An Exploratory Panel Data Analysis of Impacts of Cigarette Excise Taxes and Statewide Bans on Cigarette Consumption

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Abstract: This study seeks to provide recent, i.e., updated, and new evidence on the impact of public policy on cigarette consumption using panel data. In particular, this exploratory study uses a state-level panel data-set to investigate the impact on per capita cigarette consumption in the U.S. of public policies not only in the form of cigarette excise taxes but also in the form of heretofore largely ignored public statutes that impose statewide bans on cigarette smoking in restaurants and bars. Naturally, the impacts of certain economic and non-economic (demographic) factors on cigarette are considered as well. The five-year panel spans the period from 2002 through 2006. The estimates in this study find that the higher the total per pack cigarette excise tax, the lower the aggregate volume of cigarettes consumed per capita, whereas statewide bans on cigarette smoking in restaurants and bars are found to reduce per capita cigarette smoking as well.

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1. Introduction

The impact of excise taxes and other factors on cigarette consumption has been studied extensively. Typically, it is argued that the higher total price on cigarettes resulting from higher cigarette excise taxation acts as a deterrent to smoking; cigarettes simply become "too costly" not only for at least *some* current smokers but also to at least *some* would-be "new" smokers. Empirically, higher excise taxes usually are found to reduce the number of packs of cigarettes consumed, although other important factors influencing cigarette consumption have also been identified (Koch, 1992; Showalter, 1998; Forster and Jones, 2001; DeCicca, Kenkel, and Mathios, 2002; Lien and Evans, 2005; Tauras, 2006). Often-times, when studies find that higher excise taxes on cigarettes reduce the aggregate amount/volume of cigarette consumption, cigarette excise taxation takes on relevance not only as a potentially significant revenue source but also appears to assume the role of a valuable tool for improving public health.

This study seeks to provide recent, i.e., updated, and new evidence on the impact of public policy on cigarette consumption using panel data. In particular, this exploratory study uses a state-level panel data-set to investigate the impact on per capita cigarette consumption in the U.S. of public policies not only in the form of cigarette excise taxes but also in the form of heretofore largely ignored public statutes that impose statewide bans on cigarette smoking in restaurants and bars.

By investigating the latter impacts, this panel data study seeks to add to a high-quality and highly diverse literature (Fleck and Hanssen, 2008; Hersch, Del Rossi, and Viscusi, 2004) on cigarette smoking influences. Naturally, the impacts of certain economic and non-economic (demographic) factors on cigarette are considered as well. The five-year panel spans the period from 2002 through 2006. The estimates in this study find that the higher the cigarette excise tax, the lower the aggregate volume of cigarettes consumed per capita, whereas *statewide* bans on cigarette smoking in restaurants and bars are found to reduce per capita cigarette smoking as well.

2. Background Studies

A number of previous studies have explored determinants of cigarette consumption (Koch, 1992; Meier and Licari, 1997; Showalter, 1998; DeCicca, Kenkel, and Mathios, 2002; Forster and Jones, 2001; Lien and Evans, 2005; Anderson and Mellor, 2008; Goel, 2008; Cebula, 2010). Relevant contents of several of these studies are briefly summarized here.

For instance, raising cigarette excise taxes is commonly regarded as one of the most effective strategies for reducing cigarette consumption. In a study by Lien and Evans (2005), reductions in smoking by pregnant women and subsequent improvements in birth weight occur almost immediately after a large cigarette tax hike has been implemented. A study by Forster and Jones (2001) measures tax elasticities of cigarette consumption. Elasticity estimates are within the range of -0.4 to -0.7, indicating that, for example, an increase in the cigarette tax of 10% would lead to a decrease in the volume of cigarettes consumed of between 4% and 7%. A more recent study by Cebula (2010) provides semi-log estimates focusing on *federal plus state-level* cigarette excise taxation in which a 10% increase in the cigarette excise tax is found to reduce per capita cigarette smoking by about 2.0%-2.5%. Similar results are found in Meier and Licari (1997) and Showalter (1998).

The Koch (1992), Anderson and Mellor (2008), and Cebula (2010) studies also find that cigarette smoking is an increasing function of the age of the population. It is also argued and/or found by Koch (1992), Forster and Jones (2001), Anderson and Mellor (2008), Connelly, Goel, and Ram (2009), and others that the higher the average educational attainment level among the adult population, the lower the aggregate consumption rate of cigarettes, i.e., the greater the probability that one is a *non-smoker*. Similarly, various studies, including Koch (1992), Forster and Jones (2001), and Connelly, Goel, and Ram (2009) find that the higher the per capita income level, the lower the aggregate consumption rate of cigarettes. Additionally, there may be a potential presence of "moral hazard" in cigarette smoking behaviors. In particular, health insurance partly insulates individuals from the health problems smoking can create by reducing the financial risk associated with smoking through allowing access to healthcare and thereby mitigating the individual smoker's *financial* burden from smoking-related illness or illnesses. Consequently, health insurance coverage might potentially increase the likelihood of a risk-averse individual's smoking, *ceteris paribus*; alternatively, in theory, the *absence* of health insurance may act to *discourage* smoking among risk-averse individuals. Indeed, the Goel (2008) and Cebula (2010) studies find preliminary evidence on behalf of this hypothesis, namely, that the higher the percentage of the population *without* health insurance, the *lower* the percentage of the population that does not smoke. Finally, studies such as Connelly, Goel, and

Ram (2009), and Tauras (2006) find that higher cigarette prices *per se*, i.e., net of excise taxes, also discourages cigarette consumption.

In sum, then, based on studies cited above, cigarette smoking is hypothesized to be a decreasing function of the *absence* of health insurance, higher cigarette excise tax levels, higher income levels, higher cigarette prices *per se*, and a higher level of formal education. Furthermore, cigarette smoking is an increasing function of the age of the population, i.e., the older a given population cohort member, the greater the likelihood that said person is a smoker. Finally, although not based on the above studies and somewhat ignored thus far in the literature, it is hypothesized in this study that the presence of statewide bans cigarette smoking in restaurants and bars should act, so long as these bans are meaningfully enforced, to diminish cigarette consumption. The complex nature of smoking bans is examined in a number of studies, including Fleck and Hanssen (2008) and Hersch, Del Rossi, and Viscusi (2004).

3. A Model of Smoking Determinants

Based on the studies briefly summarized above, this study adopts an eclectic model in which the determinants of the *annual per capita cigarette consumption* in year *t* in state *j* are modeled as follows:

$$log\ CONS_{jt} = a_0 + a_1\ log\ INCOME_{jt-1} + a_2\ log\ NOINSUR_{jt-1} + a_3\ log\ TAX_{jt-1}$$
$$+ a_4\ log\ CIGPR_{jt-1} + a_5\ log\ AGE_{jt-1} + a_6\ log\ BACH_{jt-1} + a_7\ log\ BAN_{jt} + a_8\ TREND + \ \varepsilon_{jt} \quad\quad (1)$$

where:

$log\ CONS_{jt}$ = the natural log of cigarette consumption in state *j* in year *t*, measured as the number of packs of cigarettes purchased annually per capita;
a_0 = constant term;
$log\ INCOME_{jt-1}$ = the natural log of the per capita income in state *j* in year *t-1*, expressed in year 2002 dollars;
$log\ NOINSUR_{jt-1}$ = the natural log of the percent of the population *without* health insurance in state *j* in year *t-1*;
$log\ TAX_{jt-1}$ = the natural log of the average total federal *plus* state cigarette excise tax per pack in state *j* in year *t-1*, expressed in year 2002 dollars;
$log\ CIGPR_{jt-1}$ = the average price per pack of cigarettes sold in state *j* in year *t-1*, net of all excise taxes, expressed in year 2002 dollars;
$log\ AGE_{jt-1}$ = the natural log of the median age of the population in state *j* in year *t-1*;
$log\ BACH_{jt-1}$ = the natural log of the percent of the population in state *j* in year *t-1* over age 25 that has completed *at least* a four-year college (bachelors) degree;
$BANjt$ = a binary/dummy variable indicating the existence of a statewide ban on cigarette smoking in state *j* in year *t: BANjt* = 1 if a smoking ban exists and = 0 otherwise.
$TREND$ = a linear trend variable; and
ε_{jt} = stochastic error term.

In the model above, it is expected that: $a_1 < 0,\ a_2 < 0,\ a_3 < 0,\ a_4 < 0,\ a_5 > 0,\ a_6 < 0,\ a_7 < 0$ (2)

A trend variable for the study period was included in all of the estimates to allow for trending over the study period. In this specification, to reflect educational attainment, *BACH,* is adopted; similar results are obtained if the percent of the population with a high school diploma or higher is used instead. The *BAN* variable assumes a different form in each of the three estimates: *BANRjt*, if there is a statewide ban on cigarette smoking in restaurants in state *j* in year *t*; *BANBjt*, if there is a statewide ban on cigarette smoking in bars in state *j* in year *t*; and *BANR&Bjt*, if there is a statewide ban on cigarette smoking in restaurants *and* bars in state *j* in year *t*.

Data for the variables *CONS* and *CIGPR* were obtained from the Centers for Disease Control (2008, Table 8), using fourth quarter data for each year in the study period. Data for the variable *INCOMEjt-1* were obtained from the yearly American Community Survey (2008, Table B19301). The nominal per capita income variable was adjusted to reflect inflation over the study period using the GDP deflator supplied by the Council of Economic Advisors (2009, Table B-3). In addition, *CIGPRjt-1* was also adjusted to reflect inflation over the study period using the GDP deflator provided by the Council of Economic Advisors (2009, Table B-3). The data for the *NOINSUR* variable were obtained from the Centers for Disease Control and Prevention (2010, Table 10). The data on *TAX* were obtained from Orzechowski and Walker (2008, Table 11). As with the *INCOME* and *CIGPR* variables, the excise tax was adjusted to reflect inflation over the study period using the GDP deflator provided by the Council of Economic Advisors (2009, Table B-3). It should be observed that the variable *TAX* is the *sum* of the federal plus state cigarette excise taxes. The *AGE* data were obtained from the yearly American Community Survey (2008, Table B-01002). Data for computing the variable *BACH* were obtained from the U.S. Census Bureau (2009, Table 15; 2011, Table 15).

The study uses state-level panel data for all 50 states (with Washington, D.C. excluded from the study) over the period 2002 through 2006. Equation (1) was first estimated using the *Fixed-Effects Model* and then estimated using the *Random- Effects Model*. Performing the Hausman test [phtest (fixed, random)] generated a *p*-value = 0.0568 so that the study adopted the *Random-Effects Model*. The model is expressed in log-log form to simplify interpretation.

4. Empirical Results

The PLS *Random-Effects Model* estimates of equation (1) are provided in Table 1, as follows: in estimate (a), for the model adopting *BANR* (statewide bans on cigarette smoking in restaurants); in estimate (b), for the model adopting *BANB* (statewide bans on cigarette smoking in bars); and in estimate (c), for the model adopting *BANR&B* (statewide bans on cigarette smoking in restaurants *and* bars). The elasticity values for the income variable are all negative but not statistically significant at even the 10% level; thus, cigarette consumption is not significantly affected by income. As for the other non-public-policy variables, *NOINSUR, CIGPR,* and *BACH,* all nine elasticity values are negative, with three statistically significant at the 5% level and six statistically significant at the 1% level; furthermore, the estimated elasticity on the *AGE* variable is positive and statistically significant at the 1% level in all cases. Thus, as hypothesized, cigarette smoking is a decreasing function of *NOINSUR, CIGPR,* and *BACH* and an increasing function of *AGE*.

Regarding the policy variables, the estimated elasticity on the total cigarette excise tax is negative (as hypothesized) and statistically significant at the 2.5% level in all three cases. The results imply that a 10% rise in the cigarette excise tax would elicit approximately a 2% decline in cigarette consumption per capita. In addition, the coefficients on each of the three of the cigarette ban variables is negative (as hypothesized) and statistically significant at the 2.5% level. These results imply that statewide bans on cigarette smoking in restaurants and bars reduce cigarette consumption per capita by 1.5%-1.8%. Thus, the empirical results in this exploratory panel data-set analysis imply that public policy in the form of both increased cigarette excise taxation and the imposition of statewide bans on cigarette smoking in bars and restaurants do *appea*r to reduce cigarette consumption per capita. Future panel data research should treat smoking bans in a more sophisticated fashion (Fleck and Hanssen, 2008) by considering and then distinguishing between state bans and local bans and their respective impacts on cigarette smoking.

Endnote

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Table 1. Empirical Results

	Elasticity (a)	t-value	Elasticity (b)	t-value	Elasticity (c)	t-value
Explanatory Variables:						
Constant	-7.84		-7.69		-7.75	
log INCOME	-0.49	-1.61	- 0.48	-1.50	-0.48	-1.53
log NOINSUR	-0.14*	-1.98	-0.16	-2.00	-0.15*	1.96
log TAX	-0.21**	-2.36	-0.18**	-2.26	-0.19**	-2.29
log CIGPR	-1.43***	-4.60	-1.45***	-3.98	-1.44***	-4.25
log AGE	2.51***	11.25	2.52***	11.48	2.52***	11.32
log BACH	-0.54***	-3.41	-0.55***	-3.72	-0.54***	-3.44
log BANR	-0.015**	-2.30				
log BANB			-0.016**	-2.26		
log BANR&B					-0.018**	-2.26
TREND	-0.03	-1.82	-0.03	-1.94	-0.03	-1.83
R^2	0.42		0.42		0.42	
adj R^2	0.39		0.39		0.40	
F	17.18***		17.18***		17.27***	

***statistically significant at 1% level; **statistically significant at the 2.5% level; *statistically significant at 5% level. White (1980) correction adopted.