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PUBLIC POLICY AND SOME-DAY SMOKING AMONG ADULTS

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While much is known about the impact of public policy on current cigarette smoking among adults, very little is known about the determinants of some-day smoking. This paper investigates the impact of cigarette prices, clean indoor air laws, and other socio-economic factors on adult cigarette demand. Special emphasis is placed on examining the determinants of some-day smoking among adults. The estimates from this study clearly indicate that increasing the price of cigarettes, will decrease the number of people who currently smoke, will decrease the number of every-day smokers, and will decrease the number of cigarettes smoked on average among some-day smokers. Finally, clean indoor air laws are found to have a limited impact on current and some-day smoking.

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I. Introduction

The health consequences of cigarette smoking have been the focus of rigorous scientific investigation since the early 1950's. Throughout this period, cigarette smoking has been causally linked to an extensive and still increasing array of diseases. Yearly adult per capita consumption of cigarettes in the

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United States (U.S.) reached a peak of 4,345 in 1963 and began declining in 1964, the year in which the first Surgeon General's report on the health consequences of cigarette smoking was published (USDHHS, 1991).

At the same time, substantial progress was made in reducing the prevalence of adult smoking in the U.S.. According to the National Health Interview Surveys, the prevalence of current smoking declined from 42.4% in 1964 to 23.5% in 1999. However, the decline in prevalence was much more modest in the 1990's than it was in the previous two and a half decades. Between 1990 and 1999, the prevalence of cigarette smoking among adults declined by only two percentage points.

Much of the progress in curtailing cigarette smoking in the U.S. can be attributed to tobacco control strategies, including wide spread dissemination of information on the risks of smoking, anti-smoking advertisements, limits on cigarette manufacturer's advertisements, restrictions on smoking in private workplaces and public places, increases in cigarette excise taxes, restrictions on access to minors, and various others (USDHHS, 1991). Although the prevalence of smoking has declined considerably over the past several decades, cigarette smoking remains the leading cause of preventable death in the United States.

Despite the deleterious health consequences of cigarette smoking, approximately 46.5 million adults in the U.S. aged 18 and over were current smokers in 1999 (CDC, 2001). Nearly 2 million (4.3%) of these adult smokers did not smoke daily, but rather, smoked only on some-days (CDC, 2001). It was traditionally believed that some-day smoking was a transitional state in the smoking uptake or cessation continuums (USDHHS, 1988, and McKennel and Thomas, 1967). That is, due to the development of tolerance,[1] individuals escalate their dose patterns in the uptake process (i.e. increase the number of cigarettes smoked and increase the amount of nicotine extracted per cigarette) until stable daily patterns of cigarette use and nicotine blood concentration are established (USDHHS, 1988). Similarly, occasional smoking may also be a transitional state among smokers who are attempting to cut back or who quit and relapse (Evans et al., 1992).

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[1] Tolerance suggests that a given dose of a drug produces less effect, or conversely, increasing doses are required to produce a specified intensity of response.

Some recent research, however, has concluded that occasional smoking for some individuals may be a stable state. Shiffman and colleagues (1989, 1990, 1991) identified a group of long-term occasional smokers known as chippers who had chronic patterns of consuming five or fewer cigarettes a day, most abstaining from smoking for at least one day a week. Adding support to the hypothesis that a proportion of some-day smokers maintain a long-term occasional smoking habit, Evans et al. (1992) found 58.8% of occasional smokers to have reported being occasional smokers one year previously using the 1990 California Tobacco Survey. Similarly, using longitudinal data from Sweden, Lindstrom et al. (2002) found 60% of the baseline intermittent smokers to remain intermittent smokers during the first follow-up one year later.

Regardless of whether occasional smoking is a migratory or stable state, if future advances are to be made in reducing the harm caused by cigarette smoking, a better understanding of the impact of public policy on some-day smoking is needed. For those individuals where some-day smoking is a transitional state in the smoking uptake phase, public policy has the potential to stop the progression into daily smoking because, for many, their dependence on nicotine has not fully been established. For those individuals where some-day smoking is a transitional state from daily smoking to smoking cessation, public policy has the potential to facilitate and sustain the transformation. For those individuals who are long-term some-day smokers, public policy has the potential to decrease the number of days smoked, the number of cigarettes consumed, and may provide the impetus long-term intermittent smokers require to thwart the smoking habit. Since almost all smokers, either in a transitional or long-term state of smoking, are at one point in time some-day smokers, it is imperative to gain a better understanding of the determinants of some-day smoking in an attempt to mitigate the detrimental health consequences of cigarette smoking.

This study attempts to illustrate the impact of cigarette prices (which can be readily increased through cigarette excise taxes) and clean indoor air laws on some-day smoking in the United States. In particular, this study provides the first econometric evidence on the use of economic incentives to alter the smoking behavior of some-day smokers.

The remainder of the paper is organized as follows. Section II provides a

brief review of the cigarette demand literature and highlights the absence of research conducted on the economic determinants of some-day smoking. Section III describes the data and methods that are employed in this paper. Section IV presents the results from the cigarette demand equations that are estimated. Finally, Section V contains concluding remarks.

II. Brief Literature Overview

Numerous econometric studies on the determinants of cigarette demand have been conducted over the past thirty years.[2] These studies have employed diverse data, theoretical modeling, and statistical techniques to estimate the effects of cigarette prices, excise taxes, and other tobacco control policies on individual's consumption of cigarettes. The most consistent finding from these studies is that cigarette consumption is inversely related to the price of cigarettes.

Many studies have employed aggregate level data (either time series for one geographic unit or pooled cross-sectional time series for multiple geographic units) in their investigation of cigarette demand. Price elasticity estimates obtained from these studies range from -0.14 to -1.12, with a majority of the estimates falling in a narrower range of -0.30 to -0.50 (USDHHS, 2000). Differences in the price elasticity estimates can be attributed to differences in data and modeling techniques.

A growing number of studies have employed micro-level data (individual or group level data) to focus on the impact of prices, taxes, and other tobacco control policies on cigarette consumption. One of the first econometric studies to use micro-level data in investigating the determinants of cigarette consumption was conducted by Lewit, Coate, and Grossman (1981). They employed data from Cycle III of the United States Health Examination Surveys conducted between 1966 and 1970. They examined the impact of cigarette prices and anti-smoking advertisements (as part of the Fairness Doctrine) on cigarette consumption by youths aged 12 to 17. They estimated a two–part

[2] For a comprehensive review of these studies see "The Economics of Smoking" in *The Handbook of Health Economics*, North-Holland, Elsevier Science, 2000, and the various Surgeon General's reports (USDHHS, 1989, 1994, and 2000).

model of demand in which smoking propensity and intensity are modeled separately.[3] They found that the overall price elasticity of demand for youths is centered around -1.43. In addition, they found that price plays a stronger role on the decision to smoke than on the amount smoked by smokers.

Following the publication by Lewit, Coate, and Grossman (1981), the two-part model of demand became the standard methodology employed in the cigarette demand literature. For example, Lewit and Coate (1982) employed a two-part model using the 1976 Health Interview Survey to estimate price elasticities of demand by alternative age groups (20 to 25 years, 26 to 35 years, and 36 to 74 years). The investigators found that young adults (20 to 25 years old) were more responsive to changes in price than were adults of any age (more than 20 years old). The estimated total price elasticities of demand for young adults and adults of any age were -0.94 and -0.367, respectively.

Similarly, Wasserman, et al. (1991) examined the impact of cigarette prices and bans on smoking in public places on both adult and youth cigarette demand using several of the Health Interview Surveys from the 1970's and 1980's. They concluded that increasing the stringency of smoking in public places decreased overall cigarette consumption by both youths and adults alike. However, when they decomposed the impact of public smoking bans by using a two part model, they found that increasing the stringency of smoking bans decreased smoking participation among youths and decrease conditional demand among adults, but had no impact on adult smoking prevalence and had no impact on conditional demand among youths. The average estimated adult price elasticities of smoking participation and conditional demand were -0.06 and -0.04, respectively.

Moreover, Chaloupka and Wechsler (1997) used a two-part model of demand using the 1993 Harvard Alcohol Study to estimate the effects of prices and restrictions on cigarette smoking among college students. They estimated an overall price elasticity of demand of –1.11 for college students. In addition, they found restrictions on smoking in public places to have little impact on cigarette smoking by college student.

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[3] Cragg (1971) developed the two-part model and applied it to the demand for durable goods.

Finally, Evans and Farrelly (1998) employed a two-part model of demand using data from the 1979 Smoking Supplement and the 1987 Cancer Control Supplement to the National Health Interview. They estimated participation and conditional demand elasticities for adults to be -0.185 and -0.117, respectively. In addition, they found that increases in cigarette prices bring about compensating behaviors. In particular, smokers in high tax states are more likely to smoke longer cigarettes and cigarettes that have higher tar and nicotine content than smokers in low tax states.

Given the addictive nature of cigarettes, an implicit assumption of previous econometric studies of cigarette demand was that all current-smokers were homogeneous every-day smokers. That is, no previous econometric study has differentiated between some-day smokers and everyday smokers in estimating cigarette demand equations. This paper addresses this issue and provides a detailed examination of the determinants of demand for cigarettes among some-day smokers.

III. Data and Methods

The empirical models that are estimated in this study employ data from the 1991, 1993, and 1994 National Health Interview Surveys (NHIS).[4] The NHIS are cross-sectional surveys covering the civilian non-institutionalized population of the United States.[5] Information on individuals is obtained continuously throughout the year and is collected through personal interviews conducted by U.S. Bureau of Census employees using a stratified multistage probability sampling technique. The primary focus of the surveys is to collect information on the distribution, magnitude, and effects of disability and illness in the United States and to measure the amount of services used to treat these disabilities and illnesses.

[4] By special agreement, the National Center for Health Statistics (NCHS) has provided a restricted data set containing detailed information on some-day cigarette use and identifiers for each respondent's state of residence for individuals sampled in 1991, 1993 and 1994. Unfortunately, the NCHS will not distribute more recent data that contains individual level geocode identifiers.

[5] Persons in long-term care facilities, on active duty in the U.S. military, and U.S. nationals living in foreign countries are excluded from the surveys.

Each year, the respondents were asked about their current smoking habit. These data were used to construct three alternative dependent variables: participation in current cigarette smoking, participation in some-day smoking, and average monthly smoking among some-day smokers. The first measure, participation in current smoking, is a dichotomous indicator equal to 1 for respondents who indicated that they smoked either on some-days or every-day in the 30 days prior to the survey and is equal to zero otherwise. The second measure, participation in some-day smoking, is a dichotomous indicator equal to 1 for current smokers who indicated that they only smoked on some-days in the 30 days prior to the survey and is equal to zero otherwise. The third dependent variable is a continuous measure of monthly cigarette consumption for some-day smokers based on the number of days each smoker smoked each month multiplied by the average number of cigarettes smoked per day on days smoked.

Based on the survey data numerous independent variables were created to control for factors that are thought likely to influence cigarette smoking. Table 1 contains the definitions of the included covariates and Table 2 contains basic descriptive statistics of these covariates.

First of all, based on the state identifiers, cigarette prices were added to the surveys. The price data were obtained from Tobacco Institute's annual *Tax Burden on Tobacco*.[6] Each year prior to 2000, the Tobacco Institute published state-level cigarette prices as of November 1. These prices are weighted averages for a pack of 20 cigarettes based on the prices of single packs, cartons, and vending machine sales where the weights are the national proportions of each type of sale. These prices are inclusive of state level sales taxes applied to cigarettes, but are exclusive of local cigarette taxes. Since the price published is as of November 1, and the surveys are conducted throughout the year, a weighted average price for each year is computed. To account for changes in the relative price of cigarettes over time, all cigarette prices are deflated by the national Consumer Price Index published by the Bureau of Labor Statistics (1982-1984 = 100).

[6] The Tobacco Institute stopped publishing the *Tax Burden on Tobacco* in 1999. Orzechowski and Walker have taken on the responsibility of publishing the *Tax Burden on Tobacco* post 1999.

Table 1. Definitions of Included Covariates

Dependent variables	Definitions
Current smoking participation	1 = smokes either everyday or some-days, 0 = non-smoker
Some-day smoking partic.	1 = smokes some-days, 0 = smokes everyday, cond. on being a smoker
Conditional some-day smoking	Average num. of cigar. smoked (cond. on being a some-day smoker)
Independent Variables	**Definitions**
- *Tobacco control variables*	
Real price	Real state price of a pack of 20 cigar., deflated by CPI, 1982-84=100
Clean indoor air index	Magnitude of each state's clean indoor air laws
Child care centers	1 = state restricts smoking in childcare center, 0 = otherwise
Government worksites	1 = state restricts smoking in government worksites, 0 = otherwise
Gymnasiums	1 = state restricts smoking in gymnasiums, 0 = otherwise
Health care facilities	1 = state restricts smoking in health care facilities, 0 = otherwise
Hotels	1 = state restricts smoking in hotels, 0 = otherwise
Private worksites	1 = state restricts smoking in private worksites, 0 = otherwise.
Public transportation	1 = state restricts smoking in public transp. facilities, 0 = otherwise
Restaurants	1 = state restricts smoking in restaurants, 0 = otherwise

Table 1. (Continued) Definitions of Included Covariates

Dependent variables	Definitions
Retail/Grocery store	1 = state restricts smoking in retail/grocery stores, 0 = otherwise
Shopping centers	1 = state restricts smoking in shopping centers, 0 = otherwise
Preemption	1=state preempts stronger clean indoor air laws to be enact., 0=other.
- *Gender variable*	
Male	1 = male, 0 = otherwise
- *Age variables*	
Age 18-24	1 = 18 ≤ age ≤ 24, 0 = otherwise
Age 25-44	1 = 25 ≤ age ≤ 44, 0 = otherwise
Age 45-64	1 = 45 ≤ age ≤ 64, 0 = otherwise
- *Race variables*	
African american	1 = African american, 0 = otherwise
Other race	1 = Other race, 0 = otherwise
White hispanic	1 = White hispanic, 0 = otherwise
Black hispanic	1 = Black hispanic, 0 = otherwise
Other hispanic	1 = Other hispanic, 0 = otherwise
- *Marital status variables*	
Married	1 = Married, 0 = otherwise
Separated, divorced, widowed	1 = Separated, divorced, or widowed, 0 = otherwise
- *Education variables*	
High school graduate	1 = High school graduate, 0 = otherwise
Some college	1 = Attended some college, 0=otherwise
- *Employment variables*	
Not employed	1 = Not employed, 0 = otherwise
Not in labor force	1 = Not in labor force, 0 = otherwise
- *Income variable*	
Real family income	Real family income, in dollars, deflated by CPI (1982-84 = 100)

Table 1. (Continued) Definitions of Included Covariates

Dependent variables	Definitions
- *Metropolitan status variable*	
MSA central city	1 = Lives central city of MSA,
	0 = otherwise
Not in MSA non-farm	1 = Lives not in MSA not on farm,
	0 = otherwise
Not in MSA farm	1 = Lives not in MSA but on farm,
	0 = otherwise
- *Poverty variable*	
Not under poverty threshold	1 = Not under poverty threshold,
	0 = otherwise
- *Year dummy variables*	
1993	1 = year of survey is 1993, 0 = otherwise
1994	1 = year of survey is 1994, 0 = otherwise

Then, based also on the state identifiers, several variables reflecting the presence and magnitude of state clean indoor air laws were added to data. Ten separate dichotomous indicators were added to the data representing whether or not states have restrictions on smoking in: private worksites, restaurants, arenas/gymnasiums, shopping malls, government worksites, day care centers, health facilities, public transit facilities, grocery/retail stores, and hotels. In addition a dichotomous indicator is merged into the data indicating whether or not states preempt smaller governmental units from passing more restrictive clean indoor air laws.

The ten dichotomous clean indoor air indicators and the preemption indicator are used to create a clean indoor air index variable. This index was constructed to capture the magnitude of each state's clean indoor air laws. In the construction of this index variable, each restriction takes on a value of between 0 and 3 depending on the strength of protection. If smoking is prohibited, the restriction rating is 3; if smoking is restricted with separate ventilation, the restriction rating is 2; if smoking is restricted with no separate

Table 2. Basic Descriptive Statistics

Independent variable	Mean	Standard deviation
Real price	1.2429	0.1346
Clean indoor air index	6.0309	4.5864
Child care centers	0.4398	0.4964
Government worksites	0.6480	0.4773
Gymnasiums	0.4195	0.4935
Health care facilities	0.8690	0.3374
Hotels	0.0259	0.1589
Private worksites	0.3772	0.4847
Public transportation	0.8029	0.3978
Restaurants	0.6213	0.4851
Retail/Grocery store	0.5860	0.4930
Shopping centers	0.0437	0.2043
Preemption	0.4395	0.4963
Male	0.4190	0.4934
Age 18-24	0.1126	0.3161
Age 25-44	0.4277	0.4947
Age 45-64	0.2579	0.4375
African american	0.1370	0.3439
Other race	0.0355	0.1850
White hispanic	0.0725	0.2592
Black hispanic	0.0044	0.0665
Other hispanic	0.0035	0.0593
Married	0.5300	0.4991
Separated, divorced, or widowed	0.2653	0.4415
High school graduate	0.3655	0.4816
Some college	0.4215	0.4938
Not employed	0.0340	0.1812
Not in labor force	0.3691	0.4826
Real family income	175.8628	135.1638
MSA central city	0.4359	0.4959

Table 2. (Continued) Basic Descriptive Statistics

Independent variable	Mean	Standard deviation
Not in MSA non-farm	0.2130	0.4090
Not in MSA farm	0.0115	0.1068
Not under poverty threshold	0.7871	0.4093
1993	0.2523	0.4343
1994	0.2354	0.4242

ventilation the restriction rating is 1; and if smoking is not restricted, then the restriction rating is 0. The index is derived by adding up the restriction ratings for each of the ten restrictions, giving a weight of three for the private worksite, a weight of two for restaurant and shopping mall restrictions and a weight of one for the remainder of the restrictions. Furthermore, if states preempt smaller governmental units from passing more restrictive clean indoor air laws, the index is decreased by five points. The possible range of the index variable is -5 to 39, however, a much narrower range of -4 to 17 is observed in the data.

Finally, other variables were included: gender, indicators of age, indicators of race and ethnicity, marital status, indicators of education, employment status during the past two weeks, average real yearly family income;[7] indicators of type of community, poverty status, and indicators for the year the survey was conducted.

In addition, given the sensitive nature of the family income and poverty variables, indicators for respondents with missing data on family income and poverty are included in the models. The missing value indicators were created to prevent the loss of a large number of observations. For example, if family income is missing, the family income variable takes on a value of zero, while

[7] Respondents indicate that their family income falls within one of 4 categories: $0-$9,999, $10,000-$19,999, $20,000-$34,999, and greater than $35,000. The family income variable takes on the values $4,999.5, $14,999.5, $27,499.5, and $50,000 for individuals who indicate income levels between $0-$9,999, $10,000-$19,999, $20,000-$34,999, and greater than $35,000, respectively. Finally, the income values are deflated by national consumer price index, 1982-1984 =100.

an additional indicator, unknown family income takes on a value of one. This missing value indicator takes on a value of zero for all respondents whose family income is known.

The use of individual-level data allows for the investigation of both the propensity to smoke and the intensity with which smokers smoke. The cumulative distribution of cigarette consumption can therefore be characterized as a mixed distribution, one that is neither continuous nor discrete. There exists a mass of zero outcomes, or in other words, a large number of individuals who do not smoke. In addition, there exists a continuous distribution for those individuals who do smoke. Economists have traditionally modeled this mixed distribution using a two-part model developed by Cragg in 1971.[8]

A three part econometric approach to model some-day smoking demand is employed in this paper. The first part is identical to part one of Cragg's (1971) traditional two part model. That is, probit methods are used to estimate a smoking participation equation for current smokers. Formally, the following equation is estimated:

$$\Pr(cs = 1 \mid x) = G(\beta_0 + x\beta) \tag{1}$$

where *cs* represents current smoking defined as either everyday or some-day smoking, *x* is a matrix of explanatory variables, β_0 is an intercept, β is a vector of unknown coefficients to be estimated, and *G* is the standard normal cumulative distribution function. The second part of the three part model uses a probit equation to estimate the probability of being a some-day smoker conditional on past month participation in current smoking. Formally, the following equation is estimated:

$$\Pr(sds = 1 \mid x) = G(\beta_0 + x\beta), \qquad cs = 1 \tag{2}$$

where *sds* represents some-day smoking and the rest of the variables are

[8] In the first part of the two-part model, a logit or probit specification is employed to estimate the decision to smoke, whereas in the second part of the model, ordinary least squares (OLS) is used on a log transformed dependent variable to estimate the number of cigarettes smoked by smokers.

defined as above. Finally, the third part of the three part model employs generalized linear methods (GLM) to model average monthly cigarette consumption by some-day smokers. GLM are an extension of traditional linear models. However, unlike traditional methods, GLM allows the expected value of the response variable to depend on a linear predictor through a nonlinear link function and allows the response probability distribution to be one of the distributions from the exponential family. After conducting a Modified Park Test, which implied that the raw-scale variance is quadratic in the raw-scale prediction, a GLM with log-link and Gamma distribution was selected to estimate the third part of the three part model.[9] Formally, the following equation is estimated:

$$g\,[E(c)] = X\beta, \qquad \text{c} \sim F \text{ and } sds = 1 \tag{3}$$

where c represents the number of cigarettes smoked in the past month, g [.] is a log-link function and F is a gamma distribution and the rest of the variables are defined as above.

Finally, a robust method of calculating the variance-covariance matrix developed by Huber (1967) is employed. In addition, an additional standard error adjustment is employed to correct for clustering at the state level. That is, the standard errors are corrected for within state correlation. Clustering at the state level relaxes the assumptions of independence of observations so that observations only have to be independent across states but not within states.

IV. Results

Estimated effects of the responsiveness of adult smoking to the price of cigarettes and to policies that restrict smoking in public places and private worksites are discussed in this section. The full set of estimates can be found in Tables 3-5. Estimates from the current smoking participation equations are presented in Table 3. Estimates from the some-day smoking participation

[9] See Manning and Mullahy (2001) for a detailed discussion of the Modified Park Test.

Table 3. Current Smoking Participation Equations

Independent variable	Model 1		Model 2		Model 3	
Real price	-0.211 *	(0.0575)	-0.070	(0.0878)	-0.206 *	(0.0746)
Clean indoor air index					-0.000	(0.0022)
Child care centers			-0.008	(0.0171)		
Gov. worksites			0.058 *	(0.0229)		
Gymnasiums			0.015	(0.0226)		
Health care facilities			-0.009	(0.0351)		
Hotels			-0.036 ***	(0.0219)		
Preemption			0.036 *	(0.0148)		
Private worksites			-0.004	(0.0211)		
Public transport.			0.008	(0.0242)		
Restaurants			-0.087 *	(0.0237)		
Retail/Grocery store			0.015	(0.0245)		
Shopping centers			0.009	(0.0237)		
Male	0.197 *	(0.0203)	0.197 *	(0.0204)	0.197 *	(0.0203)
Age 18-24	0.741 *	(0.0491)	0.742 *	(0.0490)	0.741 *	(0.0489)
Age 25-44	0.954 *	(0.0351)	0.955 *	(0.0353)	0.954 *	(0.0350)
Age 45-64	0.753 *	(0.0232)	0.754 *	(0.0233)	0.753 *	(0.0231)
African american	-0.121 *	(0.0321)	-0.126 *	(0.0321)	-0.121 *	(0.0320)
Other race	-0.208 *	(0.0355)	-0.202 *	(0.0376)	-0.208 *	(0.0355)
White hispanic	-0.447 *	(0.0382)	-0.445 *	(0.0349)	-0.447 *	(0.0368)
Black hispanic	-0.359 *	(0.0777)	-0.362 *	(0.0796)	-0.358 *	(0.0788)
Other hispanic	-0.207 *	(0.0882)	-0.200 *	(0.0953)	-0.207 *	(0.0892)
Married	0.040 *	(0.0181)	0.041 *	(0.0181)	0.040 *	(0.0179)
Separ., divor., widow	0.272 *	(0.0209)	0.272 *	(0.0210)	0.272 *	(0.0208)
High school graduate	-0.148 *	(0.0262)	-0.148 *	(0.0264)	-0.148 *	(0.0259)
Some college	-0.492 *	(0.0237)	-0.491 *	(0.0243)	-0.492 *	(0.0235)
Not employed	0.217 *	(0.0271)	0.218 *	(0.0273)	0.217 *	(0.0272)

Table 3. (Continued) Current Smoking Participation Equations

Independent variable	Model 1		Model 2		Model 3	
Not in labor force	-0.011	(0.0159)	-0.012	(0.0162)	-0.011	(0.0159)
Real family income	-0.001*	(0.0001)	-0.001*	(0.0001)	-0.001*	(0.0001)
MSA central city	-0.069*	(0.0203)	-0.074*	(0.0213)	-0.069*	(0.0203)
Not in MSA non-farm	-0.083*	(0.0188)	-0.077*	(0.0201)	-0.083*	(0.0188)
Not in MSA farm	-0.469*	(0.0821)	-0.461*	(0.0839)	-0.469*	(0.0821)
Not und. pov. threshold	0.001	(0.0226)	0.001*	(0.0223)	0.001	(0.0226)
1993	-0.034*	(0.0110)	-0.035*	(0.0120)	-0.033*	(0.0118)
1994	-0.040**	(0.0212)	-0.035**	(0.0195)	-0.039**	(0.0236)
Constant	-0.665*	(0.0836)	-0.847*	(0.1089)	-0.670*	(0.0954)
Price elasticity	-0.336		-0.112		-0.328	

Note: All equations also include a missing value indicator for unknown real family income and unknown poverty status. Standard deviations are in parentheses. *, **, and *** correspond to 5, 10, and 15% significance levels, respectively, based on a two-tail test.

conditional on current smoking equations are presented in Table 4. Estimates from the conditional cigarette demand among some-day smoker equations are presented in Table 5.

Model 1 contains estimates from a limited specification that includes the price of cigarettes and variables reflecting the respondent's gender, age, race, marital status, education, employment, family income, type of community, poverty status, and year surveyed. Model 2 is identical to Model 1, except Model 2 also contains the clean indoor air preemption indicator and ten dichotomous clean indoor air indicators reflecting state level restrictions in

Table 4. Some-day Smoking Participation Equations Conditional on being a Current Smoker

Independent variable	Model 1		Model 2		Model 3	
Real price	0.481*	(0.0969)	0.314*	(0.1339)	0.520*	(0.1092)
Clean indoor air index			-0.002	(0.0031)		
Child care centers			0.022	(0.0423)		
Gov. worksites			-0.065	(0.0601)		
Gymnasiums			0.028	(0.0377)		
Health care facilities			0.043	(0.0739)		
Hotels			0.081	(0.0652)		
Preemption			0.005	(0.0252)		
Private worksites			-0.059**	(0.0368)		
Public transportation			0.015	(0.0502)		
Restaurants			-0.062	(0.0448)		
Retail/Grocery stores			0.094**	(0.0542)		
Shopping centers			-0.062	(0.0507)		
Male	-0.025	(0.0281)	-0.027	(0.0284)	-0.025	(0.0283)
Age 18-24	0.119*	(0.0575)	0.119*	(0.0579)	0.119*	(0.0573)
Age 25-44	-0.087	(0.0613)	-0.087	(0.0619)	-0.087	(0.0612)
Age 45-64	-0.183*	(0.0706)	-0.183*	(0.0710)	-0.182*	(0.0705)
African american	0.475*	(0.0431)	0.467*	(0.0439)	0.474*	(0.0432)
Other race	0.193*	(0.0680)	0.174*	(0.0651)	0.190*	(0.0673)
White hispanic	0.631*	(0.0533)	0.610*	(0.0542)	0.629*	(0.0521)
Black hispanic	0.547*	(0.2174)	0.556*	(0.2164)	0.552*	(0.2156)
Other hispanic	0.626*	(0.1709)	0.592*	(0.1732)	0.622*	(0.1700)
Married	-0.178*	(0.0281)	-0.178*	(0.0273)	-0.179*	(0.0279)
Separated, divor., widow.	-0.191*	(0.0313)	-0.194*	(0.0306)	-0.192*	(0.0307)
High school graduate	0.108*	(0.0475)	0.108*	(0.0471)	0.109*	(0.0475)

Table 4. (Continued) Some-day Smoking Participation Equations Conditional on being a Current Smoker

Independent variable	Model 1		Model 2		Model 3	
Some college	0.415 *	(0.0391)	0.412 *	(0.0389)	0.416 *	(0.0391)
Not employed	-0.110	(0.0779)	-0.116 ***	(0.0788)	-0.111	(0.0784)
Not in labor force	-0.073 **	(0.0431)	-0.074 **	(0.0440)	-0.073 **	(0.0433)
Real family income	0.00043 *	(0.0001)	0.00035 *	(0.0001)	0.00036 *	(0.0001)
MSA central city	0.036	(0.0309)	0.027	(0.0299)	0.036	(0.0311)
Not in MSA non-farm	-0.0004	(0.0348)	0.032	(0.0373)	-0.001	(0.0350)
Not in MSA-farm	0.348 *	(0.1029)	-0.001	(0.1017)	0.351 *	(0.1038)
Not under pov. threshold	-0.100 *	(0.0408)	0.350 *	(0.0410)	-0.101 *	(0.0408)
1993	0.114 *	(0.0376)	0.113 *	(0.0348)	0.117 *	(0.0385)
1994	0.116 *	(0.0350)	0.104 *	(0.0373)	0.123 *	(0.0370)
Constant	-1.676 *	(0.1054)	-1.478 *	(0.1723)	-1.712 *	(0.1152)
Price elasticity	0.904		0.590		0.977	

Note: All equations also include a missing value indicator for unknown real family income and unknown poverty status. Standard deviations are in parentheses. *, **, and *** correspond to 5, 10, and 15% significance levels, respectively, based on a two-tail test.

private worksites, restaurants, arenas/gymnasiums, shopping malls, government worksites, day care centers, health facilities, public transit facilities, grocery/retail stores, and hotels. Including only the price of cigarettes minimizes the collinearity resulting from the inclusion of a group of highly correlated measures of tobacco control policy.[10] Omitting these variables,

[10] In an attempt to assess the degree of multicollinearity among the smoke-free air laws and the cigarette price variable, variance inflation factors (VIF) were computed for Model 2. The VIF's suggested that there was considerable collinearity among the clean indoor air laws and between the clean indoor air laws and the cigarette price variable. The potential

Table 5. Condition Demand Equations for Some-day Smokers

Independent variable	Model 1		Model 2		Model 3	
Real price	-0.383*	(0.1515)	-0.161	(0.1735)	-0.355**	(0.1922)
Clean indoor air index					-0.002	(0.0060)
Child care facilities			0.021	(0.0473)		
Gov. worksites			0.086	(0.0808)		
Gymnasiums			0.095	(0.0881)		
Health care facilities			-0.087	(0.0824)		
Hotels			0.027	(0.1850)		
Preemption			0.066	(0.0561)		
Private worksites			-0.113***	(0.0768)		
Public transportation			0.006	(0.0764)		
Restaurants			0.040	(0.0936)		
Retail/Grocery stores			-0.072	(0.0716)		
Shopping centers			-0.126	(0.1088)		
Male	0.153*	(0.0554)	0.159*	(0.0555)	0.152*	(0.0558)
Age 18-24	0.074	(0.1447)	0.065	(0.1421)	0.073	(0.1451)
Age 25-44	0.301*	(0.1137)	0.297*	(0.1157)	0.301*	(0.1137)
Age 45-64	0.467*	(0.1411)	0.451*	(0.1300)	0.467*	(0.1413)
African american	-0.112***	(0.0687)	-0.119*	(0.0591)	-0.112***	(0.0691)
Other race	-0.682*	(0.1332)	-0.687*	(0.1456)	-0.686*	(0.1371)
White hispanic	-0.537*	(0.0910)	-0.526*	(0.0942)	-0.540*	(0.0949)
Black hispanic	-0.838*	(0.2208)	-0.868*	(0.2175)	-0.834*	(0.2233)
Other hispanic	-0.983*	(0.2244)	-1.024*	(0.2286))	-0.986*	(0.2280)
Married	0.051	(0.0664)	0.047	(0.0668)	0.049	(0.0671)
Separated, divor., widow.	0.025	(0.0850)	0.032	(0.0823)	0.023	(0.0848)
High school graduate	0.007	(0.0658)	0.018	(0.0656)	0.007	(0.0657)
Some college	-0.074	(0.0870)	-0.057	(0.0864)	-0.074	(0.0867)
Not employed	0.262*	(0.0616)	0.255*	(0.0648)	0.262*	(0.0620)

Table 5. (Continued) Condition Demand Equations for Some-day Smokers

Independent variable	Model 1		Model 2		Model 3	
Not in labor force	0.030	(0.0573)	0.029	(0.0586)	0.029	(0.0573)
Real family income	-0.001*	(0.0003)	-0.001*	(0.0003)	-0.001*	(0.0003)
MSA central city	0.118*	(0.0404)	-0.114	(0.1373)	0.118*	(0.0404)
Not in MSA non-farm	0.004	(0.0736)	0.110*	(0.0428)	0.004	(0.0747)
Not in MSA farm	0.133	(0.3244)	0.013	(0.0761)	0.131	(0.3250)
Not under pover. threshold	0.113*	(0.0553)	0.131	(0.3314)	0.114*	(0.0547)
1993	-0.042	(0.0669)	-0.033	(0.0629)	-0.039	(0.0700)
1994	-0.019	(0.0454)	-0.012	(0.0467)	-0.015	(0.0457)
Constant	4.839*	(0.2212)	4.552*	(0.2400)	4.814*	(0.2499)
Price elasticity	-0.479		-0.202		-0.444	

Note: All equations also include a missing value indicator for unknown real family income and unknown poverty status. Standard deviations are in parentheses. *, **, and *** correspond to 5, 10, and 15% significance levels, respectively, based on a two-tail test.

however, may lead to biased estimates of the effects of cigarette price and other factors on cigarette consumption. Finally, Model 3 is identical to Model 2 except the ten dichotomous clean indoor air indicator variables are replaced by a clean indoor air index variable. The index variable is designed to decrease the collinearity among the smoke-free air laws and cigarette prices and is an attempt to capture the overall magnitude of each state's restrictions on smoking in private worksites and public places.

The real price of cigarettes has a negative and statistically significant impact on current smoking participation in models 1 and 3, however, price does not

correlation stems from the fact that when states implement or enhance tobacco control programs they are likely to enact several clean indoor air restrictions at the same time while simultaneously raising the price on cigarettes through the use of excise taxation.

reach conventional significant levels in model 2. As described in the previous paragraph, the insignificant impact of price in model 2 stems from the fact that the price of cigarettes and the dichotomous clean indoor indicators are highly intercorrelated and there does not exist enough independent variation in prices to significantly affect smoking prevalence. The average current smoking participation price elasticity of demand is estimated to be -0.265. This estimate implies that had prices been 10% higher than they were during the time the surveys were being conducted, there would have been 2.65% fewer current smokers. This estimate is consistent with the work of Lewit and Coate (1982) and Evans and Farrelley (1998) who estimated current adult smoking participation elasticities of -0.26 and -0.185, respectively. It is substantially smaller, in absolute value, than Chaloupka and Wechsler's (1997) estimate of -0.53 for college students. However, this estimate is well above Wasserman and colleagues (1991) estimate of -0.06.

Conditional on being a current smoker, the real price of cigarettes has a positive and significant impact on being a some-day smoker in all the models that were estimated. The average price elasticity of some-day smoking participation conditional on current smoking is 0.860. This estimate implies that increasing the price of cigarettes would result in a substantial number of everyday smokers to decrease their consumption of cigarettes to intermittent levels.

Conditional on being a some-day smoker, the real price of cigarettes has a negative impact on the average number of cigarettes consumed in all the models that were estimated. However, given the high degree of collinearity between the tobacco control policies and the state cigarette prices, the coefficient on price is not significant at conventional levels in model 2. The average conditional price elasticity of some-day smoking is -0.375. This result implies that a 10% increase in the price of cigarettes will decrease average monthly cigarette consumption among some-day smokers by approximately 3.75%. The estimated average conditional demand elasticity for adult some-day smokers is considerably larger than the -0.103, -0.117, -0.044 conditional demand elasticities estimated for adult current smokers by Lewit and Coate (1982), Evans and Farrelly (1998), and Wasserman (1991), respectively. These results imply that some day smokers are much more responsive to changes in cigarette prices than are everyday smokers in general. Given the evidence

that many some-day smokers are long-term intermittent smokers and are less susceptible to nicotine dependence (Shiffman, 1989; Lindstrom, 2002), it is likely that an inverse relationship exists between addiction and individual's short-run price elasticity of demand.

In contrast to the strong effects of price on adult smoking, policies restricting smoking in public places and private worksites seem to have a smaller impact. The clean indoor air index variable is not significant in any of the equations that were estimated. Even after the index is disaggregated into separate dichotomous indicators for different types of restrictions, the clean indoor air laws do not seem to be strong predictors of adult smoking with a few exceptions. Stronger restrictions on smoking in restaurants have a negative and significant impact on adult current smoking prevalence. When examining some-day smoking participation among current smokers, the only restriction to have a positive and significant impact is the restriction on smoking in retail and grocery stores. Moreover, no discernable differences exist between the average number of cigarettes consumed by some-day smokers and clean indoor air laws. Finally, state preemption of smaller governmental units from passing more restrictive clean indoor air laws has a positive and significant impact on current smoking participation, but has an insignificant impact on some-day smoke prevalence among current smokers and some-day smoker conditional demand.

However, given the collinearity among the dichotomous clean indoor indicators, the conclusion that clean indoor air legislation has an insignificant impact on adult smoking cannot be based on a series of tests of single coefficients. Instead, a joint hypothesis that all the dichotomous clean indoor air coefficients are simultaneously equal to zero must be tested. A Wald test rejects the hypothesis that all of the dichotomous clean indoor air laws are simultaneously equal to zero at the 0.01 level for the current smoking and someday smoking among current smokers equations and at the 0.03 level for the average smoking among some-day smokers equation.

The results with respect to clean indoor air laws are not that surprising. Other than employees whose worksites are governed by smoke-free air laws, most individuals spend a small fraction of their time in sites that have smoking restrictions. The results from existing econometric studies have produced conflicting results with respect to clean indoor air laws. Some studies have

found stronger restrictions to be effective in decreasing smoking, while others have found smoke free air laws to have no impact at all.

V. Conclusions

The Balanced Budget Act of 1997 (Public Law 105-33, Section 9302) imposed a two-stage Federal excise tax increase on cigarettes. As part of the Balanced Budget Act of 1997, the Federal excise tax on a pack of 20 cigarettes increased by 10 cents on January 1, 2000. Two years later, the Federal excise tax on cigarettes increased an additional 5 cents per pack bringing the total Federal excise tax on cigarettes to 39 cents per pack.

In the wake of significant declines in revenues and large budget shortfalls in recent months, nineteen states increased their excise taxes on cigarettes in 2002 and four additional states have already slated increases for 2003. Currently, state excise tax rates on cigarettes range from a low of $0.025 per pack in the state of Virginia to $1.51 in Massachusetts. It is this differential tax rate that causes substantial variation in the price of cigarettes across states.

This research examines the impact of increasing cigarette prices and implementing stronger smoking restrictions on adult smoking behavior. The estimates from this study clearly indicate that increasing the price of cigarettes, will decrease the number of people who currently smoke, will decrease the number of every-day smokers, and will decrease the number of cigarettes smoked on average among some-day smokers. The estimated current smoking participation elasticities are consistent with those found in other econometric studies of adults smoking. However, the estimated average some-day smoking conditional demand elasticity of -0.375 is considerably larger in absolute value than those previously estimated for current smokers implying that some-day smokers are nearly twice as responsive to price changes as are every-day smokers in terms of daily consumption. This finding will be particularly useful to policy makers. While recent research suggests that some-day smoking may be a stable state for some current smokers, nearly all daily smokers transition through the some-day smoking state on their way to becoming everyday smokers. This research has concluded that increasing the price of cigarettes will not only decreasing the likelihood of becoming an every-day smoker, but will also decrease the average number of cigarettes consumed among

some-day smokers. Since the health consequences of smoking are a function of both the duration and intensity of smoking (USDHHS, 1998), an increase in cigarette excise taxes will almost certainly decrease smoking related death and disease in the U.S.

In contrast to the strong effects of price on adult smoking, policies restricting smoking in public places and private worksites are found to be less important predictors of adult smoking. However, the following clean indoor air relationships did conform to a priori expectations: restrictions on smoking in restaurants were found to decrease overall adult smoking prevalence; state preemption laws were found to increase overall adult smoking prevalence; and restrictions on smoking in retail and grocery stores were found to be positively related to the probability of being a some-day smoker relative to being an everyday smoker.

References

Centers for Disease Control and Prevention (1998), "Response to Increases in Cigarette Prices by Race/Ethnicity, Income, and Age Groups–United States, 1976-1993," *Morbidity and Mortality Weekly Reports* **47**: 605-9.

Centers for Disease Control and Prevention (2001), "Cigarette Smoking Among Adults–United States, 1999," *Morbidity and Mortality Weekly Report* **50**: 869-873.

Chaloupka, F.J., and H. Wechsler (1997), "Price Tobacco Control Policies and Smoking Among Young Adults," *Journal of Health Economics* 16: 359-73.

Chaloupka, F.J., and K.E. Warner (2000), "The Economics of Smoking," in A.J. Culyer and J.P. Newhouse, eds., *Handbook of Health Economics*, Netherlands, North-Holland, Elsevier Science, 2000.

Chaloupka, F.J., and H. Saffer (1992), "Clean Indoor Air Laws and the Demand for Cigarettes," *Contemporary Policy Issues* **10**: 72-83.

Cragg, J.G. (1971), "Some Statistical Models for Limited Dependent Variables with Application to the Demand for Durable Goods," *Econometrica* **39**: 829-44.

Evans, E.J., Gilpin, E., Pierce, J.P, Burns, D.M., Borland, R., Johnson, M.,

and D. Bal (1992), "Occasional Smoking Among Adults: Evidence from the California Tobacco Survey," *Tobacco Control* **1**: 169-175.

Evans, W.N., and M.C. Farrelly (1998), "The Compensating Behavior of Smokers: Taxes, Tar and Nicotine," *RAND Journal of Economics* **29**: 578-595.

Lewit, E.M., and D. Coate (1982), "The Potential for Using Excise Taxes to Reduce Smoking," *Journal of Health Economics* **1**: 121-145.

Lewit, E.M., Coate, D., and M. Grossman (1981), "The Effects of Government Regulation on Teenage Smoking," *Journal of Law and Economics* **24**: 545-69.

Lindstrom, M., Isacsson, S.O, and the Malmo Shoulder-Neck Study Group (2002), "Long Term and Transitional Intermittent Smokers: a Longitudinal Study," *Tobacco Control* **11**: 61-67.

Manning, W.G., and J. Mullahy (2001), "Estimating Log Models: To Transform or Not to Transform," *Journal of Health Economics* **20**: 461-495.

McKennel A.C., and R.K. Thomas (1967), *Adults' and Adolescents' Smoking Habits and Attitudes*, London, Ministry of Health.

Orzechowski, W., and R.C. Walker (2001), *Tax Burden on Tobacco*, Arlington (VA): Orzechowski and Walker.

Park, R. (1966), "Estimation with Heteroscedastic Error Terms," *Econometrica* **34**: 888.

Shiffman, S. (1989), "Tobacco 'Chippers' Individual Differences in Tobacco Dependence," *Psychopharmacology* **97**: 539-547.

Shiffman, S. (1991), "Refining Models of Dependence: Variations across Persons and Situations," *British Journal of Addiction* **86**: 611-615.

Shiffman, S., Fischer, L.A., Zettler-Segal, M., and N.E. Benowitz (1990), "Nicotine Exposure in Non-dependent Smokers," *Archives of General Psychiatry* **47**: 333-336.

Tauras, J.A., and F.J. Chaloupka (2001), "Determinants of Smoking Cessation: An Analysis of Young Adult Men and Women," in M. Grossman and C.R. Hsieh, eds., *The Economics of Substance Use and Abuse*, Northampton, MA, Edward Elgar Publishing Limited.

U.S. Department of Health and Human Services (1988), *The Health Consequences of Smoking: Nicotine Addiction. A Report of the Surgeon General*, Rockville, Maryland, U.S. Department of Health and Human

Services, Public Health Service, Center for Disease Control, Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health.

U.S. Department of Health and Human Services (1989), *Reducing the Health Consequences of Smoking: 25 Years of Progress. A Report of the Surgeon General*, Rockville, Maryland, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health.

U.S. Department of Health and Human Services (1991), *Strategies to Control Tobacco Use in the United States: A Blueprint for Public Health Action in the 1990's: Smoking and Tobacco Control Monographs*, Atlanta, Georgia, U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health, National Cancer Institute.

U.S. Department of Health and Human Services (1994), *Preventing Tobacco Use among Young People: A Report of the Surgeon General*, Atlanta, Georgia, Public Health Service, Center for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health.

U.S. Department of Health and Human Services (2000), *Reducing Tobacco Use. A Report of the Surgeon General*, Atlanta, Georgia, U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health.

Wasserman, J., Manning, W.G., Newhouse, J.P., and J.D. Winkler (1991), "The Effects of Excise Taxes and Regulations on Cigarette Smoking," *Journal of Health Economics* **10**: 43-64.