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The Effects of Workplace Smoking Bans on Smoking Prevalence: A State Level Analysis

Abstract

This study investigates the effects of workplace smoking bans on smoking prevalence. Using a unique panel data set on state-wide smoking prevalence in all U.S. jurisdictions, while controlling for fixed and lagged effects, I find that smoking bans decrease overall smoking prevalence. The magnitude of this impact, however, makes the federal government's goal of reducing the national smoking rate from its current level to 12 percent by 2020 a hopeful aspiration. Nevertheless, this study demonstrates that workplace smoking bans, especially in conjunction with other statewide governmental initiatives, are a worthwhile endeavor in decreasing smoking prevalence.

Keywords

smoking, workplace smoking bans, cigarette, tax, empirical analysis

Cover Page Footnote

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I. Introduction

Tobacco-related illnesses are the leading cause of preventable death in the United States, killing about 443,000 people each year.¹ In addition to the devastating human toll caused by tobacco use, smoking generates an average cost of more than \$193 billion each year, which includes \$96 billion in health care costs and \$97 billion in lost productivity.² Consequently, drastic efforts have been taken, and continue to be taken, in order to curb the use of tobacco products. These efforts have largely been a success considering less than 21 percent of the American population smoked in 2004, which is a dramatic decline from the astounding 42 percent who smoked in 1965.³

The current smoking rate among adults, however, remains at about 20 percent despite recent increases in state and local restrictions on tobacco sales and marketing, anti-smoking campaigns, and cigarette excise taxes. Nevertheless, the federal government has faced this challenge of a stall in the decline of smoking rates by setting an ambitious goal to reduce the national smoking rate from its current level to 12 percent by 2020.⁴ Although the federal government has implemented multiple policies and plans to enact even more laws intended to reduce cigarette consumption, the responsibility of devising an appropriate smoking policy has historically fallen on individual states, counties, and communities. The federal government has, therefore, encouraged states to adopt stricter policies aimed at curbing cigarette consumption, but it is up to individual states to enact the policies.

Furthermore, despite the fact that there has been significant progress made in reducing cigarette smoking in the United States, serious disparities remain in both the use of tobacco on the state-wide level, as well as access to effective policies and treatments that curtail use within the state according to a report from the Robert Wood Johnson Foundation (RWJF) and Bridging the Gap. Moreover, this report reveals sharp variations among states in regards to tobacco prevention measures, such as comprehensive smoke-free air laws, tobacco excise taxes, and levels of funding intended to advocate for effective tobacco prevention and

¹ "Targeting the Nation's Leading Killer: At a Glance 2010," *Centers for Disease Control*, 5 March 2010, <http://www.cdc.gov/chronicdisease/resources/publications/aag/osh.htm>.

² "Smoking-Attributable Mortality, Years of Potential Life Lost, and Productivity Losses United States, 200-2004." *Centers for Disease Control*. 18 November 2008. <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5745a3.htm>.

³ James Carroll, "Feds Preview Graphic Health Warnings for Cigarette Packs," *The Courier Journal* (Louisville, KY), Nov. 10, 2010.

⁴ *Ibid.*

cessation.⁵ Therefore, the aim of this paper is to empirically investigate the effectiveness of state-wide prevention measures, paying particular attention to state-wide workplace smoking bans, in reducing smoking prevalence among its adult population. As a result, the expected goal of this work is to demonstrate that the adoption of a state-wide workplace smoking ban successfully reduces smoking prevalence within the state.

In order to analyze the effectiveness of various governmental tools intended to curb smoking, I use a unique data set on state-level smoking prevalence. This data set contains panel data on the 50 U.S. states and the District of Columbia for the years 2001-2008. During this observation period various states banned smoking from private-sector workplaces; other states had already had state-wide bans in place; and still others had not adopted bans yet. This pattern of adoption of workplace smoking ban legislation makes it possible to obtain a clean identification of the effects of these laws while controlling for entity and time fixed effects.

This data set also enables me to improve and expand upon previous work. For example, this study is the first to use panel data to analyze the determinants of smoking prevalence on an aggregate level and include data on all 50 states, as well as allow for lagged impacts on smoking prevalence. Furthermore, little research has comprehensively examined the effect of workplace smoking bans on smoke prevalence while also focusing on the effect of other governmental tobacco control efforts.

The findings of this study indicate that workplace smoking bans may significantly reduce smoking prevalence, but only after a relatively large amount of time has elapsed after the initial adoption of the ban. Throughout the duration of the analysis, I also find that demographic factors have little significant impact on smoking prevalence. Overall, however, it is found that other efforts that are focused on curbing smoking, such as high excise taxes and increased levels of tobacco control funding, have a significant impact on decreasing smoking prevalence. More specifically, it is estimated that an increase in excise tax by 50¢ will decrease prevalence by .25%, a 1-percentage-point increase in funding leads to a decline in smoking prevalence by 0.00729% and finally, the adoption of a state-wide smoking ban is estimated to decrease a state's smoking prevalence by 0.4904% in two years. While together these effects are statistically significant, the magnitude of the effect is relatively small.

The paper is organized as follows. Section II reviews the expanse of empirical literature regarding the determinants of smoking initiation and cessation and effectiveness of programs intended to curb tobacco use, section III discusses

⁵ "Cigarette Smoking Prevalence and Policies in the 50 States: An Era of Change," *The Robert Wood Johnson Foundation*, (Buffalo, NY: University at Buffalo, State University of New York), 2009.

the theoretical underpinning of the study, section IV describes the data, section V presents the empirical models estimated, section VI discusses the results of the study, and section VII offers concluding remarks.

II. Literature Review

In order to reduce smoking, as well as protect nonsmokers from secondhand smoke, many state, county, and municipal governments, in addition to private establishments, have adopted smoke free laws that prohibit smoking in the workplace. Many more institutions are in the process of implementing such laws. However, the cigarette industry is not only avidly opposing new smoke free laws, but is also attempting to repeal those that are already in place.

While this clash of interests continues, the Campaign for Tobacco Free Kids has stated that laws against smoking in the workplace are beneficial because they prompt more smokers to try to quit, increase the number of successful quit attempts, and reduce the number of cigarettes that continuing smokers consume. Moreover, the Surgeon General's 2006 Report on the Health Consequences of Involuntary Exposure to Tobacco Smoke made the conclusion that "workplace smoking restrictions lead to less smoking among covered workers." The report also cited several studies that found "an association between workplace smoking policies, particularly more restrictive policies, and decreases in the number of cigarettes smoked per day, increases in attempts to stop smoking, and increases in smoking cessation rates."⁶

There is a large expanse of empirical literature that attempts to estimate the effect of workplace bans on cigarette consumption. However, in contrast to the Surgeon General's vehement belief that workplace bans lead to a significant reduction in smoking, the literature reveals that the evidence for the effects of workplace bans on smoking prevalence are mixed. On one hand, there are multiple studies that found that workplace smoking bans cause a significant reduction in not only the consumption of cigarettes smoked per day, but also led to higher smoking cessation rates. For example, William Evans, Matthew Farrelly, and Edward Montgomery concluded that workplace bans reduce smoking prevalence by 5 percentage points and average daily consumption among smokers by 10 percent.⁷ Furthermore, Daniel Longo and Ross Brownson found that there were statistically significant differences in the post-ban quit ratios

⁶ "The Health Consequences of Involuntary Exposure to Tobacco Smoke: A Report of the Surgeon General," *U.S. Department of Health & Human Services*, 27 June 2006, <http://www.surgeongeneral.gov/library/secondhandsmoke/>.

⁷ William Evans, Matthew Farrelly, Edward Montgomery, "Do Workplace Smoking Bans Reduce Smoking?" *American Economic Review* 89, no. 4 (1999):741.

between smokers employed by smoke-free hospitals and those employed in hospitals without clean air laws within a community over a span of five years.⁸

On the other hand, multiple other studies found that workplace bans had no significant impact on smoking prevalence. For example, Lois Biener, David Abrams, and Michael Follick use a series of cross sectional studies to determine that although smokers who work in hospitals that impose a smoking ban experience reduced smoking rates while working, home smoking rates and the rate of smoking cessation remained similar when compared to smokers who worked in hospitals not subject to a smoking ban.⁹ Additionally, John Mullooly, Katharina Schuman, Victor Stevens, Russell Glasgow, and Thomas Vogt compared pre-ban data to post-ban data in their analysis of the effects of a workplace smoking ban on smokers subject to the bans and concluded that the work site smoking ban had an effect on the presence of smoke in the work environment, yet the ban was found to have no significant effect on smoking prevalence or attempts to quit.¹⁰

Nevertheless, despite the mixed results of the existing studies, there seems to be a general consensus among researchers regarding what factors, in addition to workplace bans, influence an individual's decision to either start or quit smoking and thus affect smoking prevalence. For instance, a common factor influencing smoking prevalence in many of these studies was the price of cigarettes, as captured by either the price paid for a pack of cigarettes or the amount of excise tax imposed on a pack of cigarettes purchased by the smoker. A study by Chaloupka, Cummings, Morley, and Horan summarizes the findings of over 100 published studies by various economists and researchers that estimate the impact of price on cigarette smoking. They conclude that studies on a variety of aggregate and individual level data from numerous countries, states, and other areas "clearly demonstrate that changes in cigarette prices, resulting from changes in cigarette taxes, manufacturer's prices, and/or other factors, lead to changes in cigarette smoking."¹¹ Nonetheless, the magnitude of this change has been debated with various researchers estimating different price elasticities of demand for

⁸ Daniel Longo and Ross Brownson, "Hospital Smoking Bans and Employee Smoking Behavior," *The Journal of the American Medical Association* 275, no. 16 (1996): 1253.

⁹ Lois Biener, David Abrams, Michael Follick, Larry Dean, "A Comparative Evaluation of a Restrictive Smoking in a General Hospital," *American Journal of Public Health* 79 (1989): 194.

¹⁰ John Mullooly, Katharina Schuman, Victor Stevens, Russell Glasgow, Thomas Vogt, "Smoking Behavior and Attitudes of Employees of a Large HMO Before and After a Work Site Ban on Cigarette Smoking," *Public Health Reports* 105 no. 6 (1990): 626.

¹¹ F J Chaloupka, K M Cummings, CP Morley, et al., "Tax, Price and Cigarette Smoking: Evidence From the Tobacco Documents and Implications for Tobacco Company Marketing Strategies," *Tobacco Control* 11, no. 10 (2002): 69.

cigarettes. However, most of the estimates from high income countries, such as the United States, tend to fall in the relatively narrow range from -0.25 to -0.50.¹²

Studies regarding factors affecting cigarette demand also used micro level data in order to determine which demographic characteristics influence smoking initiation and cessation. Warner writes that prevalence surveys can provide important insights into patterns of—and changes in—consumption according to gender, age, income, education, and unemployment.¹³ One study that explicitly focuses on demographic characteristics of smokers, which are more vaguely explored in other studies, was performed by Kai-Wen Cheng and Don Kenkel. This study concluded that it is important to recognize that the influences of key demographic factors on cigarette demand change over time. For example, from 1944 to 2004 the gender difference in smoking rates almost disappears even though historically males were more likely to smoke than females; the black-white difference weakens, with whites only having a slightly higher smoking prevalence; and a strong gradient with schooling emerges as the more educated are found less likely to smoke. Nevertheless, the authors admit that various other studies have achieved conflicting results and must conclude that while demographic influences on cigarette demand seem significant in their study, the results of the empirical literature suggest mixed results.¹⁴

Many empirical studies have also focused on the impact that income has on cigarette demand and smoking prevalence. Findings on this impact, however, are also inconsistent. The estimated coefficient on the income variable in most studies is significant and positive, which suggests that cigarettes are “normal” goods—increasing income would have a positive effect on smoking demand and prevalence. Conversely, several studies (e.g. Yurekli and Zhang, 2000, Wasserman et al., 1991, and Keeler et al., 1993) found that income has either a negative or insignificant effect on cigarette demand, and thus has little effect on smoking prevalence.¹⁵

Funding for tobacco control programs has also received attention from economists and researchers who want to determine the effect of various tobacco prevention measures on smoking prevalence. Researchers, however, yet again reach varying conclusions. The Centers for Disease Control and Prevention (CDC) believe that adequate funding of tobacco control programs by all 50 states would reduce the number of adults who smoke by promoting quitting and

¹² Ibid.,70.

¹³ Kevin Warner, “The Effects of the Anti-Smoking Campaign on Cigarette Consumption,” *American Journal of Public Health* 67 no. 7 (1977): 649.

¹⁴ Cheng, Kai-Wen and Don S. Kenkel. “U.S. Cigarette Demand: 1944-2004.” *The B.E. Journal of Economic Analysis & Policy* 10 no.1 (2010).

¹⁵ Gallet, Craig. “The Efficacy of State-Level Antismoking Laws: Demand and Supply Considerations.” *Journal of Economics and Finance* 28 no. 3 (2004):404.

eliminating disparities in tobacco use among population groups. The results of various empirical studies find data that supports such a claim. For example, Matthew Farrelly et al. found that increases in state per capita tobacco control expenditures were independently associated with declines in smoking prevalence.¹⁶ Nonetheless, Gross et al. and Marlow find that when holding other relevant factors constant, states with higher smoking prevalence do not spend more on tobacco control than states with lower prevalence.^{17,18} Therefore, in contrast to Farrelly et al., they each conclude that state funding for tobacco control is unrelated to adult smoking prevalence.

Although there is a general consensus among researchers regarding what factors influence an individual's choice to smoke, the existing empirical work has substantial limitations that this study will attempt to overcome. To begin, many of the studies focus only on cross sectional data (e.g. Mullooly *et al.* 1990 and Beiner *et al.*, 1989) or time series data (e.g. Evans *et al.*, 1999 and Longo *et al.*, 1996) to analyze the effects of smoke free workplace bans on cigarette consumption and smoking prevalence. Such studies are unable to account for macro effects, such as other laws or public campaigns that are largely unrelated to workplace bans, but perhaps could have affected the changes in the time trend of smoking prevalence resulting in omitted variable bias. Moreover, many of these studies focus on only one type of institution or location within the United States (Longo *et al.*, 1996 and Beiner *et al.*, 1989) and are likely subject to a great degree of omitted variable bias. For example, it can be argued that workers with better health habits are more likely to work at firms that implement smoking bans, causing the results from cross sectional studies to be biased.

Furthermore, the majority of the existing empirical work was carried out prior to the year 2000. Thus there is a need for updated research on the subject especially in the face of increasingly high numbers of state governments adopting state-wide laws that ban smoking in both public and private workplaces in recent years. The comprehensive panel data that will be used in this study should allow each of these limitations to be overcome.

¹⁶ Farrelly, Matthew, Terry Pechacek, Kristin Thomas, and David Nelson. "The Impact of Tobacco Control Programs on Adult Smoking." *American Journal of Public Health* 98 no. 2 (2008): 306.

¹⁷ Gross, C. P., B. Soffer, P.B. Bach, R. Rajkumar, and H.P. Forman, "State Expenditures for Tobacco-Control Programs and the Tobacco Settlement," *New England Journal of Medicine* 347 no. 7 (2002): 1081.

¹⁸ Michael Marlow, "Determinants of State Tobacco-Control Expenditures," *Applied Economics* 40 no. 7 (2008): 832.

Section III. Theoretical Model

Economic literature regarding the consumption of addictive goods typically uses one of two models, the “irrational” model of addiction or the “rational” model of addiction, in order to explain individual consumption levels of addictive goods. Models of individual behavior based upon the “irrational” interpretation of addiction assume that addicts are myopic or lack all forms of self-control. As a result, in myopic models, current demand is a function of current price and a measure of past consumption, but is not affected by future forecasts of consumption and price. Conversely, models of individual behavior based upon the “rational” interpretation of addiction presume that addicts are rational and forward-looking; however, their addiction causes them to fail to follow their plans for optimal consumption. Moreover, unlike the “irrational” model of addiction, the “rational” model holds that individual’s consumption decisions are subject to outside influence.¹⁹

Kevin M. Murphy and Gary S. Becker were the first researchers to develop a model of “rational” addiction. The “rational” addiction hypothesis suggested by Murphy and Becker holds that an addict consumes more and more of an addictive good because this is the pattern of consumption that maximizes his or her discounted utility. For example, any given smoker understands that smoking another cigarette today will not only increase his desire to smoke tomorrow, but will also negatively affect his future health. Therefore, the smoker is confronted with a rational choice in which he must compare the benefit of smoking that next cigarette to the discounted cost of smoking that cigarette. Because the smoker is assumed to be rational, he will smoke the cigarette if, and only if, the discounted lifetime marginal benefit of smoking the cigarette is greater than its discounted lifetime marginal cost.²⁰

Furthermore, Becker and Murphy note that the marginal benefits of smoking include the current and future utility smokers gain from smoking cigarettes while the marginal costs include not only current and future economic costs, but also health consequences and the efforts involved in smoking. Moreover, the expected discounted lifetime net marginal benefit from smoking is dependent upon the personal characteristics of the individual, prices, and government restrictions and will vary over time.²¹ The lower this benefit, therefore, the less likely a nonsmoker is to begin the habit. Based on this model S. Douglas and G. Hariharan conclude that “some individuals may begin life with

¹⁹ Frank Chaloupka, “Rational Addictive Behavior and Cigarette Smoking,” *The Journal of Political Economy* 99 no. 4(1991): 729-731.

²⁰ Douglas Stratford “The Duration of the Smoking Habit,” *Economic Inquiry* 36 no. 1 (1998): 50-52.

²¹ *Ibid.*, 50.

such a low value of expected net benefit from smoking that they will never start smoking; others may begin with such a high value that they will start early and never quit” with other individuals lying somewhere in between these two extremes.²²

This “rational” model of addiction, as expounded upon by Kevin M. Murphy and Gary S. Becker, has become the standard approach to understanding addiction in economic literature. This approach, therefore, functions as the underlying theoretical model for this empirical work. Consequently, similarly to the aforementioned studies performed by Frank Chaloupka, as well as Douglas and Hariharan, this study will begin with the construction of a simple “rational” addiction model based upon the Becker-Murphy theory to explain what influences an individual’s decision to consume cigarettes, a highly addictive good.

To begin, assume every individual has a utility function,

$$U_t = (C_t, X_t, A_t, D_t, G_t),$$

where C_t is the level of consumption of an addictive good (with price P_t), X_t is the level of consumption of non-addictive goods, A_t is the level of addiction accumulated, D_t corresponds to any demographic factors that affect utility, and G_t are governmental policies intended to reduce smoking.

A rational individual will consider the marginal benefits (MB_{smoking}) and the marginal costs (MC_{smoking}) of smoking when making the decision to start smoking. If the marginal benefits outweigh the marginal costs then the individual will begin smoking:

$$MB_{\text{smoking}}(C_t, X_t, D_t, G_t | A_t = 0) > MC_{\text{smoking}}(C_t, X_t, D_t, G_t | A_t = 0)$$

An analysis for quitting smoking is analogous to the aforementioned analysis regarding starting smoking with one vital exception—the marginal cost and marginal benefit are conditional on an individual’s level of accumulated addictive capital. A rational individual will consider the marginal benefits (MB_{smoking}) and the marginal costs (MC_{smoking}) when making the decision to quit smoking. If the marginal cost outweighs the marginal benefit then the individual will quit smoking. That is:

$$MB_{\text{smoking}}(C_t, X_t, D_t, G_t | A_t > 0) < MC_{\text{smoking}}(C_t, X_t, D_t, G_t | A_t > 0),$$

where $A_t > 0$ is the amount of accumulated addictive capital at time period t .

²² Stratford Douglas and Govind Hariharan, “The Hazard of Starting Smoking: Estimates from a Split Population Duration Model,” *Journal of Health Economics* 13 no. 2 (1994).

In reference to the aforementioned equations, the marginal benefit of smoking includes factors, such as current and discounted future pleasure that it provides to an individual. Moreover, an individual's marginal benefit is enhanced by his or her accumulation of addictive capital. On the other hand, the marginal cost of smoking, which is also affected by an individual's level of accumulated capital, is impacted by a number of factors, as well. For instance, the discounted present and future value of monetary expenditures on cigarettes; the effort necessary to consume cigarettes, which is effected by policies such as indoor clean air acts; and the discounted future health costs of the habit all impact a rational individual's perceived marginal cost of smoking. Other factors, such as exposure to cigarette advertising, changes in acceptance of smoking in the individual's peer group, exposure to stress, certain demographic factors, disseminated information regarding future prices of cigarettes and acknowledgment of the general health risks associated with smoking also impact an individual's perceived marginal costs and benefits received from smoking.

Besides being confronted with a cost-benefit analysis, rational individuals are also subject to a budget constraint when faced with decisions regarding smoking. The tangent point at which an individual's indifference curve meets his or her budget constraint represents the amount of goods x (in this case cigarettes) and y (an aggregate representation of all other goods) that the individual should purchase in order to fully utilize his or her budget and obtain maximum utility. A simple budget constraint can be generalized as:

$$P_x x + P_y y = m$$

where m is the income allocated to consumption after saving and borrowing, P_x is the price of a specific good (in this case cigarettes), x is the quantity purchased of the specific good, P_y is the price of all other goods, and y is the quantity purchased of all other goods.

In summary, if an individual's marginal benefit of smoking outweighs his or her marginal cost then he or she will begin smoking. If an individual's marginal cost of smoking outweighs his or her marginal benefit then he or she will quit smoking. Additionally, any given smoker is subject to his or her budget constraint when choosing an optimal consumption level that maximizes his or her utility function. Thus according to this theoretical model, any factor that is capable of impacting an individual's perceived marginal benefit or marginal cost will, consequently, affect that individual's decision regarding smoking.

Section IV. Data and Descriptive Statistics

This study uses a panel of annual state-level variables for all U.S. jurisdictions—the 50 states and the District of Columbia. Each variable was collected to cover the period ranging from 2000 to 2008. The Data Appendix defines each variable used in the study and explains each variable's source and relevance. In this section, however, I will focus on four of the most important variables of my analysis, namely, smoking prevalence among the adult population of the state, the state excise tax imposed on cigarettes, the level of funding for tobacco control within the state, and state-wide legislation banning smoking in all workplaces, as well as provide a discussion of the descriptive statistics of the data.

I obtained data on smoking prevalence among the adult population in each state from the Centers for Disease Control and Prevention (CDC). The CDC relies on the Behavioral Risk Factor Surveillance System (BRFSS) to develop an estimate of what percentage of a state's adult population smokes. The BRFSS is the world's largest random telephone survey and surveys state residents aged 18 or older. The survey classifies a current smoker as a person who reports ever smoking at least 100 cigarettes and who currently smokes every day or on some days. This figure is then used to estimate the total percentage of the state's population that smokes, which is then recorded by the CDC. As a result, it must be noted that because of this sampling technique, the variable for smoking prevalence may possibly suffer from the problems that arise from self-reporting and from subjective answers. However, I account for time and state fixed effects, which should help mitigate any estimation problems that might arise from the nature of this data.

According to the (CDC), increasing the price of cigarettes is believed to reduce smoking prevalence substantially by discouraging initiation among young adults, prompting quit attempts, and reducing average cigarette consumption among those who continue to smoke. Therefore, increasing cigarette excise taxes is believed to be one of the most effective tobacco control policies because it directly increases cigarette prices and is, therefore, included in my data set. I obtained data on the excise tax rates imposed per pack of 20 cigarettes in each state over the relevant time period from the Office on Smoking and Health (OSH) as reported by the State Tobacco Activities Tracking and Evaluation (STATE) System of the Centers for Disease Control and Prevention (CDC). Excise tax rates recorded are those that were in place for the entire year.

Another important element of my data set, which is thought to impact smoking prevalence, is the state-level data on funding received for tobacco control programs. I attained such data from the CDC, which reports an aggregated figure of the amount, in dollars, of actual funds received by each state per year. This figure is composed of three different funding sources:

- (i) *Federal level funding from the Substance Abuse and Mental Health Services Administration (SAMHS).* SAMHS is a grant provided to each U.S. jurisdiction for the purpose of supporting the development and delivery of substance abuse prevention and treatment services nationwide. The prevention portion of the grant is used to implement programs focused on preventing the uses of alcohol, tobacco, and other drugs. However, it must be noted that states are not required to report the exact expenditures appropriated for tobacco use prevention so specific amounts spent for tobacco control, versus alcohol and other drug control, are unfortunately available.
- (ii) *Non-governmental funding received from the American Legacy Foundation.* This organization's goals are to reduce tobacco use, decrease exposure to secondhand smoke, reduce disparities in access to prevention and cessation services, and increase successful quit rates. As a result, the foundation appropriates a significant amount of money to state governments.
- (iii) *Non-governmental funding received from the Robert Wood Johnson Foundation.* This foundation provides resources and technical assistance to statewide organizations to advocate for effective tobacco prevention and cessation policy change.

Furthermore, I normalized this aggregated funding amount reported by the CDC by dividing this figure by the population (as recorded by the Census Bureau) of the given state for each year in the data set. Because this funding is used to increase the awareness of the health risks associated with smoking and, consequently, increases the marginal cost associated with smoking, it triggers quit attempts and prevents individuals from beginning to smoke thus effecting smoking prevalence.

A third, and final, variable that perhaps impacts smoking prevalence that is to be discussed in this section is state-wide legislation banning smoking in all workplaces. Such bans reduce opportunities to smoke, which increases the effort that smokers must exert in order to smoke. Workplace bans, therefore, are believed to affect smoking prevalence because they result in an increase in the marginal cost of smoking and thus decrease the likelihood of starting and increase the likelihood of quitting smoking. Using information provided by the State Legislated Actions on Tobacco Issues (SLATI) as reported by the American Lung Association, I was able to create a dummy variable that was equal to one if the

Table 1: Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max	Number of Obs
Prevalence	21.39%	3.65%	9.3%	42.8%	408
Tax	83.50¢	60.54¢	2.5¢	275¢	408
WorkBan	0.3014	0.4595	0	1	408
EDU	86.16%	3.75%	77.20%	93.00%	408
DPI	\$26,839.36	\$4,160.99	\$19,462.00	\$46,256.00	408
Funding	\$0.65	\$0.77	\$0.02	\$10.20	408
Unemployment Rate	4.95%	1.13%	2.5%	8.3%	408
% White	81.34%	13.48%	26.53%	97.14%	408
% Male	49.27%	80.94%	47.05%	52.27%	408
Median Age	36.62	2.13	27.3	42.0	408

state was subject to a state-wide workplace smoking ban for the entire year in question and equal to 0 if there was not a state-wide workplace smoking ban in place and add this variable to my data set. It should be noted that this variable was manipulated to account for its lagged effect in further analysis.

Table 1 relays the descriptive statistics for the previously elaborated upon data set, which includes a total of 408 observations (51 U.S. jurisdictions over a period of 8 years). Of particular interest is the wide disparity between smoking prevalence among the 50 states and District of Columbia observed over the time period. Note that the minimum percentage of smokers within a state is 9.3% while the maximum percentage of adults smoking within a state was 42.8% during the observed time period. There is also a large gap between the lowest and highest excise tax placed on a pack of cigarettes among states during the analyzed time period. The lowest tax charged was 2.5¢, whereas the highest tax charged was \$2.75, and the average tax amongst states was 83.5¢ over this period. Furthermore, a disparity in state-level funding was also found to exist with a state receiving as low as 2¢ per person in funding and another state receiving as high as \$10.20 per person during the course of analysis. The descriptive statistics also demonstrate the average, minimum, and maximum figures for the control

statistics in each state, as well as demonstrates that the variable of interest, *workban*, is bound between 1 and 0.

V. Empirical Model

While the theoretical model presented in Section III was based on an analysis of individuals, unfortunately no true panel data set could be feasibly created using individual level data to analyze state level effects on such individuals due to a lack of existing data. As a result, the empirical model approach used to determine the impact of workplace smoking bans on smoking prevalence will be performed using state-level, rather than individual-level, data. Therefore, smoking prevalence, the dependent variable, serves as an aggregation of the smoking decisions made by each individual residing within that state. In other words, both quitting and starting decisions will be accounted for by this measure. Each regressor is thus a factor that is believed to shape an individual's decision (which is affected by his or her perceived marginal cost and benefit), but is measured on an aggregated scale. Nevertheless, this should present few empirical issues because the state-level data merely represents estimations based upon an aggregation of individual level statistics. The main problem with aggregate level data is, perhaps, that it cannot be used as effectively for analyzing changes in control variables, such as age, gender, education, and income as an analysis performed using individual-level data.

Therefore, the empirical approach chosen to determine the impact of workplace smoking bans on smoking prevalence is to estimate a simple linear equation using OLS with smoking prevalence as the dependent variable and with control variables (educational attainment, race, gender, unemployment rate, age and income) and variables reflecting changing policies used to curb smoking (state-wide workplace smoking bans, the excise tax on cigarettes, and the amount of funding for tobacco control per capita appropriated to the state) on the right-hand side.²³ The basic regression model estimated is thus:

$$\text{Prevalence}_{it} = \beta_0 + \beta_1 \text{Tax}_{it} + \beta_2 \text{WorkBan}_{it} + \beta_3 \text{Funding}_{it} + \beta_4 \text{EDU}_{it} + \beta_5 \text{DPI}_{it} + \beta_6 \text{Unemployment}_{it} + \beta_7 \text{White}_{it} + \beta_8 \text{Male}_{it} + \beta_9 \text{Age}_{it} + u_{it}$$

Subsequently, a fixed effects regression model is estimated. State fixed effects are added to the linear model first in order to capture any unobserved state characteristics that are fixed over time, such as state level anti-smoking sentiment

²³ I include governmental policies and tools other than the workplace smoking ban in order to isolate the effect of workplace bans from the effects of other policies that might have an effect on smoking prevalence.

and social norms, as well as climate and historical circumstances that result in a large tobacco and cigarette industry within a state.²⁴ Adding these effects in the smoking prevalence regression allows for the avoidance of omitted variable bias that arises from omitted factors that vary across entities, but are constant over time within the state. Therefore, the regression including state fixed effects is:

$$\text{Prevalence}_{it} = \beta_0 + \beta_1 \text{Tax}_{it} + \beta_2 \text{WorkBan}_{it} + \beta_3 \text{Funding}_{it} + \beta_4 \text{EDU}_{it} + \beta_5 \text{DPI}_{it} + \beta_6 \text{Unemployment}_{it} + \beta_7 \text{White}_{it} + \beta_8 \text{Male}_{it} + \beta_9 \text{Age}_{it} + \alpha_i + u_{it}$$

Time fixed effects were also added to the regression in order to control for variables that vary over time but do not vary across states, such as the federal excise tax imposed on cigarettes and changes in federal packaging laws. The addition of these effects in the smoking prevalence regression allows for the avoidance of omitted variable bias that arises from omitted factors that are constant across states, but vary over time. Therefore, the inclusion of time and state fixed effects mitigates bias in the coefficients associated with many omitted variables. Accordingly, the final fixed effects regression model to be estimated is:

$$\text{Prevalence}_{it} = \beta_0 + \beta_1 \text{Tax}_{it} + \beta_2 \text{WorkBan}_{it} + \beta_3 \text{Funding}_{it} + \beta_4 \text{EDU}_{it} + \beta_5 \text{DPI}_{it} + \beta_6 \text{Unemployment}_{it} + \beta_7 \text{White}_{it} + \beta_8 \text{Male}_{it} + \beta_9 \text{Age}_{it} + \alpha_i + \lambda_t + u_{it}$$

In addition to accounting for fixed effects, I also devoted a significant amount of attention to the issue of functional form. For instance, because a log-log specification implies that the same percentage point increase in a variable is more effective at low levels, in comparison to high levels, this type of specification was used to determine the impact of funding on smoking prevalence:

$$\text{Prevalence}_{it} = \beta_0 + \beta_1 \text{Tax}_{it} + \beta_2 \text{WorkBan}_{it} + \beta_3 \ln_ \text{Funding}_{it} + \beta_4 \text{EDU}_{it} + \beta_5 \text{DPI}_{it} + \beta_6 \text{Unemployment}_{it} + \beta_7 \text{White}_{it} + \beta_8 \text{Male}_{it} + \beta_9 \text{Age}_{it} + \alpha_i + \lambda_t + u_{it}$$

Furthermore, based on the aforementioned theory that addicts are rational and forward-looking, but their addiction causes them to fail to follow their plans for optimal consumption, as well as the fact that it often takes smokers a significant amount of time to quit, I also chose to devote attention to creating specifications that accounted for this postulation. The outcome was the creation of

²⁴ States that grow tobacco have been found to have higher smoking prevalence in comparison to states that do not grow tobacco. The addition of state fixed effects, therefore, makes it possible to eliminate the influence of this variable that varies across states but does not change over time.

models that allowed for not only instantaneous, but also lagged effects. For instance, the following model was estimated to better explain the impact that a state-wide smoking ban has on smoking prevalence:

$$\text{Prevalence}_{it} = \beta_0 + \beta_1 \text{Tax}_{it} + \beta_2 \text{WorkBan}_{it-2} + \beta_3 \text{In_Funding}_{it} + \beta_4 \text{EDU}_{it} + \beta_5 \text{DPI}_{it} + \beta_6 \text{Unemployment}_{it} + \beta_7 \text{White}_{it} + \beta_8 \text{Male}_{it} + \beta_9 \text{Age}_{it} + \alpha_i + \lambda_t + u_{it}$$

Using the literature review and theoretical underpinning of this study as reference, a summary of the expected signs on each of the variables within these specifications could be constructed and is outlined as follows:

- (i) Each of the governmental tools, Tax_{it} , WorkBan_{it} , and In_Funding_{it} , are predicted to have negative coefficients because the adoption of smoking bans and increased levels of funding and excise taxes increase an individual's perceived marginal cost of smoking. This results in a smaller likelihood of starting smoking and a larger likelihood of quitting, which should result in a lower smoking prevalence at the aggregate level. In other words, greater levels of funding, higher excise taxes, and the existence of state-wide workplace bans should result in lower smoking prevalence.
- (ii) DPI_{it} has been associated with both positive and negative coefficients, and it is not agreed upon whether cigarettes are a "normal" good. Therefore, either sign can be expected.
- (iii) Based upon various existing studies, the results regarding the sign of the coefficient of each of the control variables (White_{it} , Male_{it} , and Age_{it} , Unemployed_{it}) are mixed. Historically, males, whites, younger generations, and the unemployed were more likely to smoke than their counterparts; however, today the gap seems to be closing. Nevertheless, I must hypothesize that the signs on White_{it} , Unemployment_{it} , and Male_{it} will be positive while the coefficient on Age_{it} will be negative.
- (iv) Increasingly educated individuals are better able to understand the harmful health effects of smoking and are thus less likely to begin smoking because their perceived marginal cost is relatively high. Therefore, the hypothesized sign on EDU_{it} is negative—the higher the percentage of high school graduates in a state, the smaller should be the smoking prevalence within the state.

Table 2: Regression Analysis of the Effect of Workplace Smoking Bans on Smoking Prevalence

Variable: Smoking Prevalence Dependent					
Regressor	(1)	(2)	(3)	(4)	(5)
Tax	-0.019*** (0.003)	-0.005 (0.003)	-0.006** (0.002)	-0.005* (0.0029)	-0.005* (0.0029)
WorkBan	-2.388*** (0.306)	0.121 (0.264)	0.292 (0.252)		
WorkBan (lagged one year)				0.224 (0.254)	
WorkBan (lagged two years)					-0.4904* (0.255)
EDU	-0.223*** (0.046)	-0.007 (0.076)	-0.011 (0.079)	0.0033 (0.078)	-0.0003 (0.078)
DPI	-0.0001*** 0.00004	-0.0003*** (0.00009)	0.00002 (0.0001)	0.00003 (0.0001)	0.00004 (0.0001)
Funding	0.343** (0.178)				
Funding (logarithm)		0.353 (0.321)	-0.661* (0.351)	-0.626* (0.35)	-0.729** (0.352)
Unemployment Rate	0.235** (0.120)	0.043 (0.111)	-0.088 (0.144)	-0.09 (0.144)	-0.082 (0.144)
% White	-0.017 (0.011)	0.303* (0.179)	-0.023 (0.18)	-0.039 (0.181)	-0.075 (0.181)
% Male	0.028 (0.212)	-0.833 (1.47)	1.255 (1.42)	1.401 (1.425)	0.854 (1.43)
Median Age	0.589*** (0.073)	-1.802*** (0.266)	-0.44 (0.376)	-0.495 (0.38)	-0.53 (0.379)
State Effects?	no	yes	yes	yes	yes
Time Effects?	no	no	yes	yes	yes
\bar{R}^2	0.4874	0.8754	0.8924	0.8928	0.8933

VI. Results

Table 2 presents a set of OLS estimated regressions of smoking prevalence on state-wide workplace smoking bans and other governmental methods to curb smoking usage, as well as control variables. It should be noted here that issues of multicollinearity, heteroskedasticity, and endogeneity bias were

accounted for in each of these models.²⁵ The first column details a regression without controlling for state or time fixed effects. In this specification the coefficient on *workban* is negative and significant at the 1% level, indicating, as hypothesized, that states subject to a state-wide smoking ban are associated with a lower smoking prevalence among their residents. The variables representing other governmental methods used to curb smoking prevalence, *tax* and *funding*, are also found to be significant at the 1% and 5% level, respectively. Nevertheless, it must be noted that the sign on *funding* is opposite to what was hypothesized. Furthermore, various control variables were also found to be significant including education, disposable income, unemployment rate, and median age. Median age, however, was not found to have the hypothesized sign.

Nonetheless, as argued before these results are likely subject to severe omitted variable bias because factors such as state fixed effects (e.g. anti-smoking sentiment, social norms, as well as climate and historical circumstances that result in a large tobacco and cigarette industry within the state) and time fixed effects (e.g. federal cigarette excise tax and packaging laws) are not accounted for in this specification. Once state fixed effects are controlled for, as reported in the second column of table 2, the coefficient on *workban* changes its sign and becomes insignificant. Moreover, the coefficients on *tax* and *funding* become insignificant and a different set of control variables becomes markedly significant.

The inclusion, however, of state fixed effects only corrects for that part of the omitted variable bias that arises from cross-sectional differences among states. Once time fixed effects are accounted for, as detailed in the third column of table 2, the coefficient on *workban* remains insignificant and positive. This implies that the bias on *workban* from not controlling for state and time fixed effects was negative. Each of the demographic control variables is also found to be insignificant. On the other hand, the coefficients on *tax* and *funding* are found to be statistically significant and have the predicted signs.

Columns 4 and 5 of table 2 take into account that addicts, while rational and forward-looking, fail to follow their plans for optimal consumption due to their addiction, as well as the fact that workplace smoking bans may have a relatively small effect on an individual's marginal cost of smoking. One way to validate this lattermost conjecture is by noting that the smoker's consumption is not affected by the ban at times when the smoker is not within the confines of a

²⁵ Endogenous variables are thought to not be a problem within the specified models. For example, general excise tax rates vary from state to state; however, these variations arise as each state chooses a different mixture of sales, property, and income tax to finance governmental activities. Therefore, this choice is not determined by smoking prevalence, but instead by political considerations. Similarly, the main opposition to workplace smoking bans seems to come from the tobacco industry and from advocates for freedom of choice. Therefore, ideological and political considerations, rather than smoking prevalence, are likely to be the principal factors affecting the time at which the legislation to ban smoking in workplaces is passed in a state.

workplace. Furthermore, the ban can be circumvented relatively easily because a smoker can presumably step outside to smoke throughout the work day. Over time, however, the inconvenience caused by the larger effort that the ban causes a smoker to exert in order to smoke will compound as smoking becomes a larger and larger burden on the smoker. As a result, higher marginal costs will develop over time so that smoking prevalence is likely impacted in the long term rather than in the immediate sense as is typical with the impacts caused by funding and excise tax increases.

Consequently, the fourth column of table 2 details an OLS regression that controls for state and time fixed effects, as well as accounts for a one year lag in the effect of a state-wide smoking ban on the smoking prevalence within the state. Note that there are few changes between column 4 and column 3 of the table, which does not account for a lagged effect of workplace smoking bans—all control variables remain insignificant, tax and funding remain negative and significant, and the coefficient on workban continues to have the wrong sign and be statistically insignificant at the 10% level. However, when a two- year lag is introduced the coefficient on workban becomes negative (the hypothesized sign) and statistically significant at the 10% level.

The fifth column of table 2 accounts for this two-year lagged effect of workplace smoking bans. This regression demonstrates that the demographic control variables % male, % white, unemployment rate, median age, and EDU are insignificant. These results are consistent with those studies that determined that the gap between people with differing demographic characteristics seems to be closing. Furthermore, DPI was also found to be statistically insignificant at the 10% level, which is consistent with the findings of studies performed by researchers, such as Yurekli and Zhang, and Wasserman et al..

Conversely, tax, ln_funding, and workban were found to not only have the hypothesized sign, but also be statistically significant at the 10% level. The coefficients can, therefore, be interpreted to demonstrate the effects that each of these methods used to curb smoking has on smoking prevalence at the state level. The coefficient on tax was found to be -0.005, which means that for every 1¢ a state increases the excise tax imposed on a pack of 20 cigarettes the smoking prevalence declines by 0.005%, *ceteris paribus*. However, states usually increase these taxes by a significantly larger sum than 1¢. In fact, states have increased the excise tax by as much as a \$1.00 in a single round of legislation. Therefore, if a state raises its excise tax, for example, by an arbitrary amount of 50¢ then the smoking prevalence within the state would decline by .25%, *ceteris paribus*.

The analysis for the variable referred to as funding is similar. The coefficient on funding, based upon the specification in the fifth column of table 2, was found to be -0.729. This means that a 1% increase in the funding per capita that a state receives will result in that state's smoking prevalence declining by

0.00729%, *ceteris paribus*. The average funding per capita received by any given state over the time period analyzed was \$0.65, as reported in table 1. If this value were to increase by, for example, 10% so that funding per capita given to a state increased to \$0.715 then smoking prevalence would decrease by 0.073%, *ceteris paribus*. This decrease may, however, require a large degree of additional funding. For instance, with an estimated population of over 24 million according to the U.S. Census Bureau, Texas would require an additional \$1,560,000 in funding to achieve the 0.073% decline in smoking prevalence mentioned in the example above.

Likewise, the coefficient on *workban*, -0.4904, can be interpreted in a similar fashion. Because the effect of a state-wide workplace smoking ban is lagged two years, this coefficient means that if a state enacts a ban (*workban*=1) in year x then that state will experience a decline of 0.4904% in smoking prevalence in the year $x+2$, *ceteris paribus*. Therefore, workplace smoking bans (when lagged effects are accounted for), as well as tax and funding levels were found to be statistically significant and negative. The actual magnitude of these effects, however, seems relatively small.

VII. Conclusion

This study uses a unique data set on state-wide smoking prevalence with the intention of estimating the effectiveness of governmental efforts, in particular workplace smoking bans, in decreasing smoking prevalence within the state. In contrast to earlier work, this study uses panel data and includes the impact of entity and time fixed effects, as well as accounts for the lagged effects of smoke-free bans. Therefore, this study is believed to better estimate the true impact of workplace bans on smoking prevalence.

During the course of analysis the data set and empirical strategy are used to produce estimates of the effects of a variety of variables, the choosing of which was supported by the literature review and theoretical underpinning of the study, on the prevalence of smoking on the state level. The results, overall, suggest that funding and tax significantly impact a state's smoking prevalence in a statistical sense, while demographic factors play a negligible role in determining smoking prevalence. A caveat to this study, however, should be reiterated—aggregate level data is believed to not be used as effectively as individual level data in analyzing changes in control variables, such as gender, age, and education.

On the other hand, the analysis of the effect of a state-wide smoking ban imposed on workplaces gives rise to more ambiguous results. In fact, the ban is found to be statistically insignificant until accounting for lagged effects of the ban. When taking such effects into consideration the ban becomes more significant as time elapses. Thus in the final specification of the study, it is

estimated that an increase in excise tax by 50¢ will decrease prevalence by .25%, a 10-percentage-point increase in funding leads to a decline in smoking prevalence by 0.073% and the adoption of a state-wide smoking ban decreases a state's smoking prevalence by 0.4904% in two years. While together these effects are statistically significant, the magnitude of each effect seems relatively small thus making the federal government's goal of reducing the national smoking rate from its current level to 12 percent by 2020 a hopeful aspiration.

Nevertheless, the adoption of state-wide smoking bans will result in a significant number of individuals either quitting smoking or never starting, which will undoubtedly save lives, create a cleaner work environment in which secondhand smoke is no longer a threat to workers' health, as well as reduce the economic costs on society of smoking. For example, if Kentucky were to adopt a state-wide workplace smoking ban then a decline of 0.4904% in the prevalence of smoking would be expected based on estimations in this study. Therefore, Kentucky (which has an estimated population of 4,314,113; 28.3% of whom smoke, according to the U.S. Census Bureau the CDC) could expect 21,156 fewer smokers in the state. Therefore, while the magnitude of the impact of banning smoking in the workplace is not likely to entirely achieve the federal government's ambitious goal of reducing the prevalence of smoking by around 8%, the recent initiative by many states to adopt state-wide smoking bans is worthwhile. Consequently, the results of this study encourage the adoption of state-wide workplace smoking bans in order to curb smoking prevalence within states.

Furthermore, there are many opportunities for future work regarding this topic. For example, a similar study should be conducted once every state has adopted a workplace smoking ban. Additionally, the various demographic influences on smoking prevalence is a prospectively lucrative subject for future health economic studies due to the fact that an understanding of these factors remains a key challenge following this state-level study. Moreover, although data limitations prevented me from estimating the effects of the specific state tobacco control policies at an individual level, hopefully future research could use impending individual-level longitudinal data to provide a more complete picture of the demographic and policy influences on smoking prevalence. It would also be interesting to focus directly on the effects of such variables on smoking initiation in comparison to cessation rather than smoking prevalence, which is an aggregation of the two decisions.

Data Appendix

In this appendix, I will define each variable used in the analysis, discuss each variable's source, and motivate its use if necessary.

1. Smoking Prevalence

Data obtained from the Centers for Disease Control and Prevention (CDC) in conjunction with the Behavioral Risk Factor Surveillance System (BRFSS)

- Prevalence—Measured as the percentage of a state's residents who are classified by the CDC as current smokers.

2. Factors and Other Controls

Data obtained from the U.S. Census Bureau

- White—the percentage of people in the state population who deem themselves white as a race
- Male—the percentage of males in the state population
- Age—the median age, in years, of the state population
- DPI—disposable personal income per capita in constant (2000) dollars by state
- EDU- Percentage of persons 25 and older in a state that have graduated from high school

Data obtained from the Bureau of Labor Statistics (BLS)

- Unemployment Rate- the BLS defines the unemployment rate as the percentage of people who do not have a job, have actively looked for work in the past four weeks, and are currently available for work within the state

3. Governmental Tools Used to Curb Smoking

Data obtained from the Centers for Disease Control and Prevention (CDC)

- Tax—the state excise tax rate for cigarettes expressed in cents per pack of 20 cigarettes
- Funding—amount in dollars per capita of appropriated funds intended to be used for tobacco control purposes
- WorkBan—dummy variable equaling 0 if a state does not ban smoking in all workplaces on a state-wide level and equaling 1 if the residents of a state are subject to a state-wide workplace smoking ban for the entirety of a given year

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