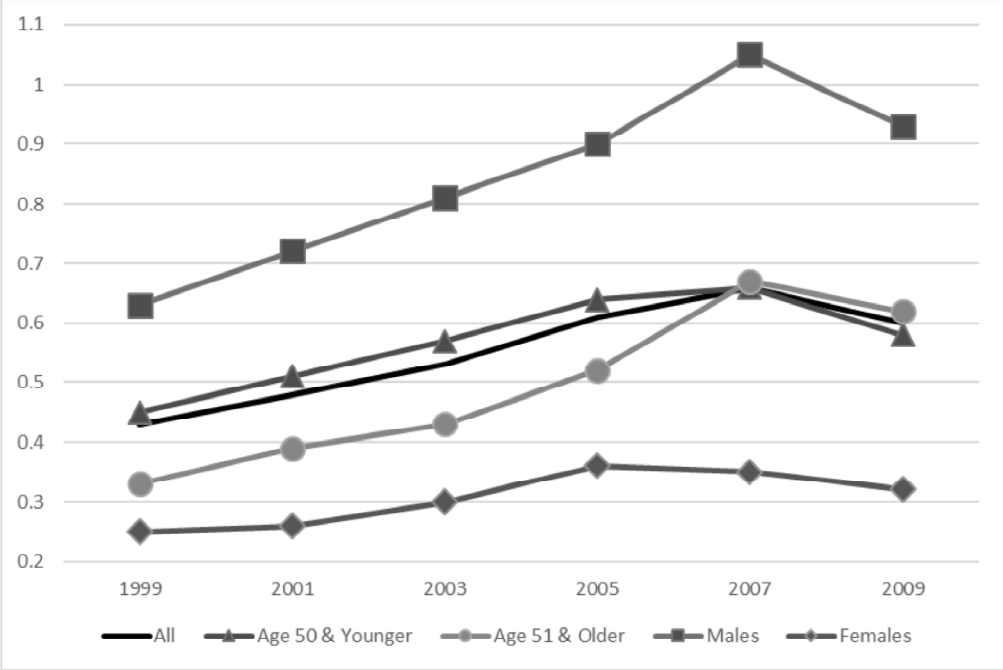


Figure 2. Trends in Average Cigarette Consumption per day by Smokers

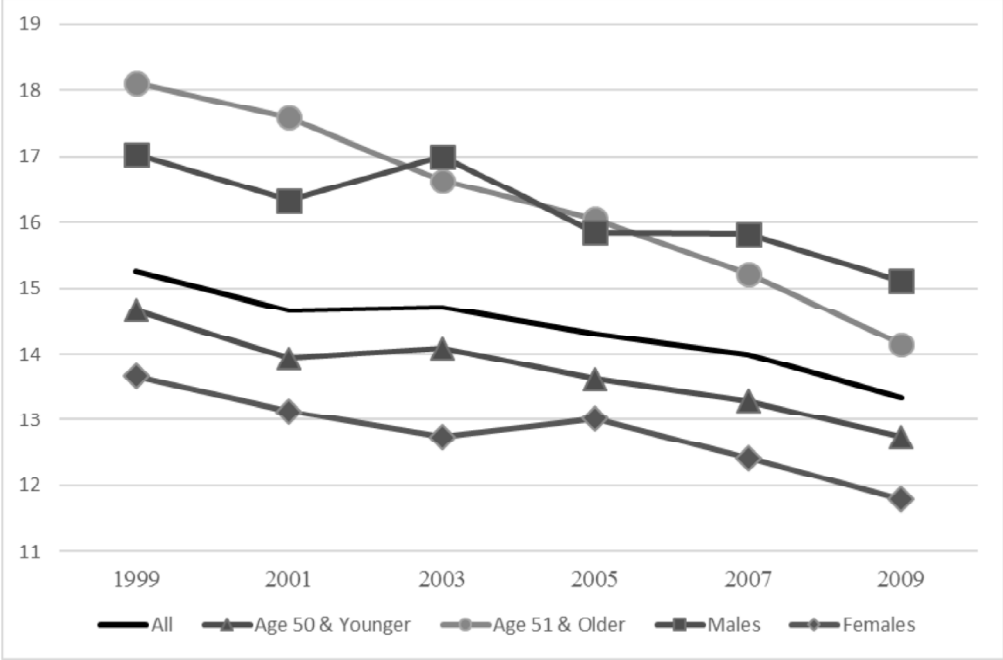
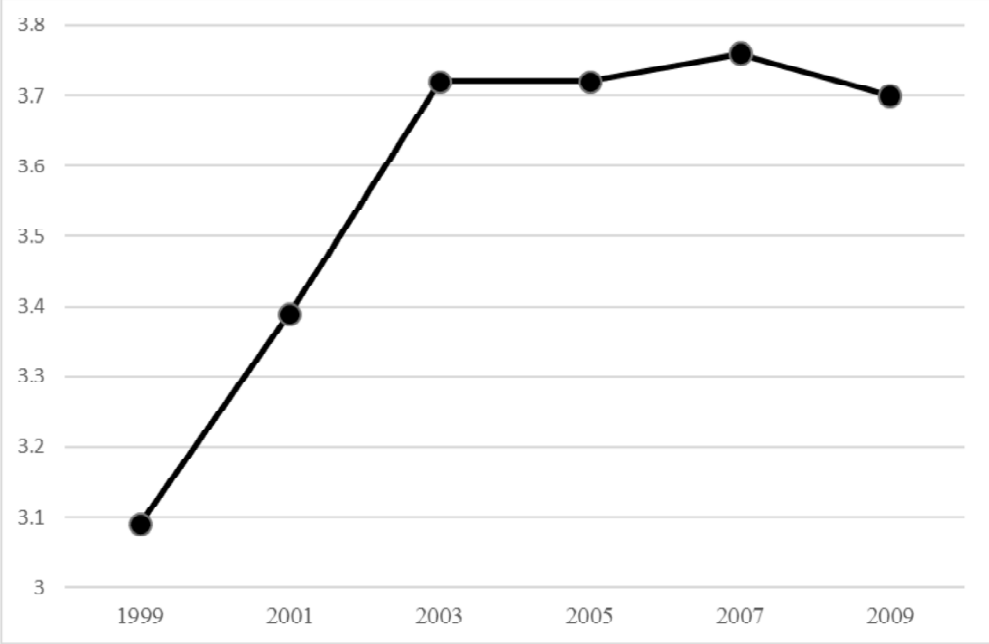


Figure 3. Trend in Cigarette Prices (in 1999 dollars)



quarterly beer prices of 250 to 300 localities are adjusted to ACCRA cost of living indices and are averaged for each state by year; a dummy variable indicating whether a state has an effective 0.08 BAC law[7] for the year of interview is used as the policy variable for alcohol. The price and policy variables are merged with the PSID data based on the respondent's state of residence and the year of interview. The model controls for age, sex, race, ethnicity, educational attainment, family income, household size, marital and employment status. Table 1 presents the descriptive statistics of the independent variables.

6. RESULTS

Separate regressions are conducted for the entire sample, younger adults (50 years of age and younger), older adults (over 50 years of age), males and females.[8]

Table 2 presents GMM estimates, with Windmeijer finite-sample corrected standard errors in parentheses. The parameter estimates for lagged alcohol consumption range from 0.11 to 0.25. Those for lagged cigarette consumption are all negative and insignificant. Cigarette prices have positive and significant effects at the 10% level (with the parameter estimate 0.087) on alcohol consumption for females only, indicating that cigarettes and alcohol are economic substitutes for females. To take into account any time-specific common trends, year fixed effects are included in all regressions. Moreover, the sample of females passes the AR(2) test and the Hansen test.[9] For all other samples, alcohol consumption is not affected by increases in cigarette prices. Smoke-free air laws are insignificant for all samples. The reason could be that there was not enough variation within states over the time of this analysis. The effects of alcohol prices

and the 0.08 BAC laws on alcohol consumption are small and insignificant. This could be also due to the lack of variation in them. In fact, federal excise taxes on alcohol have not risen since 1991 and states have been reluctant to increase alcohol taxes due to the influence of lobbies. During the sample period, 23 states lowered the legal BAC limit from 0.10% to 0.08% while the other 27 states had done so prior to 2001. Other control variables appear to be insignificant for the same reason.

Table 3, containing OLS and FE estimates, demonstrates that OLS may have overestimated the lagged dependent variable and FE may have underestimated it. OLS estimates, in Panel A, show that the lagged alcohol consumptions are positive and significant at the 1% level, whereas estimates from FE models, in Panel B, are negative and insignificant. As for lagged cigarette consumption, OLS estimates are all positive, and three in five are significant at the 5% level; FE estimates have conflicting signs and are all insignificant. All other control variables are not shown.

7. CONCLUSIONS AND DISCUSSIONS

Earlier studies in the economic literature on complementarity and substitutability between smoking and drinking have inconsistent findings. Moreover, those studies consider either the overall population or specific demographic subgroups such as teens and older adults. This paper focuses on smokers only who are most likely to be affected by changes in the prices of

Table 1
Independent Variables Descriptive Statistics

Variables	*Definition*	*Mean*	*Standard Deviation*
Cigarette Price	Price of a pack of 20 cigarettes adjusted by consumer price index to 1999 dollars	3.43	0.55
Smoking Ban Index	Numerical values created from the smoking restriction of the smoke-free air laws	18.50	13.98
Beer Price	Price of a six-pack of beer adjusted by consumer price index to 1999 dollars	6.22	1.03
0.08 BAC	Dichotomous indicator for having an effective 0.08 BAC law	0.80	0.40
Age	Age of respondent	44.06	11.10
Male	Dichotomous indicator for male	0.45	0.50
White	Dichotomous indicator for white	0.61	0.49
Black	Dichotomous indicator for black	0.29	0.46
Other Race	Dichotomous indicator for race other than white or black	0.10	0.30
Hispanic	Dichotomous indicator for Hispanic	0.05	0.22
College	Dichotomous indicator for having college degree or higher	0.25	0.43
Some College	Dichotomous indicator for having some college	0.14	0.35
High School	Dichotomous indicator for having high school diploma or equivalent	0.34	0.47
Less than High School	Dichotomous indicator for not having completed high school	0.27	0.44
Family Income	Total family income of previous year in thousands of dollars discounted 1999 dollars	49.89	56.11
Household Size	Number of persons residing in the household	2.92	1.49
Married	Dichotomous indicator for being married	0.64	0.50
Employed	Dichotomous indicator for employed	0.69	0.46

Table 2
GMM Estimates for Alcohol Consumption by Smokers

Independent Variable	*Full sample*	*Aged 50 and younger*	*Aged 51 and older*	*Males*	*Females*
Lagged alcohol consumption	0.217***	0.251***	0.108	0.210***	0.128**
	(0.051)	(0.066)	(0.083)	(0.083)	(0.055)
Lagged cigarette consumption	-0.003	-0.001	-0.001	-0.002	-0.003
	(0.004)	(0.004)	(0.006)	(0.007)	(0.003)
Cigarette price	0.050	0.015	-0.035	-0.040	0.087*
	(0.089)	(0.092)	(0.245)	(0.179)	(0.048)
Smoking ban index	-0.0003	0.001	-0.001	-0.002	-0.00004
	(0.002)	(0.003)	(0.004)	(0.004)	(0.002)
Beer price	0.037	0.024	0.073	-0.138	-0.008
	(0.112)	(0.115)	(0.267)	(0.226)	(0.055)
0.08 BAC	0.120	0.107	0.237	0.586	-0.119
	(0.252)	(0.265)	(0.789)	(0.569)	(0.150)
Age	-0.032	0.002	-0.036	-0.017	-0.003
	(0.033)	(0.022)	(0.061)	(0.069)	(0.009)
Male	1.357	0.142	3.201	-	-
	(1.095)	(0.794)	(3.804)	-	-
Black	-0.251	0.354	-2.435	0.527	0.287
	(0.780)	(0.672)	(1.850)	(2.927)	(0.269)
Other race	0.620	0.044	0.130	-11.241	-0.069
	(0.926)	(1.036)	(1.960)	(12.724)	(0.448)
Hispanic	0.829	0.959	-1.156	0.937	0.064
	(2.385)	(2.053)	(9.073)	(11.585)	(0.787)
Some college	-0.293	0.568	-1.747	-0.009	0.334
	(0.631)	(0.644)	(1.161)	(1.454)	(0.308)
High school	0.686	0.583	-0.158	2.082	0.258
	(0.429)	(0.498)	(1.560)	(1.354)	(0.231)
Less than high school	-0.194	-0.030	0.548	-2.184	-0.049
	(0.450)	(0.474)	(1.296)	(2.366)	(0.277)
Family income	0.001	0.002	0.0001	0.001	0.0000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
Household size	0.089	0.049	0.232	-0.056	0.045
	(0.048)	(0.046)	(0.200)	(0.088)	(0.043)
Married	-0.017	0.187	-0.393	0.380	0.093
	(0.183)	(0.170)	(0.583)	(0.306)	(0.128)
Employed	-0.017	0.070	-0.027	0.053	0.137
	(0.183)	(0.080)	(0.170)	(0.120)	(0.055)
Number of observations	7974	5416	2558	3623	4351
Number of instruments	53	53	53	52	52
p-value AR(2) test	0.423	0.250	0.706	0.755	0.492
p-value Hansen test	0.091	0.057	0.491	0.384	0.384

Note: Windmeijer finite-sample standard errors in parentheses. All regressions include year fixed effects.
*significant at 10% level, **significant at 5% level, ***significant at 1% level.

Table 3
OLS and FE Estimates for Alcohol Consumption by Smokers

Independent Variable	*Full sample*	*Aged 50 and younger*	*Aged 51 and older*	*Males*	*Females*
Panel A: OLS					
Lagged alcohol consumption	0.530***	0.509***	0.555***	0.600***	0.360***
	(0.042)	(0.057)	(0.061)	(0.043)	(0.074)
Lagged cigarette consumption	0.004**	0.005**	0.001	0.005**	0.0004
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
Cigarette price	-0.005	0.027***	-0.060	-0.036	0.038
	(0.031)	(0.043)	(0.039)	(0.043)	(0.041)
Smoking ban index	0.001	-0.0008	0.005*	0.002	0.0002
	(0.001)	(0.001)	(0.003)	(0.002)	(0.001)
Beer price	-0.001	-0.007	0.013	0.024	-0.013
	(0.025)	(0.029)	(0.051)	(0.045)	(0.024)
0.08 BAC	0.0006	0.002	-0.008	-0.005	0.009
	(0.039)	(0.046)	(0.078)	(0.077)	(0.035)
Panel B: FE					
Lagged alcohol consumption	-0.064	-0.091	-0.074	-0.023	-0.131
	(0.041)	(0.061)	(0.049)	(0.035)	(0.087)
Lagged cigarette consumption	-0.0002	-0.0003	0.001	-0.0004	-0.0002
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Cigarette price	0.015	0.018	-0.050	-0.050	0.039
	(0.047)	(0.064)	(0.078)	(0.081)	(0.052)
Smoking ban index	0.001	-0.0001	0.005	0.003	-0.001
	(0.002)	(0.002)	(0.004)	(0.003)	(0.001)
Beer price	-0.035	0.011	-0.119	-0.059	-0.033
	(0.050)	(0.055)	(0.116)	(0.099)	(0.043)
0.08 BAC	0.089*	0.117*	-0.037	0.181	0.020
	(0.050)	(0.067)	(0.081)	(0.095)	(0.044)
Number of observations	7974	5416	2558	3623	4351

Note: Standard errors in parentheses. All regressions include age, male, white, black, other race, Hispanic, college, some college, high school, less than high school, family income, household size, married, employed, and year fixed effects as controls. *significant at 10% level, **significant at 5% level, ***significant at 1% level.

cigarettes. Taking advantage of the unprecedented increases in cigarette prices since the MSA in 1998, this research consistently estimates the cross-price effects of cigarettes on alcohol consumption using dynamic panel methods. The key variables are cigarette prices and smoke-free air laws (recoded into smoking ban indices), which measure the full prices of smoking. Due to the addictive nature of cigarettes and alcohol, consumption of cigarettes and/or alcohol in the previous period may reinforce the consumption level of alcohol in the current period. Dynamic models allow for these reinforcement effects. Since the lagged consumption of cigarettes and alcohol are predetermined variables, not including them may result in omitted variables bias.

The system GMM estimator utilized in this paper is consistent. OLS is expected to overestimate the lagged terms and FE can be shown to underestimate them. Estimations of the effects of lagged alcohol consumption on current alcohol consumption from OLS, FE and GMM confirm these expectations: the GMM estimates are lower than those of OLS and are higher than those of FE.

Raising cigarette taxes has been one of the most effective means to prevent and reduce smoking (Chaloupka and Warner 2000). One possible negative externality of this policy is that it may inadvertently increase the consumption of alcohol if cigarettes and alcohol are substitute goods. GMM estimates indicate that cigarettes and alcohol are substitutes only for female smokers, not for other groups. There can be two explanations. First, there may be a higher percentage of social drinkers and smokers among women. When facing higher prices for cigarettes and when smoking is prohibited in restaurants and bars, they tend to drink more alcohol. Secondly, women tend to use cigarettes as a stress reliever. Amos (1996) points out that female smoking, in both developing and developed countries, is most common among those who have low levels of academic achievement, who have low status, repetitive and insecure jobs, who are single parents or divorced, and those from under-privileged ethnic groups. These women smoke, despite the cost to their health and finances, to relieve stress, calm nerves or reduce feelings of anger and frustration. Although in reality no evidence can be shown that smoking actually relieves stress, they believe that is does, and feel that they can cope competently with cigarettes. Therefore, they tend to substitute alcohol for cigarettes as it gets more costly to smoke cigarettes while the prices of alcohol stay relatively constant. To make matters worse, alcohol is most effective in reducing stress when the amount reaches the legal intoxication level, which will lead to more severe health consequences, more traffic accidents and other external harms.

Public policies should facilitate more health education on the negative consequences of smoking and drinking. This is particularly important for women since health risk behaviors of the mother can be more damaging to the children than those of the father. Since risk behaviors are related to low socioeconomic status, policies should also aim to increase women's educational attainment and income. At the same time, the government can raise the taxes on alcohol in addition to the increases in cigarette taxes. This is relevant at least for the U.S., where the allocation of taxes on cigarettes and alcohol has been disproportionate. In China, drinking has been traditionally accepted. The legal drinking age is 18, but this law is weakly enforced. With over 350 million smokers, China launched an anti-smoking campaign in 2009. As smoking is being reduced, it is crucial that the policy makers take into account the possibility of increases in drinking prevalence and intensity.

One limitation of this study is that it does not take into consideration the effects of future prices on current consumption. According to the rational addiction framework developed by Becker and Murphy (1988), consumers are forward-looking, and current consumption is also affected by the anticipated future prices. Goel and Morey (1995), Pacula (1997, 1998) and Kenkel *et al.* (2001) extend the rational addiction model to allow for two or more addictive goods for perfectly rational consumers. However, including a lead price will leave only three waves of data to use. It would be more feasible to test rational addiction as more data become available.

Notes

1. Center for Disease Control and Prevention (CDC), Tobacco-Related Mortality. Available at *http://www.cdc.gov/tobacco/data_statistics/fact_sheets/health_effects/tobacco_related_mortality* (June 15, 2015).
2. Center for Disease Control and Prevention (CDC), Tobacco-Related Mortality. Available at *http://www.cdc.gov/tobacco/data_statistics/fact_sheets/adult_data/cig_smoking/index.htm* (April 15, 2015).

3. These are used as IV style instruments in addition to the GMM style instruments.
4. Z_{di} is the instrument matrix for the differenced equation for each individual; Z_{li} is the instrument matrix for the level equation for each individual; Z_{si} is the instrument matrix for the system of equations for each individual.
5. Z_s, ΔU_i and U_i are stacked matrices across individuals.
6. All monetary prices are in 1999 dollars.
7. Under the 0.08 BAC laws, it is illegal to operate a motor vehicle if the driver has a blood alcohol concentration (BAC) of 0.08% or higher.
8. Balanced panels are used.
9. These tests are to test the validity of instruments.

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