The Impact of Smoke-Free Air Legislation and Cigarette Prices on Hospitalizations in the United States

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THESIS
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This thesis is dedicated to Janet, Holly, Jordan, and Jaimee Oliver.

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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF TABLES (continued)

LIST OF FIGURES

LIST OF FIGURES (continued)

LIST OF ABBREVIATIONS

AQI	Air Quality Index
CCS	Clinical Classification System
CDC	Centers for Disease Control and Prevention
COPD	Chronic Obstructive Pulmonary Disease
CPI	Consumer Price Index
EPA	Environmental Protection Agency
FEV	Forced Expiratory Volume
FIPS	Federal Information Processing Standards
ICD-9-CM	International Classification of Diseases, 9^{th} Revision, Clinical Modification
NAICS	North American Industry Classification System
PM	Particulate Matter
SFA	Smoke-Free Air
SIC	Standard Industrial Classification

SUMMARY

This dissertation examines the impact of tobacco control policies on the number of cancer, cardiovascular, and respiratory hospitalizations in the United States. Using county level data from up to 40 states, this study is the largest in the literature to date. It also controls for a rich set of county characteristics including the county level cigarette price, reducing omitted variable bias likely present in previous research.

The first section of the paper provides an overview of smoke-free air legislation and cigarette taxation at the local and state level, and how each policy has changed over time. The second section introduces previous research examining the biological links between exposure to tobacco smoke and various cancer, cardiovascular, and respiratory diseases. The impact on both current and former smokers is discussed, as well as how these health risks vary by age group.

The third section introduces the existing literature in the United States and internationally surrounding smoke-free air legislation and cigarette taxation. The estimated changes in morbidity and mortality among affected populations are then discussed.

The fourth section describes the hospitalization data used in this study, as well as the county level demographic, economic, and environmental controls. The fifth section describes the methods and models used to estimate the impact of comprehensive smoking bans and increased cigarette prices on changes in the number of hospitalizations among working age and older adults. Section six presents the results of each model and several sensitivity tests.

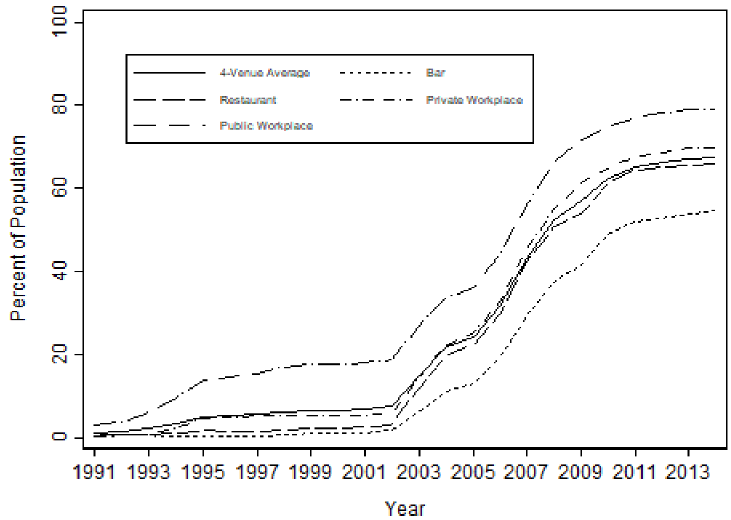
Finally, section seven summarizes the results of this study and the contributions it provides to the literature. I then discuss the relevant policy implications of implementing smoke-free air legislation and cigarette taxation in the United States.

1 INTRODUCTION

Communities in the United States are increasingly turning to smoke-free air legislation and cigarette taxation as a method of reducing tobacco consumption and protecting nonsmokers from the harms of secondhand smoke. Cigarette smoke contains thousands of chemicals, including 70 carcinogens and 250 toxins (IARC, 2004a; CDC, 2016). Many of these components are causally related to cancer, cardiovascular disease, and are known to exacerbate respiratory conditions. The result is more than 480,000 annual deaths in the United States due to active smoking, and an additional 41,000 deaths due to secondhand smoke (USDHHS, 2014).

Early smoke-free air legislation in the United States began during the 1970's, but did little to reduce nonsmokers' exposure to secondhand smoke. These laws often included exemptions or allowed for indoor smoking sections, which did not provide adequate protection from environmental tobacco smoke (USDHHS, 2010). In 1992, the Environmental Protection Agency (EPA) classified secondhand smoke as a Group A carcinogen, prompting the enactment of more restrictive smoke-free air legislation (EPA, 1992). These laws, deemed comprehensive, prohibited all indoor smoking with no exceptions. Figure 1 tracks the percentage of the US population protected by comprehensive smoke-free air legislation in bars, restaurants, public work-

Figure 1: Comprehensive Smoke-Free Air Legislation, 1991-2014

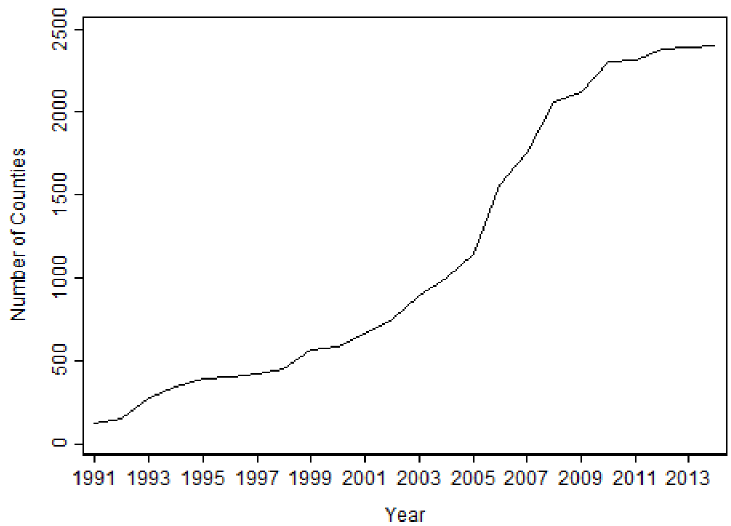


places, private workplaces, and the average across these four venues, from 1991-2014.

Over this time period, public and private workplace restrictions have consistently protected the largest percentage of the population, with restaurants and bars typically lagging behind. Coupled with Figure 2, which displays the number of counties enacting comprehensive smoke-free air legislation each year, these graphs reflect the changing development of smoking bans over time.

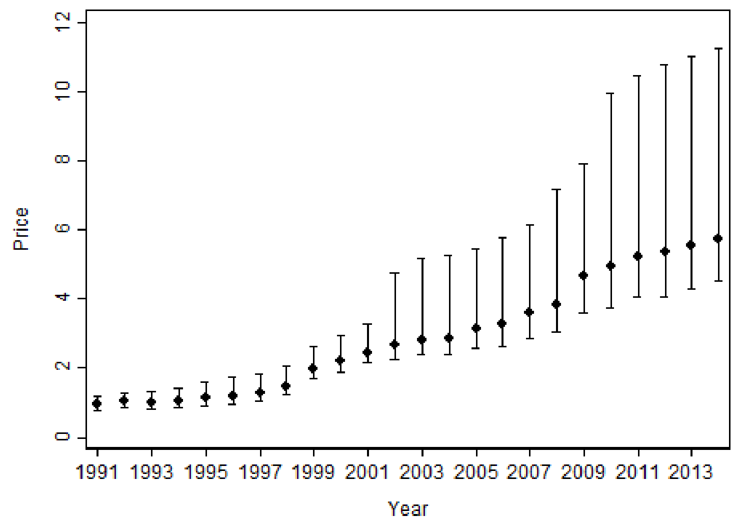
The modest increase in coverage throughout the 1990's resulted from the laws originally being enacted at the local level, covering a single public

Figure 2: Number of Counties with Comprehensive Smoke-Free Air Legislation, 1991-2014



venue, and affecting a small proportion of the county population. The rapid expansion during the 2000's reflects the transition from local to state level legislation, with each new law protecting larger segments of the population. The trend in real cigarette prices follows a similar path during this time. Figure 3 shows the yearly average real cigarette price from 1991-2014, as well as the yearly minimum and maximum price across all states. Large increases in the average price occurred in both 1999 and 2009. In addition to the industry initiated price increase in 1999 to pay for the Master Settlement Agreement, the lawsuit brought forth from 46 US states against the major tobacco companies, many state and local governments subsequently increased the cigarette excise tax in their jurisdictions as well. The large price change in

Figure 3: Mean, Minimum, and Maximum Cigarette Price (in 2014 dollars), 1991-2014



2009 resulted from an increase in the federal cigarette tax enacted to fund the State Children's Health Insurance Program. These changes are observable in Figures 4 and 5, which chart the yearly average cigarette tax in cents per pack of cigarettes and the annual number of new cigarette taxes at the state and local level.

Despite the expansion of these policies, as of 2017, large disparities continue to exist in the level of cigarette taxation within and across states, while only 58.3% of the US population is protected by comprehensive smoke-free air legislation in all four public venues (CTFK, 2017; ANRF, 2017).

Figure 4: Yearly Cigarette Tax (in 2014 cents), 1991-2014

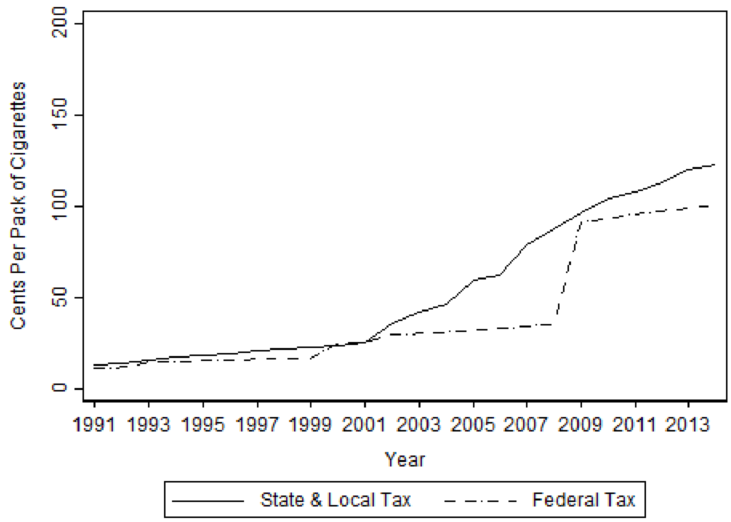
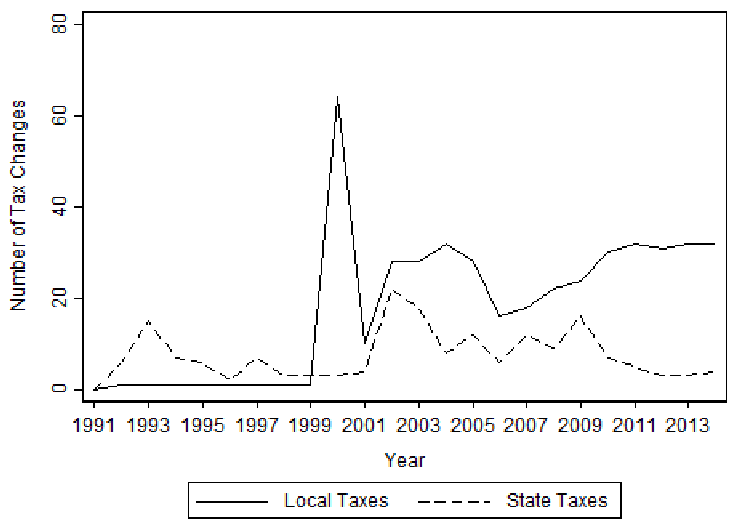


Figure 5: Number of Cigarette Tax Changes, 1991-2014



This paper analyzes the extent to which tobacco control policies impact the number of cancer, cardiovascular, and respiratory hospitalizations in the United States. The diagnoses examined in this study include lung cancer, breast cancer, prostate cancer, acute myocardial infarction, coronary atherosclerosis, acute cerebrovascular disease, peripheral and visceral atherosclerosis, artery aneurysms, arterial embolism, hypertension, tuberculosis, chronic obstructive pulmonary disease (COPD), and asthma. Additionally, appendicitis hospitalizations are used as a counterfactual outcome, as they are unlikely to be affected by tobacco control policies.

To measure these effects, a Poisson model is used with county and year fixed effects and robust standard errors, while controlling for county demographic, economic, and environmental characteristics. This study is the first in the economics literature to examine the effects of comprehensive smoke-free air legislation and county level cigarette prices on hospitalizations in the United States. It is also the largest in the literature to date, examining up to 40 states from 1991-2014, with an average nine years of data after the enactment of smoke-free air legislation. The longer time span and larger number of states allows for a more accurate estimation of the impact of each tobacco control policy, and presents results representative of the general population. Finally, it is the first economic study to examine the impact of tobacco control policies on hospitalizations for breast cancer, prostate cancer, hypertension, tuberculosis, arterial embolism, peripheral and visceral atherosclerosis, artery aneurysms, and coronary atherosclerosis.

2 REVIEW OF THE PHYSIOLOGICAL MECHANISMS LINKING ACTIVE AND PASSIVE SMOKING WITH DISEASE INCIDENCE

2.1 Introduction

Cigarette smoke is comprised of both mainstream and sidestream smoke. Mainstream smoke refers to the smoke inhaled by the smoker from the cigarette and subsequently exhaled, while sidestream smoke is the smoke emitted from the end of a burning cigarette. The primary source of secondhand smoke exposure among nonsmokers is sidestream smoke, and while both components contain essentially the same chemicals, their concentrations can differ quite drastically. This is due to the range of temperatures at which the cigarette burns when being smoked. As a result, sidestream smoke contains up to 10 times greater concentrations of many chemicals compared to mainstream smoke, making it nearly as damaging as active smoking (NRC, 1986; Schick and Glantz, 2005; Barnoya and Glantz, 2005).

Several biological links connect exposure to cigarette smoke with disease incidence. When cigarette smoke enters the body through the airways, it interacts with and damages cells and DNA, causes inflammation, and reduces the body's ability to fight infections. Both active smoking and secondhand smoke are associated with increased inflammation, occurring in the respiratory and cardiovascular systems and leading to damaging health effects even at low levels of exposure (USDHHS, 2010).

For individuals with asthma, inhalation of tobacco smoke causes the airways to become inflamed, restricting air flow to the lungs, and increases the likelihood of asthma symptoms (CDC, 2014). Similarly, inflamed airways are a common component of COPD, a largely irreversible disorder characterized by narrowed airways and a premature reduction in lung function at all ages (USDHHS, 2014). Exposure to tobacco smoke was first established as a primary cause of COPD in the 1964 Surgeon General's report, and while genetics plays some role in an individual's susceptibility to the disease, cigarette smoke remains the primary source of disease incidence and mortality (USDHEW, 1964; USDHHS, 2014).

Exposure to cigarette smoke also leads to immediate and harmful effects on the cardiovascular system. Many of the chemicals in tobacco smoke, including carbon monoxide, are less than 2.5 micrometers in diameter, allowing them to pass through the lungs and enter the bloodstream. The presence of carbon monoxide in the bloodstream triggers red blood cell and platelet production, increasing the risk of blood clot formation and arterial plaque accumulation (Benewitz, 2003; USDHHS, 2010). Similarly, the presence of nicotine in the body activates the sympathetic nervous system, which increases an individual's heart rate and blood pressure (USDHHS, 2014). Additional effects include a stiffening of the arterial lining, arterial inflammation, reduced blood flow, and the impairment of fibrinolysis, which aids in dissolving blood clots (USDHHS, 2014). Arterial inflammation can lead to damaged arterial walls, arterial dilation, and an increased likelihood of arterial rupturing (USDHHS, 2004). Smoking also damages endothelial cells, whose function is to maintain blood flow in the arteries. This leads to arterial inflammation, and if chronic, to the development of plaque buildup as platelets more easily stick to the arterial wall. Inflammation mediators can eventually cause the plaque to rupture, resulting in thrombosis (USDHHS, 2014).

Conditions directly resulting from these effects include coronary atherosclerosis, a chronic disease characterized by arterial plaque buildup and reduced blood flow, and acute myocardial infarction, which occurs when blood flow to the heart becomes blocked. Additionally, these adverse effects do not require long term exposure prior to taking place. Exposure to second-hand smoke for even one hour has been shown to reduce endothelial function and increase platelet production, while heart rate and blood pressure increase just minutes after smoking begins (Yarlioglues et al., 2011; Cryer et al., 1976).

The carcinogenic compounds introduced into the bloodstream also interact with and damage DNA, inhibit DNA repair, and mutate genes which normally act as tumor suppressors (Cal/EPA, 2005a; Taneja and Vassallo, 2012; USDHHS, 2014). These genetic mutations are permanent, and can lead to uncontrolled cellular growth inherent in cancer (USDHHS, 2010). Other components of cigarette smoke, while not carcinogenic, are known to promote tumor growth (USDHHS, 2010; IARC, 2007). For breast and lung cancer, tobacco compounds associated with the disease have been identified, as have specific gene mutations in breast and lung tissue (Terry and Rohan, 2002; USDHHS, 2014). While the gene mutations responsible for prostate cancer have yet to be identified, defects in certain genes can increase the risk of prostate cancer incidence. Four main channels for the development and severity of the disease have been proposed and include inflammation, exposure to carcinogenic substances, hormone changes, and genetic mutations (DeNunzio et al., 2015). The greatest risk factors for the disease remain patient age, race, and family history, and while the latter more than doubles the risk of developing prostate cancer, most cases occur in men with no family history (American Cancer Society, 2016).

The biological link between cigarette smoke and active tuberculosis is thought to be related to the weakened immune systems of smokers and those exposed to secondhand smoke. The infectious bacterial disease primarily affects the lungs, and is spread through the air from person to person. One can be infected with the bacteria that causes tuberculosis, Mycobacterium tuberculosis, for years without showing any symptoms. Signs of active tuberculosis can include a prolonged cough, with or without blood, and chest pain. Despite being treatable, it causes nearly 2 million deaths worldwide each year, and roughly 33% of the world's population is infected with the bacteria (WHO, 2017).

2.2 Changes in Risk Associated with Active and Passive Smoking

Smoking cessation and avoidance of secondhand smoke are effective methods to reduce many of the health risks described in Section 2.1. In the time since smoking was first deemed causally related to lung cancer in the 1964 Surgeon General's report, researchers have sought to quantify the increased risk of lung cancer among smokers and those exposed to secondhand smoke. Active smoking is associated with a 13 to 14 times greater risk of developing lung cancer among younger adults and increases with age. Among adults ages 75 and older, smokers have a 22 to 23 times greater risk of lung cancer incidence than do non-smokers. The elevated risk for former smokers is two to four times greater among younger adults, and roughly six times greater among adults ages 75 and older, compared to never smokers (USDHHS, 2014). For nonsmoking adults, exposure to secondhand smoke is associated with a 20% to 30% greater risk of lung cancer incidence (USDHHS, 2006). After smoking cessation, the relative risk of lung cancer is 11 to 14 times higher for up to 10 years. Even 40 years after smoking cessation, the risk of developing lung cancer is 88% greater for males and 50% greater for females compared to never smokers (USDHHS, 1990; IARC, 2007).

Among studies that best controlled for exposure to active smoking and secondhand smoke, the relative risk of developing breast cancer is 2.08 times greater among smokers, and the relative risk for women exposed to secondhand smoke is 1.90 times greater than for women with no lifetime exposure (Johnson, 2005). For former smokers the relative risk is roughly 14% greater than never smokers and decreases with time since cessation, eventually reaching baseline levels after 20 years (Jones et al., 2017). When estimates are stratified by age, younger women appear to be slightly more affected by exposure to tobacco smoke. Among premenopausal women, active smoking and exposure to secondhand smoke are associated with a relative risk of 2.11 and 2.19, respectively. For postmenopausal women, active smoking is associated with a 24% increased risk of disease incidence, while secondhand smoke is associated with an 8% increased risk (Luo et al., 2011).

While the existing research has not definitively established a causal link between active smoking and the development of prostate cancer, smokers experience greater rates of disease progression and mortality than do non-smokers (USDHHS, 2014). A recent meta-analysis found no increased risk of prostate cancer incidence among current or former smokers. However, current smokers have up to a 30% greater risk of prostate cancer mortality compared to never smokers (Huncharek et al., 2010). The literature has yet to perform subgroup analysis of prostate cancer risk by age, or establish a link between secondhand smoke exposure and the disease. If smoking does not impact prostate cancer incidence but only disease progression, the estimated effects of smoke-free air legislation and increased cigarette prices will reflect only the extent to which these laws reduce smoking prevalence and cigarette consumption. If there is no benefit of reduced exposure to secondhand smoke for prostate cancer, the health benefits of tobacco control policies will likely be modest compared to other diagnoses with an established causal relationship.

For active smokers, the relative risk of coronary atherosclerosis and acute myocardial infarction is 2.10 to 2.90 times greater than never smoker. This risk is reduced nearly 50% one year after smoking cessation, and declines with age (Lightwood and Glantz, 1997; Kramer et al., 2006). Within 5-9 years, the risk returns to the level of never-smokers (USDHHS, 2010). Additionally, exposure to passive smoke increases the relative risk of heart disease by 25%, and increases the risk of death by roughly 30% (He et al., 1999; Glantz and Parmley, 1991).

Similarly, the relative risk of acute cerebrovascular disease is 1.5 times greater for current smokers and 1.2 times greater for former smokers and is consistent across genders, age groups, and by race (USDHHS, 2010; Shah and Cole, 2010). Upon smoking cessation the elevated risk declines with time, reaching baseline levels after roughly 2 to 5 years (Wolf et al., 1988; Kawachi et al., 1993). Exposure to secondhand smoke produces a similar 25% greater risk of acute cerebrovascular disease incidence (Oono et al., 2011; USDHHS, 2014). Previous research has also found that the risk of developing arterial embolism is 23% greater among current smokers and 10% greater among former smokers, compared to never smokers (Cheng et al., 2013).

Cigarette smoking was first associated with aneurysm mortality in the 1979 Surgeon General's report, and among cardiovascular diseases, aortic aneurysms exhibit the greatest increase in relative risk in response to cigarette smoke exposure (USDHEW, 1979; Benowitz, 2003). While aneurysms are most common in men over the age of 60, smoking in early adulthood is related to disease incidence at younger ages (USDHHS, 2012). For older adults, current and former smokers are roughly eight and three times more likely to experience an aneurysm than are non-smokers, respectively. Further, exposure to secondhand smoke is associated with a 12% increased risk of aneurysm mortality among non-smokers, while smoking cessation is associated with a 4% annual decline in aneurysm risk (Wilmink et al., 1999; Kihara et al., 2017). Due to the increased rate of aneurysm-related death among smokers, the U.S. Preventive Services Task Force has recommended ultrasound screenings for ever-smoking men ages 65 to 75 (USPSTF, 2014).

In a study examining the effects of active and passive smoking on peripheral arterial disease, those with the disease were significantly older (Agarwal, 2009). Active smoking is associated with nearly three times greater odds of developing peripheral arterial disease, while former smokers have a 70%

greater risk of disease incidence (Lu et al., 2014). Among adults ages 18 and older, individuals exposed to high levels of secondhand smoke were over 5.5 times more likely to develop peripheral arterial disease (Lu et al., 2013). For non-smoking women ages 60 and older, exposure to secondhand smoke was associated with a 67% increased risk of disease incidence (He et al., 2008). In a cohort study of women ages 45 and older, the risk of peripheral arterial disease was 21 times greater among current smokers, and over three times greater for former smokers. While the increased risk declines with years since smoking cessation, it remains double that of never smokers even 20 years later (Conen et al., 2011).

The existing literature finds mixed results as to whether active or passive smoking increases the risk of developing hypertension. Similarly, smoking cessation may have multiple and opposing effects on blood pressure and hypertension incidence. Specifically, smoking cessation leads to reduced inflammation and improvements to endothelial function, which may lead to lower blood pressure, while the weight gain typically associated with smoking cessation may lead to higher blood pressure (USDHHS, 1990). Smoking cessation is associated with an 80% greater risk of developing hypertension, and that those who quit gained nearly twice as much weight as continuing smokers and never smokers (Janzon et al., 2004). Other studies find that active smoking is associated with a 13% greater risk of hypertension incidence, and former smokers have a 4% increased risk (Dochi et al., 2009; Bowman et al., 2007). However, among individuals not taking anti-hypertensive medication, exposure to secondhand smoke leads to increased blood pressure, and elderly non-smokers exposed to secondhand smoke have a 38% greater risk of developing the disease (Wu et al., 2017; Seki et al., 2010).

For respiratory conditions such as COPD, active smoking is associated with a four times greater risk of disease incidence than nonsmokers, and exposure to secondhand smoke for as little as one hour per day is associated with a 44% greater risk (Jayes et al., 2016). Forced expiratory volume (FEV) is a test of lung function that measures the amount of air an individual can exhale during a forced breath. While lung function naturally declines with age, the decrease can be up to 10 times greater for those with COPD. Additionally, current smokers are 22 to 26 times more likely to die from COPD than non-smokers, and up to 50% of smokers will eventually develop the disease (Thun et al., 2013; Lundback et al., 2003). However, the elimination of cigarette smoke exposure leads to improvements in lung function and less severe symptoms (Chaudhuri et al., 2006; CDC, 2014). Specifically, smoking cessation slows the excess decline of FEV within one to two years, and while it is never completely eliminated, after five years it approaches the normal decline observed in non-smokers (IARC, 2007). Because cigarette smoke limits the lungs' ability to self-repair, smoking cessation is an effective mechanism to regain some of the damage caused by active smoking and secondhand smoke, regardless of age.

Finally, exposure to tobacco smoke roughly doubles the risk of developing tuberculosis, and roughly 30% of individuals exposed to active tuberculosis will become infected with the bacteria that leads to the disease (USDHHS 2014). Active smoking is associated with a 77% greater risk of Mycobacterium tuberculosis infection, and is similar across all age groups (Den Boon et al., 2005). These results are consistent with a meta-analysis that finds active smoking is associated with a relative risk of 1.73 for tuberculosis infection and 2.33 for active tuberculosis (Bates et al., 2007). Additionally, nonsmokers exposed to passive smoking were 70% more likely to be infected with Mycobacterium tuberculosis (Leung et al., 2010). Upon smoking cessation, tuberculosis mortality declines roughly 65%, quickly returning to levels consistent with nonsmokers (Wen et al., 2010).

3 REVIEW OF THE ECONOMIC LITERATURE ON SMOKE-FREE AIR LEGISLATION AND CIGARETTE TAXATION

3.1 Introduction

The mechanisms by which comprehensive smoke-free air legislation and cigarette prices affect exposure to active and secondhand smoke are well documented in the existing literature. Once an indoor smoking ban is enacted, compliance with the legislation is nearly universal, and concentrations of environmental tobacco smoke decline by up to 99% (Callinan et al., 2010; Hahn, 2010). Smoke-free air laws covering workplaces have been found to reduce smoking prevalence by 3.8%, and when observed across a wider range of public places, declines have been as high as 32% (Fichtenberg and Glantz, 2002; IOM, 2007; Callinan et al., 2010). Comprehensive smoke-free air legislation also leads to a nearly 8% decline in cigarette consumption among adults (Tauras, 2006).

In addition to lower rates of smoking, another effect of smoke-free air legislation is the associated change in public opinion towards smoking and exposure to secondhand smoke. Support for public smoking bans has increased significantly after smoke-free air laws are implemented, both among the general population and continuing smokers (Waa and McGough, 2006; Pursell et al., 2007). These laws also induce quit attempts among current smokers and help recent quitters remain smoke-free (Albers et al., 2007; Fong et al., 2006). Further, exposure to secondhand smoke in private locations such as cars and homes generally remains unchanged after smoking bans are enacted, suggesting smokers do not substitute towards smoking in private once their ability to smoke in public is restricted (Callinan et al., 2010). Legislative smoking bans also prompt individuals to adopt similar informal bans in their homes, regardless of the homeowner's smoking status (Cheng et al., 2011). These changing attitudes and behaviors work to further reduce smoking prevalence, cigarette consumption, and exposure to secondhand smoke.

In addition to smoke-free air laws, cigarette taxation is frequently employed as a means of raising the costs associated with smoking, and has been found to reduce smoking prevalence, cigarette consumption, and smoking initiation (USDHHS, 2012). Among younger smokers, a 10% increase in the cigarette price leads to a 3.1% reduction in smoking prevalence and a 5.2% decrease in the number of cigarettes smoked (Tauras et al., 2005). For adults, a $1.00 increase in the cigarette price is associated with a 6% to 8% decline in smoking prevalence (DeCicca and McLeod, 2008). When estimated separately by age groups, an increase in the cigarette price leads to an increased probability of smoking cessation among adults that declines with age (Franz, 2008). The inverse relationship between age and responsiveness to cigarette prices has also been noted in several meta-analyses of the literature (Chaloupka and Warner, 2000; IARC, 2011). Each of these effects in turn reduces exposure to environmental tobacco smoke, and the benefits accrue to both smokers and non-smokers.

Many studies have examined the impact of smoke-free air legislation on various health outcomes, defined as either the number of hospitalizations, emergency department visits, or deaths for a given diagnosis or condition. The disease most often studied, particularly among earlier research, is acute myocardial infarction events. As smoke-free air laws increased in number and scope to protect larger populations, the health outcomes similarly expanded to include angina, acute cerebrovascular disease, transient ischemic attack, asthma, COPD, as well as the more broadly defined categories of acute coronary syndrome and coronary heart disease. While diagnoses were generally found to decline, individual results ranged from a 47% decrease to moderate increases. These differences can be attributed to several factors, including sample size, the length of follow-up time, the age of individuals included in the study, the estimation method and model specification, the outcome variable of interest, and the ability of researchers to minimize omitted variable bias. Despite the extensive literature examining the impact of smoking bans on health outcomes, there are very few studies that assess the impact of cigarette prices on these same health conditions.

3.2 Relevant Studies from the United States

The first study examining the health effects of smoke-free air legislation occurred in Helena, Montana (Sargent et al., 2004). A public place smoking ban was enacted in June, 2002, but was halted by court order six months later. Researchers compared the number of primary and secondary diagnoses of acute myocardial infarction events among city residents subject to the ban with county residents unaffected by the legislation. During the time the law was in effect, acute myocardial infarctions declined 40% among the treatment group, while the control group experienced a slight increase. Despite the large effect size, the study examined only a single hospital serving a small population, and occurred over a short time period.

To address these shortcomings, two studies examined larger populations in Colorado over a period of 18 and 36 months (Bartecchi et al., 2006; CDC, 2009). In 2003, a comprehensive smoking ban was enacted in Pueblo City, Colorado, allowing for a comparison of acute myocardial infarction hospitalizations of city residents affected by the ban with two control groups: Pueblo County residents located outside Pueblo City, and residents of nearby El Paso County. After controlling for age, gender, and seasonality, the researchers find that acute myocardial infarction hospitalizations declined by 27% and 34% in the 18 and 36 months after the smoking ban was enacted, respectively. These results support the idea that smoke-free air legislation works to improve cardiovascular health, as well as suggests that the benefits increase over time.

Analysis of local and county level laws expanded to include state level legislation after New York State enacted a comprehensive smoking ban covering workplaces, restaurants, and bars in 2003 (Juster et al., 2007). Observations were restricted to adults ages 35 and older with a principal diagnosis of acute myocardial infarction or acute cerebrovascular disease. The results suggest that comprehensive smoke-free air legislation reduced the number of acute myocardial infarction hospitalizations by 8% but had no impact on acute cerebrovascular disease. The authors note that several smoke-free air policies existed prior to the 2003 legislation, which may bias the estimates downward toward finding no effect. However, while there are several years of pre-treatment observations, the study is limited to one year of post-treatment data.

With additional evidence supporting the effectiveness of smoking bans in reducing hospitalization rates, the analysis began expanding to include additional diagnoses. Using data from Delaware, researchers compared the number of asthma hospitalizations for Delaware and non-Delaware residents before and after a 2002 comprehensive smoking ban (Moraros et al., 2010). Among adults ages 18 and older, they find a 5% decrease in asthma hospitalizations and a 4.7% decrease in acute myocardial infarctions for Delaware residents during the post-ban period. However, the 5% decline in asthma hospitalizations occurs only when the year fixed effect is omitted from the preferred model. When time is included as a covariate, asthma hospitalizations increased by 12% among Delaware residents in the post-ban period.

A second statewide analysis of asthma hospitalizations soon followed, examining a comprehensive smoking ban in Arizona by comparing counties with and without prior smoking bans in place (Herman and Walsh, 2011). Diagnosis groups included acute myocardial infarction, acute cerebrovascular disease, asthma, and several counterfactual conditions including appendicitis. The results suggest that counties without a prior smoke-free air law experienced a 13% reduction in acute myocardial infarctions, a 14% reduction in acute cerebrovascular disease events, and a 22% reduction in asthma hospitalizations during the post-ban period. However, only one year of post-ban data is used in the analysis, so these declines represent only the immediate effects of the smoking ban rather than any long-term reductions.

Two additional studies make use of Medicare claims data to analyze smoke-free air laws in the United States. The first examines 387 counties, while controlling for population, age, gender, seasonal effects, state fixed effects, county random effects, and both linear and non-linear effects over time (Barr et al., 2012). The authors report a 5% decline in acute myocardial infarction hospitalizations in the 12 months following a smoking ban, but note that these findings disappear once non-linear trends are included in the analysis. This again suggests that model specification may play a role in determining whether declines in hospitalizations are attributed to smoke-free air legislation.

The second Medicare study examined smoking bans in workplaces, restaurants, and bars, both collectively and individually (Vander Weg et al., 2012). The diagnoses include acute myocardial infarction and COPD hospitalizations across all counties in the United States, with hip fracture discharges serving as the counterfactual condition. However, because exposure to cigarette smoke is associated with osteoporosis, and in turn a greater number of hip fracture events, this diagnosis group may not be an appropriate counterfactual. The results suggest that in the first year after a smoking ban is enacted, acute myocardial infarction hospitalizations declined by 11%, and the decline increased to 20% after three years. Similarly, COPD hospitalizations declined by 10% in the 12 months following the first ban, and 17% after three years, while hip fracture hospitalizations experienced statistically significant changes in nearly half of the results. Despite these large declines, counties consistently experienced an increase in hospitalizations prior to the enactment date of the smoking ban, making the common trends assumption less plausible. The authors note that the overall declines in acute myocardial infarctions are driven by counties that implemented smoking bans across multiple venues, and find that no declines were observed in counties with only one ban. In each of the estimates above, the authors control for state fixed effects, time fixed effects, county random effects, and hospital supply, but do not control for population or other time varying characteristics, making omitted variable bias more plausible.

The most recent study in the literature to control for state cigarette taxes measured the impact of comprehensive smoking bans across several hundred counties in the United States (Ho et al., 2016). The authors examined acute myocardial infarction hospitalizations, among others, with hip fracture diagnoses serving as the counterfactual condition, and counties with 10% to 75% of the population protected by smoke-free air legislation in a given year are excluded from the analysis. To control for cigarette prices, the state level cigarette tax rate is included as a covariate. While this likely reduces some omitted variable bias, it also imposes the assumption that each county within a state faces an identical cigarette tax rate. The results suggest that acute myocardial infarction events are unaffected by either smoke-free air legislation or increased state level cigarette taxes, and the findings are consistent across all age groups.

Several studies have examined smoking bans of reduced strength or limited scope. As is the case with comprehensive laws, these studies produce a wide range of findings, with some effects larger than those found resulting from comprehensive bans. The largest decline in hospitalizations resulted from a partial smoking ban in Bowling Green, Ohio (Khuder et al., 2007). While workplaces were required to go smoke-free, participation was optional for bars and restaurants. The authors report that hospitalizations for coronary heart disease, a broad category including angina, heart failure, atherosclerosis, and acute myocardial infarction, declined by 39% in the first year following the smoking ban and by 47% after three years. However, the findings are driven by the treatment date chosen in the study. Despite the law being enacted in March 2002, the authors define the treatment date as October 2002, and later report that hospitalizations initially increased until November 2002. Had the actual treatment date been used, the decline in hospitalizations would have been much smaller. This not only affected the findings of this study, but its inclusion in nearly every meta-analysis biases the average effect of smoking bans upward.

Broadening the scope of analysis, researchers included both comprehensive and qualified strength smoking bans, as well as examined a larger sample of mortality and hospitalization outcomes from across the United States (Shetty et al., 2011). Using data representing 60% of deaths among working age adults and 4% of hospitalizations, the authors were the first to control for state cigarette taxes, a likely source of omitted variable bias in previous research. The outcome variables of interest included the number of hospitalizations and deaths for acute myocardial infarction, asthma, and COPD, with hip fractures serving as the counterfactual condition. Results suggest that workplace restrictions led to a 2% decline in acute myocardial infarction hospitalizations and a 1.9% increase in deaths. For respiratory conditions, asthma and COPD hospitalizations declined 0.1% and 5%, respectively, though none of the above changes were statistically significant. Subgroup analysis by age reveals that for older adults, the presence of any smoking ban leads to a roughly 5% increase in acute myocardial infarction, asthma, and COPD hospitalizations. For working age adults, hospitalizations for each diagnosis declined modestly in response to smoke-free air laws. When including additional county level controls for the number of hospital beds per person and the number of physicians per person, workplace bans led to a 9.40% increase in acute myocardial infarction hospitalizations among working age adults. When the percent of the population in the labor force is subsequently included, the impact on acute myocardial infarction changes to a 6.59% decrease. The coefficient on the log of state cigarette taxes undergoes a similar movement, changing from a 0.10% increase to a 3.46% increase when the labor force covariate is included. Taken together with the slight increases observed across age groups and diagnoses, these results suggest that previous findings may not be representative of the general population.

Building on previous research by combining additional years of hospitalization data from New York, along with observations from Florida and Oregon, researchers examined the effect of comprehensive and moderate strength smoking bans among adults ages 35 and older (Loomis and Juster, 2012). Comprehensive laws were defined as those which banned smoking in all public locations, while moderate laws were those that covered workplaces but provided few protections in restaurants or bars. While Florida did not enact legislation covering bars, the authors defined the Florida law as comprehensive. After controlling for time fixed effects, seasonal fixed effects, and county by time fixed effects, the results suggest that comprehensive smoke-free air laws led to 15.5% and 18.4% fewer acute myocardial infarction hospitalizations in New York and Florida, respectively. In Oregon, the size and direction of the results depended on whether each smoking ban was interacted with a time variable. When presenting the percentage change in hospitalizations due to each law, the authors elected to only report those findings that were statistically significant. For acute cerebrovascular disease, hospitalizations declined by 18.1% in Florida but increased by an unknown amount in New York. Interestingly, when researchers revisited Florida's smoke-free air law to determine whether racial disparities exist in adult acute myocardial infarction hospitalizations, they find no decline for any age or race group during the post-ban period (Mead et al., 2016).

Similarly, in a follow-up study in Colorado, researchers examined the impact of a statewide smoking ban on the number of acute myocardial infarction hospitalizations (Basel et al., 2014). Despite the large declines found at the county level in previous research, no change was observed after the enactment of the state level law, and the results were consistent even when accounting for locations that had enacted previous legislation.

Kentucky has also been the focus of several studies at both the county and state level. A partial smoking ban in Lexington-Fayette County was used to measure changes in emergency department visits for asthma and hospitalizations for acute myocardial infarction (Rayens et al., 2008; Hahn et al., 2011). The first study reports a 24% decline in emergency department visits for asthma among all adults ages 20 and older, while the second finds a 23% decline in acute myocardial infarction hospitalizations among women. Additionally, recent research using statewide data has examined COPD hospitalizations and lung cancer incidence in response to comprehensive and moderate/weak smoke-free air laws (Hahn et al., 2014; Hahn et al., 2017). In these studies, comprehensive laws are defined as 100% smoking bans in workplaces and public places, while moderate laws are 100% smoking bans covering restaurants and bars but not all workplaces. The results suggest that comprehensive smoking bans led to 22% fewer COPD hospitalizations and 7.9% fewer cases of lung cancer, respectively, while moderate laws were associated with a 12% decline in COPD events.

Additional research has examined hospitalizations and emergency department visits for acute myocardial infarction, acute cerebrovascular disease, COPD, and asthma in Beaumont, Texas, and Olmstead County, Minnesota. During the two years following a local smoking ban in Texas, researchers find that hospitalizations for acute myocardial infarction and acute cerebrovascular disease decreased by 26% and 29%, respectively, and no change was observed for COPD or asthma (Head et al., 2012). In Minnesota, a smoking ban in 2002 prohibited smoking in restaurants, and in 2007 the legislation was extended to include workplaces and bars. This two part ban was used to assess the change in emergency department visits for asthma and COPD, hospitalizations for acute myocardial infarction, and out-of-hospital deaths due to coronary artery disease. After controlling for population, gender, and year, researchers found out-of-hospital deaths from coronary artery disease were unchanged after either law, and report a 34% decline in acute myocardial infarction hospitalizations after the 2007 law (Hurt et al., 2012). In a separate analysis, emergency department visits for asthma declined by 16% after the 2007 law, while no change was observed for COPD diagnoses (Croghan et al., 2015).

Nearly every study estimating the potential health benefits from increased cigarette taxes define the outcome variable in terms of the overall number of lives saved rather than attribute the effects to any particular disease. In studies that examine the impact of tobacco taxes on mortality rates for specific conditions, a 10% increase in the cigarette tax was found to reduce cardiovascular mortality by roughly 1.2% and lung cancer mortality by 4%. While these declines resulted in nearly 6,000 fewer deaths annually from 1954 through 1988, the author also found that bronchitis and hypertension mortality were unaffected by cigarette tax increases (Moore, 1996). Additionally, using state level data from 1970-2005, a lagged $1.00 increase in the tobacco tax was found to decrease lung cancer mortality by 15.7% but had no effect on heart disease and stroke (Bowser et al., 2014).

3.3 Relevant International Studies

Research examining the impact of local and national smoke-free air legislation has been conducted in many countries, including Canada, New Zealand, England, and Switzerland, among others. Similar to the overview of studies in the United States, the research described here is not an exhaustive review of the literature.

Two of the earliest studies on comprehensive smoking bans used legislative changes in England, and Christchurch, New Zealand, to examine acute myocardial infarction events before and after each law (Sims et al., 2010; Barnett et al., 2009). In New Zealand, the authors report a 5% decline in hospitalizations, and also stratified the results by age, gender, and smoking status. Surprisingly, the youngest age group, adults ages 30 to 54, saw a 6% increase among men, a 59% increase among women, and a 71% increase among non-smokers during the post-ban period. In England, a 2.4% decline in emergency room visits was observed after the implementation of the smoke-free air law.

In Uruguay, a 2006 law prohibiting smoking in workplaces, restaurants, and bars was examined to determine the health effects on adults ages 20 and older for up to four years after the law was enacted (Sebrie et al., 2014). After controlling for year and seasonal effects, acute myocardial infarction hospitalizations declined by 17%, but did not increase in sizes with the number of years since the legislation was enacted.

Declines of a similar magnitude were observed after a comprehensive law covering workplaces, restaurants, and bars was enacted in Ireland. In Cork and Kerry counties, hospitalizations for acute coronary syndrome were reduced by 12% in the year after the law took effect, and by 13% after three years (Cronin et al., 2012). Nationwide, among adults ages 20 to 60, asthma admissions declined by 40%, while COPD increased by 18%. For cardiovascular conditions, acute myocardial infarction and acute cerebrovascular disease declined by 11% and 7%, respectively. Despite the large changes in nearly every diagnosis, only asthma admissions were statistically significant (Kent et al., 2012). A national study of mortality rates displayed similar results for cardiovascular conditions, and the opposite effect for COPD. Deaths due to acute myocardial infarction and acute cerebrovascular disease declined by 11% and 32%, respectively, while COPD decreased by 38% (Stallings-Smith et al., 2013).

Similar to research in the United States, numerous studies have examined smoking bans of either reduced strength or limited scope. Several of the earliest international studies focused on a 2005 qualified smoking ban in Italy, and the subsequent changes in cardiovascular health at the regional and national level. In the Piedmont region of Italy, while acute myocardial infarction hospitalizations were unchanged in the overall population, researchers found an

11% decline among adults younger than age 60 (Barone-Adesi et al., 2006). In Rome, deaths and hospitalizations due to acute coronary syndrome declined by 11.2% among adults ages 35 to 64, 7.9% among adults ages 65 to 74, and no change was observed for adults ages 75 and older (Cesaroni et al., 2008).

These declines were less consistent when larger populations were analyzed. In the Piedmont, Friuli-Venezia Giulia, Lazio, and Campania regions of Italy, acute myocardial infarction hospitalizations declined by 14% among adults ages 40 to 64 (Vasselli et al., 2008). However, in a follow-up study at the national level, researchers find smaller effects, with acute coronary events declining 4% among adults younger than age 70, and no change among adults ages 70 and older. Similarly, acute myocardial infarction hospitalizations declined by 3% and increased 1% in each age group, respectively (Barone-Adesi et al., 2011). Another study in Tuscany, Italy, cites model specification as a possible source of bias in the literature. The authors report a 5.4% decline in acute myocardial infarction events, but note that no effect is found once non-linear time trends are included in the analysis (Gasparrini et al., 2009).

In Argentina, hospital admissions for acute coronary syndrome were examined in response to both comprehensive and qualified smoking bans enacted in 2006 (Ferrante et al., 2012). Much like previous research, this study focused on the short-term health effects, using two years of data prior to and following each smoking law. Results suggest that the comprehensive smoking ban in Santa Fe led to a 13% decline in acute coronary syndrome hospitalizations, while no change was observed after the qualified smoking law was enacted in Buenos Aires.

The first of two studies examining smoke-free air laws in Canada measured the effects of a three-part ban in Toronto on changes in hospitalizations for acute myocardial infarction, ischemic stroke, asthma, and COPD, among others, with appendicitis used as a counterfactual condition (Naiman et al., 2010). For COPD, observations represent adults ages 45 and older, while asthma hospitalizations represent individuals younger than age 65. The first phase of smoking restrictions was implemented in 1999 and prohibited smoking in workplaces, while the second phase extended to restaurants but included exemptions. Finally, in 2004, the third phase extended to bars but again included exemptions. The results suggest that the first phase of the ban had no impact on hospitalizations for acute myocardial infarction, ischemic stroke, asthma, or COPD. It was not until the second phase of the ban when hospitalizations declined for each diagnosis. During this phase, comparisons were made with the number of hospitalizations that occurred during the first phase of the smoking ban. This suggests that either restaurant bans are more effective at reducing hospitalizations than are workplace bans, or the results at least partially reflect a delayed benefit from the workplace ban. During the third phase, only acute myocardial infarction events declined.

The second Canadian study examined the impact of a qualified smoking restriction in Prince Edward Island (Gaudreau et al., 2013). Legislation was enacted in 2003, and allowed for exemptions in restaurants and bars until 2006. Researchers studied changes in the number of hospitalizations for acute myocardial infarction, acute cerebrovascular disease, COPD, asthma, as well as several counterfactual conditions including appendicitis. Data was analyzed from 1995 to 2008, providing six years of post-ban observations, the longest in the literature to date. The results suggest that among adults ages 35 and older, acute myocardial infarction events declined by 13.6% in the month following the smoking ban, and the decline increased to 23.9% six years later. No significant change was observed for acute cerebrovascular disease, COPD, or appendicitis in the month following the smoking restriction, while asthma diagnoses slightly increased but were not statistically significant. The authors note that when the law became comprehensive in 2006, there was no additional decline for any diagnoses.

3.4 Summary

The literature described above finds that smoking bans generally lead to fewer hospitalizations for cardiovascular and respiratory conditions, though individual estimates vary widely. Several meta-analyses summarizing the literature find the average decline in acute myocardial infarction hospitalizations to be 11% to 27%, and acute cerebrovascular disease to be 21% after the enactment of smoke-free air legislation (Lin et al. 2013; Lightwood and Glantz, 2009; Tan and Glantz, 2012; Meyers et al., 2009; Dinno and Glantz, 2007). While some find that the decline in acute myocardial infarction hospitalizations continues over time, another meta-analysis finds no additional change as the number of post-ban years increases (Meyers et al., 2009; Lightwood and Glantz, 2009; Mackay et al., 2010; Tan and Glantz, 2012; Jones et al., 2014). In studies that examined the more broadly defined category of acute coronary events, a 10% to 14% decline in hospitalizations was reported (Mackay et al., 2010; Jones et al., 2014). For respiratory conditions, adult asthma hospitalizations declined by 15% and COPD events by 20%, on average, after the implementation of smoke-free air legislation (Rando-Matos et al., 2017). While these meta-analyses describe generally consistent findings, the range of results in previous literature may be biased upwards, in part due to publication bias (Lin et al., 2013; Rando-Matos, 2017). Additionally, the large findings may be due to model specification and treatment date definitions used in the existing literature.

Many of the existing studies examined a limited population and controlled for few independent variables. Their findings, then, may not be representative of the general population and potentially suffer from omitted variable bias. If the counties that enact smoke-free air legislation are also those that implement cigarette taxes, failing to control for the price of cigarettes will likely introduce omitted variable bias. Because higher prices tend to reduce cigarette consumption and smoking prevalence, which in turn may lead to fewer hospitalizations, their omission attributes the impact of cigarette taxation to the smoke-free air policy. The result is smoke-free air laws appearing more effective at reducing hospitalizations than they actually are. Several studies attempt to improve their estimates by including controls for demographic characteristics, access to healthcare, or state level cigarette taxes. However, with many local and county municipalities free to impose additional cigarette taxes independent of the state government, controlling only for the state level cigarette tax is an imprecise measure of the actual cigarette price faced by consumers. While including the state level cigarette tax controls for a portion of the unobserved variation in tobacco control policies, it also imposes several assumptions. The first is that each county within a state faces the same cigarette tax, and the second is that individuals bordering states with lower cigarette taxes do not travel to purchase cigarettes in the cheaper state. If cross border cigarette sales occur and are driven by differences in price, an increase in the cigarette tax may not necessarily translate into a decrease in smoking prevalence, cigarette consumption, and improved health. This would both decrease the effectiveness of cigarette taxation as a tobacco control policy, as well as reduce the omitted variable bias discussed above. Despite these issues, in studies that control for state cigarette taxes, the observed declines in hospitalizations are markedly smaller than those found previously, and are generally not statistically significant (Shetty et al., 2010; Ho et al., 2016).

4 DATA AND VARIABLE CONSTRUCTION

4.1 Hospital Discharges

Hospital inpatient discharge data was obtained from individual state health departments, hospital associations, and the Healthcare Cost and Utilization Project. For each state, observations were restricted to in-state residents admitted to the hospital, regardless of discharge status. The dataset is further restricted to include only observations for adults ages 18 and older.[1]

Each primary diagnosis group is defined according to the Healthcare Cost and Utilization Project's Clinical Classification System (CCS), which aggregates individual primary diagnosis codes from the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) into larger, disease-specific groupings. The CCS and ICD-9-CM codes for each diagnosis are shown in Table I. Discharge counts for each diagnosis are aggregated by patient age group (18+, 18-64, 65+) to the county level, defined as patient county of residence using either Federal Information Processing Standards (FIPS) codes or patient ZIP code.

Due to data availability, not all states are represented each year from 1991-2014. Figure 6 details the number of states in the dataset by year, and

[1]Discharges from Oklahoma and West Virginia include counts for ages 15-17 and are assumed to equal zero.

Table II shows the number of hospitalizations per 100,000 population for each diagnosis among counties that did and did not implement a tobacco control policy at any time during the study period. A county is considered to have enacted a tobacco control policy if at least 50% of the county population is protected by smoke-free air legislation across four public venues, or if they have implemented a local cigarette tax. Comparisons are shown for both the first and final year of the study, and the balance of hospitalizations per 100,000 population vary by year and diagnosis group. In general, the hospitalization rates in policy and non-policy counties have smaller differences between them in 2014 than in 1991. In both 1991 and 2014, policy counties had lower hospitalizations rates for hypertension and tuberculosis than do non-policy counties.

4.2 Tobacco Control Policies and County Characteristics

Data detailing the enactment date and number of individuals protected by comprehensive smoke-free air legislation in bars, restaurants, public workplaces, and private workplaces was developed by the University of Illinois at Chicago Health Policy Center, using data from the US Census and the American Nonsmoker's Rights Foundation database (ANRF, 2017). Each venue-specific variable takes into account the proportion of the county protected by each law, and the percentage of the year that a law is in effect. For example, if a county enacts a comprehensive smoking ban covering all

Figure 6: Number of States in Dataset, 1991-2014

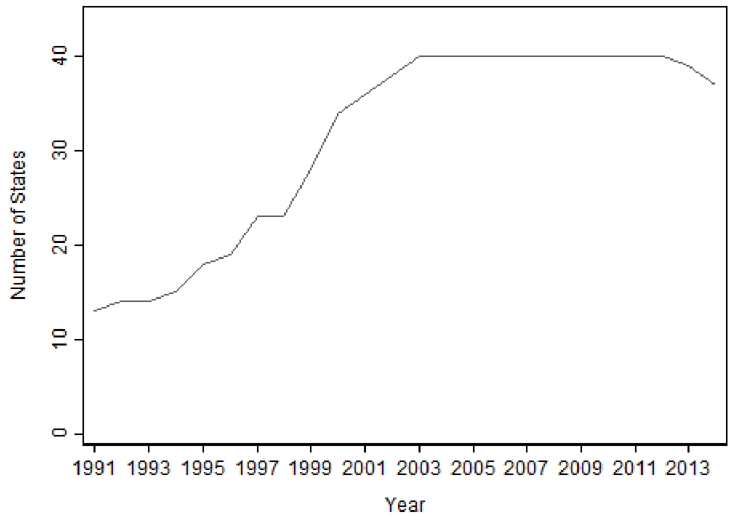


TABLE I: DIAGNOSES AND ICD-9-CM, CCS CODES

Diagnoses	ICD-9-CM Codes	CCS Codes
Cancer Diagnoses		
Lung Cancer	162.2-162.5, 162.8-162.9, 209.21, 231.2, V10.11	19
Breast Cancer	174.0-175.0, 175.9, 233.0, V10.3	24
Prostate Cancer	185, 233.4, V10.46	29
Cardiovascular Diagnoses		
Acute Myocardial Infarction	410.0-410.92	100
Coronary Atherosclerosis	411.0-414.06, 414.2-414.4, 414.8-414.9, V45.81-V45.82	101
Acute Cerebrovascular Disease	346.60-346.63, 430-432.1, 432.9-434.91, 436	109
Peripheral & Visceral Atherosclerosis	440.0-440.9, 443.9, 557.0, 557.1, 557.9	114
Artery Aneurysms	441.0-441.9, 442.0-442.9, 443.21-443.29, 447.70-447.73	115
Arterial Embolism	444.0-444.9, 445.01, 445.02, 445.81, 445.89	116
Hypertension	401.0-401.9, 402.00-405.99, 437.2	98, 99
Respiratory Diagnoses		
Tuberculosis	010.00-018.96, 137.0-137.4, V12.01	01
COPD	490-494.1, 496	127
Asthma	493.00-493.92	128
Counterfactual Diagnosis		
Appendicitis	540.0-540.9, 541, 542, 543.0, 543.9	142

TABLE II: HOSPITALIZATIONS PER 100,000 IN POLICY AND NON-POLICY COUNTIES

	1991		2014	
Variable	Non-Policy, Mean	Policy, Mean	Non-Policy, Mean	Policy, Mean
Cancer Diagnoses				
Lung Cancer	70.35	80.20	58.38	51.25
Breast Cancer	72.06	83.41	24.15	18.13
Prostate Cancer	55.92	71.49	25.78	26.51
Cardiovascular Diagnoses				
Acute Myocardial Infarction	248.54	350.49	308.93	274.38
Coronary Atherosclerosis	529.19	717.61	259.01	168.43
Acute Cerebrovascular Disease	246.10	236.99	287.59	241.30
Peripheral & Visceral Atherosclerosis	50.54	48.04	80.73	60.52
Artery Aneurysms	30.45	42.85	38.41	33.43
Arterial Embolism	39.01	44.82	14.47	12.19
Hypertension	191.01	81.37	257.21	88.84
Respiratory Diagnoses				
Tuberculosis	50.60	6.56	5.30	1.26
COPD	128.86	126.50	453.32	296.19
Asthma	113.34	126.33	98.01	70.67
Counterfactual Diagnosis				
Appendicitis	71.96	89.26	48.87	47.10

restaurants on January 1 of a given year, the percentage of the population protected by the restaurant ban equals 100% for that and all future years. If the county instead enacts the same legislation on July 1, the law would be in effect for one half of the year, and the restaurant ban would equal 50% for that year and 100% in all subsequent years.

Smoke-free air legislation is often enacted simultaneously in multiple venues, making it difficult to disentangle the individual effect of each law. In this study, a policy indicator is set equal to one when the simple average level of protection across all four venues is greater than or equal to 50%, and zero otherwise. However, using the simple average assigns an identical weight to each venue, and imposes the assumption that individuals are equally affected by a smoke-free air law in any venue. In reality, more time is likely spent in the workplace than in a bar or restaurant. Therefore, the impact of a public or private workplace ban is likely to be greater than a bar or restaurant ban. To more accurately reflect the difference in time spent in each venue, a second indicator variable is created. This weighted policy indicator is set equal to one for the years in which at least 50% of the county population is protected by smoke-free air legislation across all four venues, and zero otherwise, with twice the weight placed on laws covering public and private workplaces.

To separate out the immediate impact of smoke-free air legislation, which is typically estimated in the existing literature by examining a minimal number of post-ban observations, and the more long term effects, two indicator variables are created: *New Law*$_{it}$ and *Established Law*$_{it}$.[2] The former is an indicator variable equal to one for the first year in which the weighted average level of protection is at least 50% across all four venues, and zero otherwise. The latter is an indicator variable equal to one in all subsequent years, and zero otherwise. Finally, to capture the cumulative effects of smoke-free air legislation over time, two additional variables are created: *Years Since SFA*$_{it}$, which is equal to the number of years since smoke-free air legislation covering at least 50% of the population was enacted, and *Years Since SFA*$^2_{it}$, which is equal to the squared number of years since smoke-free air legislation covering at least 50% of the population was enacted.

County level cigarette tax data was constructed by the Institute for Health Research and Policy at the University of Illinois at Chicago, using state and federal tobacco tax data from the Tobacco Institute's *Tax Burden on Tobacco*, and county level tax data from the Campaign for Tobacco-Free Kids (Orzechowski and Walker, 2014; CTFK, 2017). Due to data limitations, only taxes greater than or equal to 5% of the total price are included in the dataset. The base price of a pack of cigarettes, without tax, is listed as of November 1 of each year, and these prices are then weighted to obtain the annual base price. Any federal, state, county, and local taxes are added to the annual base price, and are adjusted for the percentage of the year they are in effect. For example, if a county implements a $1.00 per pack tax on

[2] A similar estimation strategy was first implemented by Hahn et al. (2014).

cigarettes beginning on January 1 of a given year, the price of cigarettes for that and all future years includes the full $1.00 increase. If the same tax were implemented on July 1, the tax is in effect for only one half of the year, and the price of cigarettes would increase by $0.50 during the first year and $1.00 in all subsequent years. When local governments impose cigarette taxes independent of the county in which they reside, county residents face multiple cigarette prices. To account for this within-county variation in price, any taxes below the county level are weighted by the local town's share of the county population, and this weighted average is included in the county price.

When the real price of cigarettes is increased through a state or local tax, cigarette consumption is expected to decrease, leading to fewer hospitalizations for tobacco-related diagnoses. However, previous research suggests that having a source of low or untaxed cigarettes reduces the impact of cigarette price increases, as smoking cessation takes place less frequently when individuals can continue purchasing cigarettes cheaply (Hyland et al., 2006). If this occurs, cigarette consumption may decline by only a portion of the expected amount, leading to smaller declines in hospitalizations and the tax policy appearing less effective than anticipated. Therefore, controlling only for a county's own cigarette price may underestimate the true impact of a cigarette tax increase and bias the estimates toward zero. To account for possible tax avoidance behavior, county adjacency data from the US Census was obtained to generate corrected cigarette prices. The county adjacency dataset lists every county in the United States, paired with every county with whom it shares a border, both within the same state and across state lines. Following Chaloupka and Pacula (1999), a county's own cigarette price is included in each model, as well as a second variable representing the largest price difference between a county's own cigarette price and the lowest price of any neighboring county. A second measure to be used as a specification check follows Chaloupka (1991) by calculating the average cigarette price, equal to the simple average of a county's own cigarette price and the lowest price of any neighboring county. Finally, all cigarette prices are adjusted to 2014 dollars using Consumer Price Index (CPI) data from the Bureau of Labor Statistics.

To control for changes in county size and age composition, yearly population estimates for adults ages 18+, 18-64, and 65+ were obtained from CDC WONDER and the US Census American FactFinder. To control for economic characteristics, median household income data at the county level was collected from the Area Health Resources Files, and combined with CPI data to obtain the real median household income in 2014 dollars. The county level unemployment rate was obtained from the Bureau of Labor Statistics, and monthly estimates are aggregated to a yearly average for each county.

Annual concentrations of the pollutant $PM_{2.5}$ were collected from the EPA and the CDC Public Health Tracking Network. Outdoor air pollution is negatively correlated with tobacco control policies, and has been linked to increased cancer, cardiovascular, and respiratory events (Brook et al., 2010; Burnett et al., 1999; Kim et al., 2017). Hundreds of monitoring stations across the United States routinely measure concentrations of $PM_{2.5}$ in the atmosphere. For the years 1991-2010, monthly average estimates of the pollutant were obtained from the EPA, originally calculated as hourly pollution values derived from the Weather Research and Forecasting model and the Community Multiscale Air Quality model. The data encompass nearly 10.4 million square miles of North America, and both the Atlantic and Pacific oceans. This region was broken down into a grid comprised of 36km adjacent square zones, and matched with GPS data detailing the latitude and longitude of the four corner points and one central point of each zone. Additionally, GPS data detailing the central location of each county in the United States was obtained from the US Census, Geography Division. These datasets were merged, and the distance between the central point of each county and the central point of each 36km measurement zone was calculated. Counties were then assigned the average pollution value from the two closest 36km measurement zones.[3] The dataset was then collapsed by county and year to obtain the yearly average concentration of $PM_{2.5}$ in each county. For the years 2011-2014, data were obtained from the CDC Public Health Tracking Network, which utilizes EPA monitoring station information, and linear

[3]As a specification check, pollution values were assigned to counties based on the shortest distance between them but this did not impact the results.

interpolation was used to obtain estimates for counties without monitoring stations in 2013 and 2014.

Over the study period, limited pollution data was available for both Hawaii and Alaska. Monitoring stations differ in the particles they analyze, and $PM_{2.5}$ is not always measured. In both states, Air Quality Index (AQI) values and concentrations of $PM_{2.5}$, PM_{10}, and O_3 were collected from available monitoring stations.[4] Using EPA conversion charts, concentrations of O_3 were first converted to equivalent AQI values, then all AQI data were converted to concentrations of $PM_{2.5}$. Daily concentrations of PM_{10} were converted into corresponding units of $PM_{2.5}$ using a conservative conversion rate (HK EPD, 2012).[5]

Finally, the number of bars and restaurants in each county were obtained from the US Census, County Business Register. Establishments are defined according to either the Standard Industrial Classification (SIC) system or North America Industry Classification System (NAICS). Changes to the coding system occurred in 1997, 2002, 2007, and 2012, and US Census conversion files were used to translate updated codes to the earlier, more general SIC codes. This data is intended to control for the accessibility of each venue

[4] PM_{10} is any particle less than or equal to 10 micrometers in diameter, O_3 is the concentration of Ozone, and AQI is a standardized measure of pollution which can more easily be disseminated to the public.

[5] The conversion rate $PM_{2.5} = 0.75 * PM_{10}$ was used to translate PM_{10} concentrations into $PM_{2.5}$ estimates.

within a county. For example, if a county with many restaurants enacts a restaurant smoking ban, the impact may be greater than if an identical law were enacted in a county with relatively few restaurants.

5 METHODS

Previous research has generally employed either a Poisson, Negative Binomial, or Ordinary Least Squares estimation strategy to measure changes in the number of hospitalizations, deaths, or emergency department visits before and after smoke-free air legislation is enacted. For Negative Binomial models, estimation can be conducted using either the Conditional or Unconditional model. The Unconditional Negative Binomial model calculates a separate intercept term for each cluster, but potentially suffers from the incidental parameters problem that increases with the number of clusters. If the number of clusters is greater than 20, the Conditional model, which does not estimate a separate intercept term for each cluster, is preferred (Hilbe, 2011). However, the Conditional Negative Binomial model is not a true fixed effects model, and will assign a non-zero coefficient to variables with zero variation. With over 2,500 counties in this study, neither the Conditional nor Unconditional Negative Binomial models are a viable option.

Estimation with Ordinary Least Squares is another potential method, using either the log of the dependent variable to account for the non-negative number of hospitalizations, or by calculating the rate of hospitalizations per 100,000 population. Since the log of zero cannot be computed, the former method omits all observations equal to zero. In this study the percentage of observations equal to zero varies by diagnosis and are shown in Table III,

TABLE III: PERCENTAGE OF OBSERVATIONS EQUAL TO ZERO

Variable	Ages 18+	Ages 18-64	Ages 65+
Cancer Diagnoses			
Lung Cancer	5.75	16.48	8.48
Breast Cancer	9.55	17.71	18.55
Prostate Cancer	8.95	20.53	15.92
Cardiovascular Diagnoses			
Acute Myocardial Infarction	0.70	2.91	1.42
Coronary Atherosclerosis	0.73	2.32	1.45
Acute Cerebrovascular Disease	0.90	5.63	1.31
Peripheral & Visceral Atherosclerosis	4.99	14.84	7.14
Artery Aneurysms	11.27	33.14	14.70
Arterial Embolism	20.58	37.12	29.81
Hypertension	4.01	10.93	6.37
Respiratory Diagnoses			
Tuberculosis	68.24	74.86	80.62
COPD	1.35	5.05	1.95
Asthma	4.94	7.79	12.52
Counterfactual Diagnosis			
Appendicitis	4.89	5.83	29.52

ranging from 0.70% for acute myocardial infarction to 80.62% for tuberculosis discharges among adults ages 65 and older. A potential solution is to add a nominal value to each observation so that none are equal to zero prior to taking the log, but this makes interpretation more difficult (Wooldridge, 2010). Similarly, using the rate of hospitalizations per 100,000 population creates variables whose standard deviation is often greater than the mean, making it possible for predicted outcomes to assume negative values.

While overdispersion exists due to the panel structure of the data, it affects only the standard errors and has no impact on the coefficient estimates.

Scaling the standard errors by the dispersion statistic produces the standard errors that would have occurred if no overdispersion were present. These corrected standard errors are identical to robust standard errors, whose use relaxes the equidispersion assumption requiring the variance to equal the mean.

For these reasons, a Poisson model with robust standard errors is used to measure the effect of tobacco control policies on the number of hospitalizations in county i during year t for each primary diagnosis group and age subgroup. The estimating equation for Models 1 and 2 can be written as:

$$y_{it} = exp(\beta_1 SFA_{it} + \beta_2 CigPrice_{it} + \beta_3 X_{it} + \alpha_i + \mu_t + \epsilon_{it}) \qquad (1)$$

Where SFA_{it} is the smoke-free air indicator variable, $CigPrice_{it}$ is the real price of cigarettes including all taxes, and X_{it} are county level variables, including population, percent of the population that is non-white, real median household income, percent of the population that is unemployed, annual average concentration of $PM_{2.5}$, the number of bars per 1,000 population, and the number of restaurants per 1,000 population. Finally, α_i and μ_t are county and year fixed effects, respectively.

In Model 1, the smoke-free air indicator is equal to one when the simple average level of protection is at least 50% across all four venues, and zero otherwise. Model 2 is identical to Model 1 except the smoke-free air indicator is equal to one when the weighted average level of protection is at least 50% across all four venues, and zero otherwise.

Because the relative risk associated with smoking cessation for each disease declines over a period of several years, Model 2 is re-estimated using individual lags for each tobacco control policy and the pollution level for 2, 4, 6, and 8 years prior to the current period. Each lagged year is then entered into the model and estimated separately. This examines the extent to which smoke-free air legislation, cigarette prices, and pollution in previous years impact the number of hospitalizations for each diagnosis in a given year.

Much of the existing literature uses very few years of post-treatment data, with many studies examining just a single year when a smoking ban was in effect. To separate out the initial impact of smoke-free air legislation, which may be comparable with previous research, from any long-term effects, Model 3 is written as:

$$y_{it} = exp(\beta_1 NewLaw_{it} + \beta_2 EstablishedLaw_{it} + \beta_3 CigPrice_{it} + \beta_4 X_{it} + \alpha_i + \mu_t + \epsilon_{it}) \quad (2)$$

Where *New* Law_{it} is an indicator variable equal to one during the first year in which the weighted average level of protection is at least 50%, and zero otherwise, and *Established* Law_{it} is an indicator variable equal to one during all subsequent years of smoke-free air protection, and zero otherwise.

Each of the models presented thus far implicitly assumes the effect of smoke-free air legislation is constant over time; a smoking ban is assumed to be equally effective from years 2 to 3 as it is from years 9 to 10. To relax this assumption, equation (1) is modified as follows, and is estimated using Model 4:

$$y_{it} = exp(\beta_1 SFA_{it} + \beta_2 CigPrice_{it} + \beta_3 YearsSinceSFA_{it} + \beta_4 YearsSinceSFA_{it}^2 + \beta_5 X_{it} + \alpha_i + \mu_t + \epsilon_{it}) \quad (3)$$

This model uses the weighted average SFA_{it} indicator, with the additional variables *Years Since* SFA_{it} and *Years Since* SFA_{it}^2 to control for the cumulative effects of smoke-free air legislation over time. The remaining independent variables are identical to Models 1 through 3 in equations (1) and (2).

Subgroup analysis is then performed using Model 2 with the largest tobacco producing states in the country. As of 2012, the largest tobacco producers were North Carolina, Kentucky, Virginia, Tennessee, South Carolina, Georgia, and Pennsylvania (US Department of Agriculture, 2014). However, due to data availability, North Carolina is excluded from the analysis.

With many individual diagnosis groups, it may be difficult to determine the net effect of each tobacco control policy on human health. To better understand the overall effect, diagnosis groups are aggregated into larger cancer, cardiovascular, and respiratory categories, and the impact of each tobacco control policy is re-estimated using Model 2. Then, using the aggregated categories, the predicted number of hospitalizations are calculated under the current tobacco control policies in place, and then again assuming states had followed the Healthy People 2020 guideline to raise the cigarette tax by $1.50 per pack (USDHHS, 2011).[6] Finally, the difference in predicted outcomes is calculated from 2010-2014 to obtain the total number of hospitalizations that could have been avoided if this guideline was implemented by each state.

In each model above, the expected sign of the policy variables are less than one for all diagnoses except hypertension and appendicitis, which are ambiguous. The relative size of $\textit{New Law}_{it}$ and $\textit{Established Law}_{it}$ are ambiguous and depend on the level of immediate and delayed health effects. The linear variable $\textit{Years Since SFA}_{it}$ should be less than one if the health benefits of smoke-free air legislation increase over time, and the non-linear effect $\textit{Years Since SFA}^2_{it}$ is ambiguous and depends on the rate of change in each health outcome. The effect of $PM_{2.5_{it}}$ should be greater than one, as higher pollution levels are expected to lead to an increase in the number of hospitalizations for each diagnosis, while the remaining variables are each ambiguous.

[6] Among the states in this study, only Minnesota was compliant with this guideline, beginning in 2013. This compliance was accounted for when calculating the predicted values.

Table IV shows the observable characteristics of counties that are included in the dataset and of counties whose hospitalization data were unavailable for inclusion in this study. The observable characteristics between each group are similar in both 1991 and 2014, with the exception of the population that is non-white in 2014. This similarity reduces concerns that selection into the study is in some way non-random.

Another concern is that locations enacting smoke-free air legislation or implementing a cigarette tax might be different from those that elect not to implement tobacco control policies. Table V displays the observable characteristics of counties in 1991 and 2014 that enact either smoke-free air legislation covering at least 50% of the population, or implement a local cigarette tax at any time during the study period. In 1991, counties that at any point enact a tobacco control policy have a lower percentage of the population that is non-white (5.60% vs. 17.29%), slightly greater concentrations of the pollutant $PM_{2.5}$ (14.27 vs. 9.64), and roughly twice as many bars per 1,000 population (0.45 vs. 0.26). In 2014 these same differences exist, with non-policy counties having a larger percentage of the population that is non-white (16.55% vs. 9.37%), fewer bars per 1,000 population (0.07 vs. 0.30), and slightly lower real median household income (43.68 vs. 49.03). The remaining observable characteristics are essentially unchanged between groups, reducing concern that some unobservable characteristic differs between the treatment and control groups.

TABLE IV: CHARACTERISTICS OF INCLUDED, OMITTED COUNTIES

	1991		2014	
Variable	Omitted Counties, Mean	Included Counties, Mean	Omitted Counties, Mean	Included Counties, Mean
Percent of Population				
Ages 18+	100.00	100.00	100.00	100.00
Ages 18-64	80.09	79.33	77.69	77.35
Ages 65+	19.91	20.67	22.31	22.65
Real Cigarette Price	0.95	0.98	5.80	5.72
$PM_{2.5}$ Concentration	13.29	12.76	8.48	8.16
Percent of Population, Non-White	14.68	7.94	18.14	11.81
Unemployment Rate	7.34	7.06	6.37	6.23
Real Median HHI (in thousands)	14.59	14.77	45.74	47.44
Number of Bars per 1,000	0.33	0.27	0.29	0.21
Number of Restaurants per 1,000	1.42	1.41	2.09	2.02

TABLE V: CHARACTERISTICS OF POLICY AND NON-POLICY COUNTIES

	1991		2014	
Variable	Non-Policy, Mean	Policy, Mean	Non-Policy, Mean	Policy, Mean
Percent of Population				
Ages 18+	100.00	100.00	100.00	100.00
Ages 18-64	82.56	79.73	77.92	76.98
Ages 65+	17.44	20.27	22.08	23.02
Real Cigarette Price	1.01	1.02	4.97	6.00
$PM_{2.5}$ Concentration	9.64	14.27	8.15	8.42
Percent of Population, Non-White	17.29	5.60	16.55	9.37
Unemployment Rate	8.56	8.11	7.03	6.00
Real Median HHI (in thousands)	16.36	16.50	43.68	49.03
Number of Bars per 1,000	0.26	0.45	0.07	0.30
Number of Restaurants per 1,000	1.50	1.56	1.71	2.17

Another potential source of bias stems from the possibility that individuals sort to counties based on personal characteristics that also impact the treatment variable. Relocation to a county may occur either before or after the passage of a smoke-free air law based on some observable or unobservable characteristics. To alleviate concerns that sorting is driving the decision to enact legislation, Table VI displays the average observable characteristics among treated counties one year prior to and one year following the enactment of smoke-free air legislation. With the exception of real median household income, each variable is essentially unchanged before and after a county enacts smoke-free air legislation covering at least 50% of the population. Because the observable characteristics are unchanged around the treatment variable, it is less likely that sorting occurs based on either observable or unobservable characteristics.

While this table alleviates concerns surrounding sorting into counties, it also suggests that previous research omitting the county level cigarette price may have upwardly biased estimates of the impact of smoke-free air legislation. This is because the real cigarette price is increasing during this same time. With counties simultaneously enacting smoking bans and cigarette taxation, failing to control for the county level cigarette price will assign the impact of the taxation policy onto the smoking ban variable.

TABLE VI: COUNTY CHARACTERISTICS, PRE- AND POST-SFA LEGISLATION (1 YEAR)

Variable	Pre-SFA Law, Mean	Post-SFA Law, Mean
Percent of Population		
Ages 18+	100.00	100.00
Ages 18-64	79.37	78.98
Ages 65+	20.63	21.02
Real Cigarette Price	3.83	4.47
$PM_{2.5}$ Concentration	9.49	8.89
Percent of Population, Non-White	8.33	8.60
Unemployment Rate	6.01	7.06
Real Median HHI (in thousands)	36.60	39.60
Number of Bars per 1,000	0.36	0.34
Number of Restaurants per 1,000	2.14	2.11

5.1 Sensitivity Tests

The first specification test uses Model 2 to estimate the impact of smoke-free air legislation on each diagnosis when including incrementally more covariates. If the results are consistent as observable characteristics are added, this provides support for the assumption that they would remain consistent if some unobservable covariate were included. All models control for population, county and year fixed effects, and use robust standard errors. First, the only independent variables included are county population and each set of fixed effects, followed by county population, fixed effects, plus the full set of county covariates, and finally county population, fixed effects, the county covariates, and the county level real cigarette price. The coefficients on smoke-free air legislation are expected to be slightly smaller across each column as additional controls are included. Additionally, this should provide some insight into the level of bias present in the existing literature that does not control for the county level real cigarette price.

The second specification test uses various measures of the cigarette price to test the robustness of the results across each definition. In this study, a county's own cigarette price is included in each model, along with the largest difference between a county's own price and the lowest price in any neighboring county. Model 2 is re-estimated using the following definitions of the cigarette price: (1) a county's own cigarette price, (2) a county's own cigarette price, plus a second variable capturing the price differential (the default measurement), and (3) the simple average of a county's own cigarette price and the lowest price of any neighboring county. If individuals purchase cigarettes in a nearby county for a lower price to avoid the tax in their home county, this will cause the estimates of (1), a county's own cigarette price, to be biased downward toward zero and smaller than estimates in both (2) and (3). The relative difference between estimates using definitions (2) and (3) are ambiguous.

Next, the sensitivity of the results to the assumption that a county is considered protected when at least 50% of the population is covered by a smoking ban across all four venues is tested. Model 2 is re-estimated under the alternative assumptions that a county is considered protected by smoke-free air legislation when the average level of protection covers at least 25%, 50% (the default assumption), 75%, and 100% of the population across all four venues. If the changes in hospitalizations are similar under the 25% assumption, this would suggest that some health benefits accrue from the passage of a smoking ban in only one public venue. Similarly, if null findings at lower levels of protection become significant at the 75% or 100% level, this would suggest that the health benefits of a smoking ban either occur only when they cover all public places, or are at least partially driven by delayed effects from earlier single-venue bans.

Implicit in each model is the assumption that informal smoking bans or bans covering less than 50% of the population across all four venues did not exist prior to the observed start date in the dataset. If such bans did exist, and led to measurable improvements in health, the smoke-free air indicator variable will not fully capture the effect of these laws. This is because a county will have begun to benefit from the resulting decline in smoking prevalence, cigarette consumption, and reduced exposure to secondhand smoke prior to the observed treatment date. To test for the extent to which outcome variables change prior to the treatment date, Model 2 is re-estimated using individual indicator variables for each year prior to and following the enactment of a smoking ban. The policy indicators for the four years leading up to the enactment of smoke-free air legislation are presented in tables. The coefficient estimates and 95% confidence intervals are also shown graphically using four years prior to and 10 years following the enactment of a smoking ban. Because the 50% leading indicators may be reflecting the impact of single-venue bans prior to their expansion into additional venues, this exercise is repeated under the alternative assumption that a county is considered protected by smoke-free air legislation when the average level of protection across all four venues is at least 25%.

Finally, with a large number of diagnoses, it is increasingly likely that a tobacco control policy will appear to be statistically significant by chance alone. Several corrective methods exist to account for multiple hypothesis testing, and each involves either changing the p-values of the relevant estimates or reducing the critical value. While the existing smoke-free air literature does not typically adjust for multiple comparisons, both the Bonferroni method and the Hochberg method have been used in previous research. The Bonferroni method is based on the number of regressions used, and is considered a conservative approach that may lead to many false negatives. The relevant Bonferroni-adjusted critical values account for the number of regressions estimated in Model 2, which include 14 separate diagnoses across three age groups, resulting in 39 total tests. A comparison of the original p-values from Model 2 are presented alongside the Bonferroni-adjusted critical values, as well as adjusted p-values, termed q-values, obtained using two methods developed in Benjamini and Hochberg (1995) and Benjamini, Krieger, and

Yekutieli (2006).[7] Each method is less stringent than the Bonferroni adjustment, and is more likely to result in a number of false positives.

[7]These procedures are described in Anderson (2008), and were implemented using Stata do files from the author.

6 RESULTS

Results of Model 1 are shown in Tables VII through X for each diagnosis and age group. For cancer diagnoses, the results suggest that after controlling for county level characteristics, county fixed effects, and year fixed effects, comprehensive smoke-free air legislation leads to a statistically significant decline in breast cancer hospitalizations for all adults (4.7%), working age adults (3.9%), and adults ages 65 and older (5.2%). Contrary to previous research which finds larger declines among pre-menopausal women, this suggest that older adults are impacted more by smoke-free air legislation than are working age adults. Additionally, a $1.00 increase in the real cigarette price leads to a 3.4% decline in breast cancer hospitalizations among all adults, and also a statistically significant decline of 5.1% among older adults. While lung cancer and prostate cancer hospitalizations are unaffected by smoking bans in this model, an increase in the real cigarette price leads to 6.7% fewer prostate cancer hospitalizations among adults ages 65 and older.

For cardiovascular conditions, smoke-free air legislation has little impact on hospitalizations across diagnoses and age groups. Acute myocardial infarction and acute cerebrovascular disease each decline roughly 1%, but neither are statistically significant. The exceptions are hospitalizations for artery aneurysms and hypertension, which decline 2.7% among older adults and increase 10.5% among all adults, respectively. While an increase in the

TABLE VII: MODEL 1 - CANCER HOSPITALIZATIONS[a,b]

Variables	Ages 18+	Ages 18-64	Ages 65+
Lung Cancer			
SFA Laws	1.019	1.021	1.013
	(0.014)	(0.015)	(0.013)
Real Cigarette Price	0.991	0.979	0.994
	(0.013)	(0.013)	(0.013)
Breast Cancer			
SFA Laws	0.953***	0.961*	0.948**
	(0.014)	(0.015)	(0.015)
Real Cigarette Price	0.966*	0.978	0.949**
	(0.015)	(0.016)	(0.016)
Prostate Cancer			
SFA Laws	1.019	1.032	0.989
	(0.017)	(0.017)	(0.019)
Real Cigarette Price	0.975	1.008	0.933***
	(0.016)	(0.016)	(0.018)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

real cigarette price leads to a greater number of hospitalizations for peripheral and visceral atherosclerosis, and acute cerebrovascular disease among older adults, statistically significant declines are observed for both coronary atherosclerosis and hypertension across all age groups, as well as for artery aneurysms among adults ages 65 and older. For coronary atherosclerosis, an identical decline of 6.1% is observed across each age subgroup, while the largest declines of 16.2% to 17.5% occur for hypertension. Among older adults, a $1.00 increase in the real cigarette price leads to a 2.4% decline in artery aneurysms. Similarly, COPD and asthma are unaffected by the enactment of comprehensive smoking-free air legislation, while tuberculosis

TABLE VIII: MODEL 1 - CARDIOVASCULAR HOSPITALIZATIONS[a,b]

Variables	Ages 18+	Ages 18-64	Ages 65+
Acute Myocardial Infarction			
SFA Laws	0.989	1.001	0.985
	(0.010)	(0.009)	(0.011)
Real Cigarette Price	1.001	0.993	1.008
	(0.010)	(0.010)	(0.011)
Coronary Atherosclerosis			
SFA Laws	1.006	1.016	0.998
	(0.017)	(0.015)	(0.018)
Real Cigarette Price	0.939***	0.939***	0.939***
	(0.015)	(0.015)	(0.016)
Acute Cerebrovascular Disease			
SFA Laws	0.984	1.001	0.981
	(0.012)	(0.011)	(0.011)
Real Cigarette Price	1.022	1.012	1.028*
	(0.013)	(0.011)	(0.013)
Peripheral & Visceral Atherosclerosis			
SFA Laws	1.012	1.010	1.012
	(0.014)	(0.014)	(0.013)
Real Cigarette Price	1.039**	1.031*	1.042**
	(0.015)	(0.015)	(0.014)
Artery Aneurysms			
SFA Laws	0.981	0.997	0.973*
	(0.011)	(0.012)	(0.010)
Real Cigarette Price	0.985	0.992	0.976*
	(0.009)	(0.012)	(0.009)
Arterial Embolism			
SFA Laws	1.004	1.023	0.997
	(0.016)	(0.017)	(0.016)
Real Cigarette Price	0.984	0.968	0.991
	(0.017)	(0.018)	(0.017)
Hypertension			
SFA Laws	1.105*	1.107*	1.094
	(0.050)	(0.047)	(0.052)
Real Cigarette Price	0.838***	0.857**	0.825***
	(0.044)	(0.044)	(0.043)

*$p<0.05$, **$p<0.01$, ***$p<0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE IX: MODEL 1 - RESPIRATORY HOSPITALIZATIONS[a,b]

Variables	Ages 18+	Ages 18-64	Ages 65+
Tuberculosis			
SFA Laws	0.844**	0.790**	0.913**
	(0.047)	(0.060)	(0.028)
Real Cigarette Price	0.930*	0.955	0.887***
	(0.031)	(0.034)	(0.025)
COPD			
SFA Laws	1.013	1.023	1.009
	(0.013)	(0.015)	(0.012)
Real Cigarette Price	1.016	1.038*	1.010
	(0.014)	(0.016)	(0.013)
Asthma			
SFA Laws	1.006	1.016	0.986
	(0.014)	(0.016)	(0.015)
Real Cigarette Price	1.005	1.004	1.019
	(0.014)	(0.017)	(0.016)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE X: MODEL 1 - COUNTERFACTUAL HOSPITALIZATIONS[a,b]

Variables	Ages 18+	Ages 18-64	Ages 65+
Appendicitis			
SFA Laws	0.981	0.982	0.995
	(0.015)	(0.016)	(0.014)
Real Cigarette Price	0.993	0.993	0.993
	(0.012)	(0.013)	(0.011)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

hospitalizations decline by 15.6%, 21%, and 8.7% among adults ages 18 and older, ages 18 to 64, and ages 65 and older, respectively. An increase in the real cigarette price leads to a 7% decrease in tuberculosis hospitalizations among adults ages 18 and older, and leads to a 3.8% increase in COPD events among working age adults. This latter change in not large enough, however, to significantly increase hospitalizations among all adults. As expected, the counterfactual condition appendicitis is not affected by either tobacco control policy for any age group.

Model 2 estimates the effect of tobacco control policies using the weighted average smoke-free air indicator. Results in Tables XI through XIV are largely consistent with estimates from Model 1. The declines in breast cancer are 3.6% among all adults, 2.6% among working age adults, and 4.7% among older adults, though the findings for working age adults are not statistically significant. Here, the declines in breast cancer hospitalizations resulting from smoke-free air laws are slightly smaller than those in Model 1, suggesting that the benefits may arise more from smoking bans in restaurants and bars rather than those in workplaces, which received increased weight in this model. A $1.00 increase in the real cigarette price leads to a 3.5% decline in breast cancer hospitalizations among all adults, and a 5.1% decline among adults ages 65 and older. Similarly, prostate cancer discharges decline by 6.8% among older adults but are relatively unchanged among working age adults. Lung cancer hospitalizations are again essentially unchanged, despite the

TABLE XI: MODEL 2 - CANCER HOSPITALIZATIONS[a,b]

Variables	Ages 18+	Ages 18-64	Ages 65+
Lung Cancer			
SFA Laws, Weighted	1.023	1.022	1.017
	(0.014)	(0.015)	(0.013)
Real Cigarette Price	0.991	0.979	0.993
	(0.013)	(0.013)	(0.013)
Breast Cancer			
SFA Laws, Weighted	0.964**	0.974	0.953**
	(0.013)	(0.015)	(0.015)
Real Cigarette Price	0.965*	0.976	0.949**
	(0.015)	(0.016)	(0.016)
Prostate Cancer			
SFA Laws, Weighted	1.025	1.041*	0.993
	(0.016)	(0.017)	(0.018)
Real Cigarette Price	0.974	1.007	0.932***
	(0.016)	(0.016)	(0.018)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

modest decline of 2.1% among working age adults after an increase in the cigarette price. Contrary to the results of Model 1, prostate cancer diagnoses among working age adults increase by 4.1% after the enactment of smoke-free air legislation in this specification.

Results for cardiovascular and respiratory diagnoses are consistent with those in Model 1. After a smoke-free air law is enacted, artery aneurysms for adults ages 65 and older decrease by 2.2%, while hypertension events increase by 11% among all adults. The changes in acute cerebrovascular disease hospitalizations are not significantly different from zero, though there is

TABLE XII: MODEL 2 - CARDIOVASCULAR HOSPITALIZATIONS[a,b]

Variables	Ages 18+	Ages 18-64	Ages 65+
Acute Myocardial Infarction			
SFA Laws, Weighted	0.991	1.002	0.987
	(0.010)	(0.009)	(0.011)
Real Cigarette Price	1.000	0.993	1.008
	(0.010)	(0.010)	(0.011)
Coronary Atherosclerosis			
SFA Laws, Weighted	1.010	1.019	1.003
	(0.017)	(0.015)	(0.017)
Real Cigarette Price	0.939***	0.939***	0.938***
	(0.015)	(0.015)	(0.016)
Acute Cerebrovascular Disease			
SFA Laws, Weighted	0.986	1.003	0.983
	(0.012)	(0.011)	(0.011)
Real Cigarette Price	1.022	1.012	1.027*
	(0.013)	(0.011)	(0.013)
Peripheral & Visceral Atherosclerosis			
SFA Laws, Weighted	1.014	1.010	1.014
	(0.013)	(0.014)	(0.013)
Real Cigarette Price	1.039**	1.031*	1.042**
	(0.015)	(0.015)	(0.014)
Artery Aneurysms			
SFA Laws, Weighted	0.987	1.005	0.978*
	(0.011)	(0.012)	(0.010)
Real Cigarette Price	0.985	0.991	0.976*
	(0.009)	(0.012)	(0.009)
Arterial Embolism			
SFA Laws, Weighted	1.011	1.023	1.005
	(0.016)	(0.017)	(0.016)
Real Cigarette Price	0.983	0.968	0.990
	(0.017)	(0.018)	(0.017)
Hypertension			
SFA Laws, Weighted	1.110*	1.106*	1.101*
	(0.048)	(0.045)	(0.050)
Real Cigarette Price	0.838***	0.857**	0.825***
	(0.043)	(0.043)	(0.043)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XIII: MODEL 2 - RESPIRATORY HOSPITALIZATIONS[a,b]

Variables	Ages 18+	Ages 18-64	Ages 65+
Tuberculosis			
SFA Laws, Weighted	0.907*	0.872*	0.941*
	(0.037)	(0.047)	(0.024)
Real Cigarette Price	0.913**	0.933*	0.880***
	(0.029)	(0.031)	(0.025)
COPD			
SFA Laws, Weighted	1.014	1.022	1.011
	(0.013)	(0.015)	(0.012)
Real Cigarette Price	1.015	1.038*	1.010
	(0.014)	(0.016)	(0.013)
Asthma			
SFA Laws, Weighted	1.005	1.014	0.986
	(0.014)	(0.016)	(0.015)
Real Cigarette Price	1.005	1.004	1.019
	(0.014)	(0.017)	(0.016)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XIV: MODEL 2 - COUNTERFACTUAL HOSPITALIZATIONS[a,b]

Variables	Ages 18+	Ages 18-64	Ages 65+
Appendicitis			
SFA Laws, Weighted	0.980	0.979	1.003
	(0.014)	(0.014)	(0.013)
Real Cigarette Price	0.994	0.993	0.992
	(0.012)	(0.013)	(0.011)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

a slight 1.4% decline among all adults and a 1.7% decline among adults ages 65 and older. For tuberculosis, discharges decrease by 9.3% among all adults, 12.8% among working age adults, and 5.9% among older adults. While significant, these declines are also smaller than those in Model 1, suggesting the relative weight placed on workplace bans does not translate into greater improvements in respiratory health. The impact of a $1.00 increase in the real cigarette price remains essentially unchanged from Model 1, leading to declines in and coronary atherosclerosis, hypertension, and tuberculosis hospitalizations, while slightly increasing the number of peripheral and visceral atherosclerosis events. Appendicitis hospitalizations again remain unaffected by either the enactment of smoke-free air legislation or an increase in the real cigarette price.

Comparing the results of Model 2 with those of Model 1 suggests that the additional weight placed on smoke-free air legislation in public and private workplaces leads to slightly smaller changes in the number of hospitalizations for each diagnosis. This suggests that the benefits of smoke-free air legislation may arise more from bar and restaurant bans than from those occurring in workplaces over this time period. Whether this is due to informal workplace bans enacted prior to legislative smoking bans is unknown but remains a plausible explanation.

Tables XV through XVIII show the impact of previous tobacco control policies and pollution levels on the current number of hospitalizations for all adults ages 18 and older. Lags for 2, 4, 6, and 8 years were entered in the model individually. The impact of smoke-free air legislation on cancer diagnoses is largely ineffective over the lags shown here, yet generally trends in the correct direction. Due to the increased lung cancer risk among current and former smokers that persists for up to 40 years after smoking cessation, it is not surprising that hospitalizations have yet to exhibit large declines. Breast cancer hospitalizations decline by 2.3% in the current period as a result of the smoke-free air legislation in place two years prior, while prostate cancer hospitalizations decline slightly as the lagged years increase. The lagged impact from an increase in the real cigarette price is slightly more effective at reducing cancer hospitalizations in the current period than are smoke-free air laws. Lung cancer hospitalizations declined for each lagged value, ranging from 0.7% after two years to a statistically significant decline of 3.2% after six years. For breast cancer, the effect is generally consistent for two to six years after a price change, with hospitalizations declining up to 5.1%. Prostate cancer follows a similar trend with increasing lags, as declines range from 2.9% to 4.2%.

For cardiovascular hospitalizations shown in Table XVI, smoke-free air laws continues to have no effect on most diagnoses. Hypertension hospitalizations increase as a result of smoking bans in previous years, while peripheral and visceral atherosclerosis diagnoses increase 5.5% after an eight year lag. An increase in the lagged cigarette price now leads to declines in coro-

TABLE XV: LAGGED COEFFICIENTS AND CANCER HOSPITALIZATIONS, AGES 18+[a,b]

Variables	Lag=2	Lag=4	Lag=6	Lag=8
Lung Cancer				
SFA Laws, Weighted	1.011	1.015	1.011	1.009
	(0.013)	(0.013)	(0.013)	(0.014)
Real Cigarette Price	0.993	0.984	0.968*	0.982
	(0.014)	(0.014)	(0.015)	(0.016)
Breast Cancer				
SFA Laws, Weighted	0.977	0.989	0.981	1.040
	(0.015)	(0.017)	(0.019)	(0.023)
Real Cigarette Price	0.957*	0.952**	0.949*	1.000
	(0.017)	(0.017)	(0.021)	(0.027)
Prostate Cancer				
SFA Laws, Weighted	1.009	0.990	0.995	0.983
	(0.017)	(0.019)	(0.023)	(0.032)
Real Cigarette Price	0.971	0.974	0.963	0.958
	(0.017)	(0.018)	(0.022)	(0.025)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

nary atherosclerosis, artery aneurysms, arterial embolism, and hypertension, while peripheral and visceral atherosclerosis continue to increase over time. Finally, acute cerebrovascular disease initially increases by 2.4%, though the number of hospitalizations trends downward over time and eventually declines by 2.4%.

For respiratory conditions, the impact of smoke-free air legislation increases over time, though in the wrong direction. COPD hospitalizations increase by 1.9% as a result of the smoking bans in place two years prior, and by 8.2% when estimates with an eight year lag. Similarly, asthma hos-

TABLE XVI: LAGGED COEFFICIENTS AND CARDIOVASCULAR HOSPITALIZATIONS, AGES 18+[a,b]

Variables	Lag=2	Lag=4	Lag=6	Lag=8
Acute Myocardial Infarction				
SFA Laws, Weighted	0.993	0.992	0.991	0.977
	(0.011)	(0.012)	(0.013)	(0.015)
Real Cigarette Price	0.999	0.993	0.973*	0.965**
	(0.010)	(0.009)	(0.011)	(0.013)
Coronary Atherosclerosis				
SFA Laws, Weighted	0.993	0.979	0.991	1.009
	(0.017)	(0.015)	(0.016)	(0.019)
Real Cigarette Price	0.940***	0.944**	0.937***	0.923***
	(0.016)	(0.018)	(0.018)	(0.017)
Acute Cerebrovascular Disease				
SFA Laws, Weighted	0.996	1.000	1.011	1.014
	(0.010)	(0.010)	(0.011)	(0.012)
Real Cigarette Price	1.024*	1.013	0.988	0.976
	(0.012)	(0.012)	(0.014)	(0.015)
Peripheral & Visceral Atherosclerosis				
SFA Laws, Weighted	1.022	1.018	1.023	1.055**
	(0.012)	(0.013)	(0.016)	(0.021)
Real Cigarette Price	1.036*	1.050***	1.062**	1.082***
	(0.014)	(0.016)	(0.020)	(0.019)
Artery Aneurysms				
SFA Laws, Weighted	0.994	0.995	0.997	0.968
	(0.012)	(0.012)	(0.012)	(0.017)
Real Cigarette Price	0.968**	0.950**	0.914***	0.925**
	(0.011)	(0.015)	(0.023)	(0.024)
Arterial Embolism				
SFA Laws, Weighted	1.014	1.004	1.003	0.979
	(0.015)	(0.016)	(0.018)	(0.023)
Real Cigarette Price	0.975	0.969	0.964	0.976
	(0.017)	(0.018)	(0.020)	(0.023)
Hypertension				
SFA Laws, Weighted	1.096**	1.077**	1.068***	1.098***
	(0.035)	(0.025)	(0.019)	(0.022)
Real Cigarette Price	0.883***	0.920**	0.933*	0.962
	(0.033)	(0.028)	(0.028)	(0.029)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XVII: LAGGED COEFFICIENTS AND RESPIRATORY HOSPITALIZATIONS, AGES 18+[a,b]

Variables	Lag=2	Lag=4	Lag=6	Lag=8
Tuberculosis				
SFA Laws, Weighted	0.919*	0.953*	0.991	1.046
	(0.033)	(0.022)	(0.021)	(0.024)
Real Cigarette Price	0.927*	0.939	0.976	0.983
	(0.030)	(0.032)	(0.037)	(0.038)
COPD				
SFA Laws, Weighted	1.019	1.032*	1.057***	1.082***
	(0.013)	(0.014)	(0.015)	(0.019)
Real Cigarette Price	1.018	1.004	0.978	0.964
	(0.015)	(0.016)	(0.019)	(0.020)
Asthma				
SFA Laws, Weighted	1.021	1.046**	1.075***	1.110***
	(0.014)	(0.014)	(0.016)	(0.021)
Real Cigarette Price	1.010	1.004	0.992	0.990
	(0.015)	(0.016)	(0.018)	(0.021)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XVIII: LAGGED COEFFICIENTS AND COUNTERFACTUAL HOSPITALIZATIONS, AGES 18+[a,b]

Variables	Lag=2	Lag=4	Lag=6	Lag=8
Appendicitis				
SFA Laws, Weighted	0.986	0.989	1.001	0.984
	(0.014)	(0.016)	(0.021)	(0.031)
Real Cigarette Price	0.999	0.982	0.942**	0.948*
	(0.013)	(0.014)	(0.021)	(0.022)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

pitalizations increase from 2.1% to 11% over the lagged period shown here. While these findings are consistent with several previous studies showing an increase in respiratory events after the implementation of smoke-free air legislation, it is unclear what mechanism is driving these changes. Also, the health benefits appear to diminish for tuberculosis, which declines by 8.1% in response to the two year lagged smoke-free air indicator, but disappears as the lag increases to eight years. However, the lagged effect of a $1.00 increase in the real cigarette price trends in the correct direction, reducing the number of hospitalizations for each diagnosis at a larger rate for each lag. Finally, while appendicitis hospitalizations are unaffected by any lagged smoking ban, the real cigarette price does lead to statistically significant declines for lags six and eight.

The effects of previous tobacco control policies on hospitalizations for working age adults are shown in Tables XIX through XXII. The lagged effects of smoke-free air laws are cigarette prices are similar to the changes in hospitalizations among all adults ages 18 and older. Prostate cancer diagnoses trend downward as a result of lagged smoke-free air legislation and cigarette price increases, while lung cancer diagnoses decline by 4.6% and 4.8% as a result of a $1.00 increase in the real cigarette price six and eight years prior, respectively. Previous smoking bans generally do not affect breast cancer hospitalizations until the eighth lag, while consistent declines are observed in response to an earlier change in the real cigarette price.

TABLE XIX: LAGGED COEFFICIENTS AND CANCER HOSPITALIZATIONS, AGES 18-64[a,b]

Variables	Lag=2	Lag=4	Lag=6	Lag=8
Lung Cancer				
SFA Laws, Weighted	1.004	1.001	0.999	1.029
	(0.012)	(0.012)	(0.013)	(0.017)
Real Cigarette Price	0.979	0.975	0.954**	0.952**
	(0.014)	(0.013)	(0.015)	(0.016)
Breast Cancer				
SFA Laws, Weighted	0.996	1.016	0.999	1.047*
	(0.017)	(0.018)	(0.018)	(0.025)
Real Cigarette Price	0.962*	0.951**	0.947*	1.004
	(0.018)	(0.018)	(0.022)	(0.027)
Prostate Cancer				
SFA Laws, Weighted	1.024	1.001	0.986	0.949
	(0.016)	(0.016)	(0.020)	(0.028)
Real Cigarette Price	0.993	0.988	0.975	0.968
	(0.017)	(0.018)	(0.022)	(0.024)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

The overall decline in acute myocardial infarctions resulting from increased cigarette prices is also present among working age adults, and increases over time to a 4.8% decline under the eighth lag. Changes in the lagged cigarette price lead to further declines for coronary atherosclerosis, acute cerebrovascular disease, artery aneurysms, and arterial embolism events, and these changes generally increase with greater lags.

Tuberculosis hospitalizations again decline only under two and four year lags, suggesting the majority of the overall health benefits occur in the short run rather than as a result of delayed effects. While COPD and asthma

TABLE XX: LAGGED COEFFICIENTS AND CARDIOVASCULAR HOSPITALIZATIONS, AGES 18-64[a,b]

Variables	Lag=2	Lag=4	Lag=6	Lag=8
Acute Myocardial Infarction				
SFA Laws, Weighted	1.006	1.005	1.003	0.984
	(0.010)	(0.012)	(0.012)	(0.014)
Real Cigarette Price	0.986	0.979*	0.957***	0.952***
	(0.010)	(0.009)	(0.010)	(0.012)
Coronary Atherosclerosis				
SFA Laws, Weighted	1.010	0.996	1.002	1.008
	(0.015)	(0.015)	(0.016)	(0.019)
Real Cigarette Price	0.937***	0.937***	0.932***	0.922***
	(0.016)	(0.018)	(0.019)	(0.018)
Acute Cerebrovascular Disease				
SFA Laws, Weighted	1.009	1.009	1.013	1.018
	(0.010)	(0.010)	(0.010)	(0.013)
Real Cigarette Price	1.014	1.007	0.981	0.962*
	(0.011)	(0.010)	(0.013)	(0.015)
Peripheral & Visceral Atherosclerosis				
SFA Laws, Weighted	1.019	1.013	1.026	1.057**
	(0.011)	(0.012)	(0.015)	(0.021)
Real Cigarette Price	1.027	1.030*	1.032	1.044*
	(0.014)	(0.014)	(0.017)	(0.018)
Artery Aneurysms				
SFA Laws, Weighted	1.015	1.004	0.991	0.980
	(0.013)	(0.014)	(0.015)	(0.021)
Real Cigarette Price	0.970*	0.958*	0.925**	0.932**
	(0.013)	(0.016)	(0.024)	(0.024)
Arterial Embolism				
SFA Laws, Weighted	1.038*	1.017	1.007	1.016
	(0.016)	(0.018)	(0.021)	(0.029)
Real Cigarette Price	0.963*	0.957*	0.954*	0.963
	(0.018)	(0.018)	(0.019)	(0.024)
Hypertension				
SFA Laws, Weighted	1.095**	1.081***	1.072***	1.094***
	(0.033)	(0.023)	(0.018)	(0.024)
Real Cigarette Price	0.889**	0.912**	0.912**	0.924*
	(0.032)	(0.027)	(0.027)	(0.029)

*$p< 0.05$, **$p< 0.01$, ***$p< 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XXI: LAGGED COEFFICIENTS AND RESPIRATORY HOSPITALIZATIONS, AGES 18-64[a,b]

Variables	Lag=2	Lag=4	Lag=6	Lag=8
Tuberculosis				
SFA Laws, Weighted	0.873*	0.914**	0.952	1.023
	(0.049)	(0.030)	(0.026)	(0.025)
Real Cigarette Price	0.942	0.953	0.987	0.977
	(0.035)	(0.040)	(0.049)	(0.049)
COPD				
SFA Laws, Weighted	1.035*	1.054***	1.084***	1.125***
	(0.015)	(0.015)	(0.017)	(0.022)
Real Cigarette Price	1.037*	1.024	0.996	0.985
	(0.017)	(0.018)	(0.021)	(0.023)
Asthma				
SFA Laws, Weighted	1.029	1.053***	1.080***	1.121***
	(0.016)	(0.015)	(0.018)	(0.025)
Real Cigarette Price	1.004	0.991	0.972	0.970
	(0.018)	(0.018)	(0.019)	(0.022)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XXII: LAGGED COEFFICIENTS AND COUNTERFACTUAL HOSPITALIZATIONS, AGES 18-64[a,b]

Variables	Lag=2	Lag=4	Lag=6	Lag=8
Appendicitis				
SFA Laws, Weighted	0.986	0.988	0.998	0.981
	(0.015)	(0.017)	(0.022)	(0.033)
Real Cigarette Price	0.999	0.982	0.940**	0.945*
	(0.014)	(0.016)	(0.022)	(0.024)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

continue to increase as a result of smoke-free air legislation, the real cigarette price leads to a small decline in hospitalizations under greater lags. Similarly, appendicitis hospitalizations are affected only by changes in the real cigarette price under a lag of six and eight years.

Among older adults, the changes in hospitalizations resulting from tobacco control policies in previous years are largely consistent with the findings of working age adults, with results shown in Tables XXIII through XXVI. Lung and breast cancer hospitalizations are similar to previous estimates and generally decline in response to each tobacco control policy, and prostate cancer hospitalizations now decline 4.6% to 5.8% in response to a $1.00 increase in the real cigarette price for lags two through six.

Acute myocardial infarction events decrease by 1.3% as a result of smoke-free air legislation in place two years prior, and the decline extends to 2.3% as the lag increases, although the changes are not statistically significant. In addition, smoking bans lead to fewer coronary atherosclerosis events and a greater number of hypertension hospitalizations, while the remaining diagnoses are generally unchanged. While an increase in the real cigarette price leads to a greater number of peripheral and visceral atherosclerosis hospitalizations, it also leads to declines in coronary atherosclerosis, artery aneurysms, arterial embolism, and for shorter lags, hypertension. Among respiratory conditions, tobacco control policies had a smaller effect on each diagnosis, only occasionally leading to increases in COPD and asthma hos-

TABLE XXIII: LAGGED COEFFICIENTS AND CANCER HOSPITALIZATIONS, AGES 65+[a,b]

Variables	Lag=2	Lag=4	Lag=6	Lag=8
Lung Cancer				
SFA Laws, Weighted	1.013	1.023	1.020	1.003
	(0.015)	(0.015)	(0.016)	(0.018)
Real Cigarette Price	0.999	0.987	0.973	0.994
	(0.016)	(0.015)	(0.017)	(0.018)
Breast Cancer				
SFA Laws, Weighted	0.951**	0.952*	0.960	1.053*
	(0.016)	(0.019)	(0.022)	(0.027)
Real Cigarette Price	0.950**	0.954*	0.956	1.001
	(0.018)	(0.020)	(0.025)	(0.033)
Prostate Cancer				
SFA Laws, Weighted	0.987	0.980	1.012	1.033
	(0.021)	(0.025)	(0.031)	(0.042)
Real Cigarette Price	0.942**	0.954*	0.943*	0.944
	(0.020)	(0.021)	(0.027)	(0.031)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

pitalizations. Just as appendicitis discharges increased among all adults and working age adults in response to lagged values of the real cigarette price, hospitalizations among older adults increased for greater lagged values as well. Comparing the relative change in hospitalizations by age subgroup, the impact of increased cigarette prices was generally greater among working age adults. This is consistent with previous research suggesting an inverse relationship exists between age and responsiveness to changes in the cigarette price.

TABLE XXIV: LAGGED COEFFICIENTS AND CARDIOVASCULAR HOSPITALIZATIONS, AGES 65+[a,b]

Variables	Lag=2	Lag=4	Lag=6	Lag=8
Acute Myocardial Infarction				
SFA Laws, Weighted	0.987	0.986	0.985	0.977
	(0.011)	(0.012)	(0.013)	(0.016)
Real Cigarette Price	1.012	1.007	0.990	0.981
	(0.010)	(0.010)	(0.013)	(0.015)
Coronary Atherosclerosis				
SFA Laws, Weighted	0.982	0.966*	0.983	1.009
	(0.019)	(0.017)	(0.017)	(0.021)
Real Cigarette Price	0.943**	0.951*	0.943**	0.926***
	(0.018)	(0.019)	(0.018)	(0.018)
Acute Cerebrovascular Disease				
SFA Laws, Weighted	0.992	0.998	1.011	1.018
	(0.011)	(0.010)	(0.011)	(0.013)
Real Cigarette Price	1.034*	1.021	0.999	0.988
	(0.013)	(0.013)	(0.016)	(0.016)
Peripheral & Visceral Atherosclerosis				
SFA Laws, Weighted	1.023	1.024	1.026	1.069**
	(0.013)	(0.015)	(0.018)	(0.022)
Real Cigarette Price	1.045**	1.064***	1.079***	1.102***
	(0.016)	(0.017)	(0.023)	(0.022)
Artery Aneurysms				
SFA Laws, Weighted	0.986	0.994	1.003	0.970
	(0.013)	(0.013)	(0.013)	(0.018)
Real Cigarette Price	0.967**	0.948**	0.910***	0.923**
	(0.012)	(0.017)	(0.024)	(0.025)
Arterial Embolism				
SFA Laws, Weighted	1.001	0.995	1.003	0.970
	(0.018)	(0.018)	(0.021)	(0.027)
Real Cigarette Price	0.985	0.984	0.983	0.992
	(0.019)	(0.020)	(0.025)	(0.027)
Hypertension				
SFA Laws, Weighted	1.090*	1.068*	1.061*	1.115***
	(0.039)	(0.030)	(0.025)	(0.024)
Real Cigarette Price	0.887**	0.941	0.969	1.012
	(0.034)	(0.031)	(0.033)	(0.032)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XXV: LAGGED COEFFICIENTS AND RESPIRATORY HOSPITALIZATIONS, AGES 65+[a,b]

Variables	Lag=2	Lag=4	Lag=6	Lag=8
Tuberculosis				
SFA Laws, Weighted	0.957	0.981	1.029	1.073*
	(0.025)	(0.026)	(0.025)	(0.033)
Real Cigarette Price	0.905**	0.953	1.029	1.049
	(0.030)	(0.035)	(0.039)	(0.041)
COPD				
SFA Laws, Weighted	1.013	1.024	1.045**	1.067***
	(0.013)	(0.013)	(0.015)	(0.018)
Real Cigarette Price	1.016	1.001	0.976	0.961
	(0.015)	(0.017)	(0.020)	(0.021)
Asthma				
SFA Laws, Weighted	1.001	1.029	1.064***	1.095***
	(0.014)	(0.016)	(0.018)	(0.023)
Real Cigarette Price	1.037*	1.043*	1.045	1.037
	(0.017)	(0.020)	(0.026)	(0.026)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XXVI: LAGGED COEFFICIENTS AND COUNTERFACTUAL HOSPITALIZATIONS, AGES 65+[a,b]

Variables	Lag=2	Lag=4	Lag=6	Lag=8
Appendicitis				
SFA Laws, Weighted	0.990	0.989	1.014	1.014
	(0.012)	(0.012)	(0.017)	(0.022)
Real Cigarette Price	1.004	0.991	0.949***	0.946**
	(0.012)	(0.011)	(0.015)	(0.017)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

The results of Model 3 are presented in Tables XXVII through XXXI, which show the effects of smoke-free air legislation, estimated separately for the first year in which a smoking ban is in place, and collectively for all subsequent years. Separating out the impact allows for a clear view of whether there is an initial decline in hospitalizations, and to what extent the health benefits change after the first year. The results suggest that breast cancer hospitalizations among all adults declines by 3.1% during the first year of a smoking ban and by 3.7% thereafter, while a $1.00 increase in the real cigarette price leads to a 3.5% decline. While breast cancer hospitalizations decline for each age group, the overall decrease is driven by the 3.4% fewer diagnoses among adults ages 65 and older. The decline in hospitalizations for working age adults remains roughly constant in subsequent years, while among older adults the decline is larger after the first year. For prostate cancer, working age adults see an increase in hospitalizations after a comprehensive smoking ban in both the first year and over time. However, an increase in the cigarette price leads to 6.7% fewer hospitalizations among older adults.

As in Models 1 and 2, hospitalizations for acute myocardial infarction, acute cerebrovascular disease, peripheral and visceral atherosclerosis, arterial embolism, COPD, and asthma are generally unchanged for any time period following a smoking ban. Artery aneurysms among adults ages 65 and older decline as a result of both increased cigarette prices (2.4%) as well as two or

TABLE XXVII: MODEL 3 - CANCER HOSPITALIZATIONS[a,b]

Variables	Ages 18+	Ages 18-64	Ages 65+
Lung Cancer			
New Law	1.021	1.024	1.012
	(0.012)	(0.014)	(0.011)
Established Law	1.023	1.022	1.019
	(0.016)	(0.016)	(0.015)
Real Cigarette Price	0.991	0.979	0.993
	(0.013)	(0.013)	(0.013)
Breast Cancer			
New Law	0.969**	0.971*	0.966**
	(0.011)	(0.012)	(0.013)
Established Law	0.963*	0.976	0.949**
	(0.015)	(0.017)	(0.017)
Real Cigarette Price	0.965*	0.976	0.949**
	(0.015)	(0.016)	(0.016)
Prostate Cancer			
New Law	1.034*	1.042*	1.008
	(0.016)	(0.018)	(0.016)
Established Law	1.022	1.040*	0.988
	(0.018)	(0.018)	(0.021)
Real Cigarette Price	0.974	1.007	0.933***
	(0.016)	(0.016)	(0.018)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XXVIII: MODEL 3 - CARDIOVASCULAR HOSPITALIZATIONS, TABLE 1[a,b]

Variables	Ages 18+	Ages 18-64	Ages 65+
Acute Myocardial Infarction			
New Law	0.994	0.997	0.993
	(0.007)	(0.007)	(0.008)
Established Law	0.990	1.004	0.985
	(0.011)	(0.011)	(0.012)
Real Cigarette Price	1.000	0.993	1.008
	(0.010)	(0.010)	(0.011)
Coronary Atherosclerosis			
New Law	1.016	1.016	1.013
	(0.013)	(0.012)	(0.013)
Established Law	1.008	1.020	0.999
	(0.019)	(0.017)	(0.020)
Real Cigarette Price	0.939***	0.939***	0.938***
	(0.015)	(0.015)	(0.016)
Acute Cerebrovascular Disease			
New Law	0.989	0.998	0.986
	(0.008)	(0.009)	(0.008)
Established Law	0.985	1.004	0.982
	(0.013)	(0.012)	(0.013)
Real Cigarette Price	1.022	1.012	1.027*
	(0.013)	(0.011)	(0.013)
Peripheral & Visceral Atherosclerosis			
New Law	0.998	0.990	0.998
	(0.013)	(0.015)	(0.013)
Established Law	1.020	1.017	1.020
	(0.015)	(0.015)	(0.014)
Real Cigarette Price	1.038**	1.031*	1.042**
	(0.015)	(0.015)	(0.014)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XXIX: MODEL 3 - CARDIOVASCULAR HOSPITALIZATIONS, TABLE 2[a,b]

Variables	Ages 18+	Ages 18-64	Ages 65+
Artery Aneurysms			
New Law	0.994	0.995	0.988
	(0.009)	(0.013)	(0.010)
Established Law	0.985	1.009	0.974*
	(0.012)	(0.013)	(0.012)
Real Cigarette Price	0.985	0.991	0.976*
	(0.009)	(0.012)	(0.009)
Arterial Embolism			
New Law	1.006	0.994	1.006
	(0.016)	(0.018)	(0.016)
Established Law	1.012	1.032	1.005
	(0.018)	(0.019)	(0.017)
Real Cigarette Price	0.983	0.968	0.990
	(0.017)	(0.018)	(0.017)
Hypertension			
New Law	1.060	1.055	1.059
	(0.036)	(0.034)	(0.039)
Established Law	1.125*	1.123**	1.114*
	(0.053)	(0.049)	(0.054)
Real Cigarette Price	0.837***	0.857**	0.824***
	(0.043)	(0.043)	(0.043)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XXX: MODEL 3 - RESPIRATORY HOSPITALIZATIONS[a,b]

Variables	Ages 18+	Ages 18-64	Ages 65+
Tuberculosis			
New Law	0.970	0.980	0.949**
	(0.019)	(0.029)	(0.018)
Established Law	0.894*	0.849*	0.939*
	(0.046)	(0.060)	(0.027)
Real Cigarette Price	0.913**	0.934*	0.880***
	(0.029)	(0.032)	(0.025)
COPD			
New Law	1.008	1.002	1.011
	(0.010)	(0.011)	(0.010)
Established Law	1.015	1.028	1.011
	(0.015)	(0.017)	(0.013)
Real Cigarette Price	1.015	1.038*	1.010
	(0.014)	(0.015)	(0.013)
Asthma			
New Law	0.999	1.003	0.990
	(0.011)	(0.012)	(0.013)
Established Law	1.007	1.018	0.985
	(0.016)	(0.018)	(0.017)
Real Cigarette Price	1.004	1.004	1.019
	(0.014)	(0.017)	(0.016)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XXXI: MODEL 3 - COUNTERFACTUAL HOSPITALIZATIONS[a,b]

Variables	Ages 18+	Ages 18-64	Ages 65+
Appendicitis			
New Law	0.988	0.988	1.006
	(0.011)	(0.012)	(0.014)
Established Law	0.977	0.976	1.002
	(0.015)	(0.016)	(0.015)
Real Cigarette Price	0.994	0.994	0.992
	(0.012)	(0.013)	(0.011)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

more years after smoke-free air legislation begins (2.6%). The large increase in hypertension events two or more years after a smoking ban is enacted suggests that the increase in hospitalizations is not the result of an immediate change in health, but rather is driven by events occurring in the years following a policy change. A \$1.00 increase in the real cigarette price continues to reduce the number of hospitalizations for coronary atherosclerosis, artery aneurysms, arterial embolism, hypertension, and tuberculosis. As expected, appendicitis hospitalizations among all age groups remain unaffected by smoke-free air legislation and changes in the real cigarette price.

Tables XXXII through XXXV show the results of Model 4 for adults ages 18 and older. In each table, column (1) shows the baseline coefficient estimates that are identical to those of Model 2 which does not control for either cumulative effect of smoking bans over time. Columns (2) and (3) sequentially add the covariates $\textit{Years Since SFA}_{it}$ and $\textit{Years Since SFA}_{it}^2$.

Lung cancer is unaffected by either tobacco control policy across columns (1) through (3), while prostate cancer hospitalizations increase 3.5% when controlling for the linear effect of smoking bans over time. However, no increase is found once the non-linear cumulative effect is included in column (3). Additionally, the impact of a \$1.00 increase in the real cigarette price leads to a 2.5% decline across all model specifications. Breast cancer hospitalizations are largely unaffected by the inclusion of additional variables in columns (2) and (3), declining roughly 3.5% as a result of each tobacco control policy. In

TABLE XXXII: MODEL 4 - CANCER HOSPITALIZATIONS, AGES 18+[a,b]

Variables	(1)	(2)	(3)
Lung Cancer			
SFA Laws, Weighted	1.023	1.026	1.022
	(0.014)	(0.014)	(0.013)
Real Cigarette Price	0.991	0.991	0.990
	(0.013)	(0.014)	(0.014)
Breast Cancer			
SFA Laws, Weighted	0.964**	0.967**	0.963**
	(0.013)	(0.012)	(0.012)
Real Cigarette Price	0.965*	0.965*	0.964*
	(0.015)	(0.015)	(0.015)
Prostate Cancer			
SFA Laws, Weighted	1.025	1.035*	1.021
	(0.016)	(0.016)	(0.017)
Real Cigarette Price	0.974	0.975	0.973
	(0.016)	(0.016)	(0.016)
Years Since SFA	N	Y	Y
Years Since SFA^2	N	N	Y

*$p< 0.05$, **$p< 0.01$, ***$p< 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XXXIII: MODEL 4 - CARDIOVASCULAR HOSPITALIZATIONS, AGES 18+[a,b]

Variables	(1)	(2)	(3)
Acute Myocardial Infarction			
SFA Laws, Weighted	0.991	0.994	0.989
	(0.010)	(0.011)	(0.007)
Real Cigarette Price	1.000	1.001	1.000
	(0.010)	(0.010)	(0.010)
Coronary Atherosclerosis			
SFA Laws, Weighted	1.010	1.014	1.000
	(0.017)	(0.016)	(0.017)
Real Cigarette Price	0.939***	0.939***	0.937***
	(0.015)	(0.015)	(0.016)
Acute Cerebrovascular Disease			
SFA Laws, Weighted	0.986	0.990	0.986
	(0.012)	(0.011)	(0.011)
Real Cigarette Price	1.022	1.023	1.022
	(0.013)	(0.013)	(0.013)
Peripheral & Visceral Atherosclerosis			
SFA Laws, Weighted	1.014	1.010	1.000
	(0.013)	(0.014)	(0.015)
Real Cigarette Price	1.039**	1.038**	1.036*
	(0.015)	(0.015)	(0.015)
Artery Aneurysms			
SFA Laws, Weighted	0.987	0.988	0.988
	(0.011)	(0.010)	(0.010)
Real Cigarette Price	0.985	0.985	0.985
	(0.009)	(0.009)	(0.009)
Arterial Embolism			
SFA Laws, Weighted	1.011	1.017	1.005
	(0.016)	(0.016)	(0.016)
Real Cigarette Price	0.983	0.984	0.981
	(0.017)	(0.017)	(0.017)
Hypertension			
SFA Laws, Weighted	1.110*	1.078*	1.053
	(0.048)	(0.040)	(0.040)
Real Cigarette Price	0.838***	0.834***	0.831***
	(0.043)	(0.042)	(0.041)
Years Since SFA	N	Y	Y
Years Since SFA^2	N	N	Y

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XXXIV: MODEL 4 - RESPIRATORY HOSPITALIZATIONS, AGES 18+[a,b]

Variables	(1)	(2)	(3)
Tuberculosis			
SFA Laws, Weighted	0.907*	0.911**	0.926**
	(0.037)	(0.032)	(0.026)
Real Cigarette Price	0.913**	0.911**	0.915**
	(0.029)	(0.029)	(0.030)
COPD			
SFA Laws, Weighted	1.014	1.008	0.997
	(0.013)	(0.013)	(0.011)
Real Cigarette Price	1.015	1.014	1.011
	(0.014)	(0.014)	(0.013)
Asthma			
SFA Laws, Weighted	1.005	0.998	0.981
	(0.014)	(0.013)	(0.012)
Real Cigarette Price	1.005	1.003	1.000
	(0.014)	(0.015)	(0.015)
Years Since SFA	N	Y	Y
Years Since SFA^2	N	N	Y

*$p<0.05$, **$p<0.01$, ***$p<0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XXXV: MODEL 4 - COUNTERFACTUAL HOSPITALIZATIONS, AGES 18+[a,b]

Variables	(1)	(2)	(3)
Appendicitis			
SFA Laws, Weighted	0.980	0.984	0.975
	(0.014)	(0.014)	(0.015)
Real Cigarette Price	0.994	0.994	0.992
	(0.012)	(0.013)	(0.013)
Years Since SFA	N	Y	Y
Years Since SFA^2	N	N	Y

*$p<0.05$, **$p<0.01$, ***$p<0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

Table XXXIII, acute myocardial infarction and acute cerebrovascular disease hospitalizations decline by 1.1% and 1.4%, respectively, once controlling for both cumulative effects of smoking bans over time. For coronary atherosclerosis, the impact of smoke-free air legislation remains essentially unchanged, while a $1.00 increase in the real cigarette price leads to 6.3% fewer hospitalizations. As in previous models, the real cigarette price leads a greater number of hospitalizations for peripheral and visceral atherosclerosis, while fewer artery aneurysms are observed across columns (1) through (3) as a result of both tobacco control policies. The initial results in column (1) suggest that smoking bans lead to a greater prevalence of hypertension, though this effect disappears once linear and non-linear controls are included in column (3). The smoke-free air variable suggests an initial increase of 5.3% that is not statistically significant, while the real cigarette price continues to reduce hypertension hospitalizations by 16.9%. For respiratory conditions, tuberculosis continues to exhibit large declines after the enactment of both tobacco control policies, while COPD and asthma decline modestly once controlling for the cumulative effects of a smoking ban over time. Finally, appendicitis hospitalizations are unaffected by either policy, and the estimates are stable as controls for the cumulative effects of smoke-free air legislation are included.

For working age adults, the results of Model 4 are generally consistent with those of all adults ages 18 and older. In Table XXXVI, the statistically significant increase in prostate cancer hospitalizations remains when including the linear effect in column (2), as well as once controlling for the squared number of years since a smoking ban was enacted in column (3). No change occurs for lung cancer hospitalizations, which show a slight increase after a smoking ban is enacted, and a 2% decline after a change in the real cigarette price. Whereas breast cancer discharges among all adults declined significantly after each tobacco control policy, working age adults only experience large declines in column (3). For cardiovascular diagnoses in Table XXXVII, acute myocardial infarction and acute cerebrovascular disease are essentially unchanged across columns (1) through (3). Similar to the full sample of adults ages 18 and older, coronary atherosclerosis hospitalizations declined by 6.4% among working age adults after a $1.00 increase in the real cigarette price. Hypertension hospitalizations show significant declines of 15% after an increase in the real cigarette price and are unaffected by smoke-free air legislation. Additionally, peripheral and visceral atherosclerosis no longer increases in response to either tobacco control policy in column (3). For respiratory diagnoses, the real cigarette price does not change the number of tuberculosis diagnoses among working age adults, while smoke-free air legislation leads to a 9.2% decline when controlling for both cumulative effects over time. Both COPD and asthma are unchanged after a smoking ban is enacted, while COPD increases slightly after a $1.00 increase in the real cigarette price. Finally, the counterfactual condition appendicitis is not affected by either tobacco control policy.

TABLE XXXVI: MODEL 4 - CANCER HOSPITALIZATIONS, AGES 18-64[a,b]

Variables	(1)	(2)	(3)
Lung Cancer			
SFA Laws, Weighted	1.022	1.023	1.027
	(0.015)	(0.015)	(0.014)
Real Cigarette Price	0.979	0.979	0.980
	(0.013)	(0.014)	(0.014)
Breast Cancer			
SFA Laws, Weighted	0.974	0.975	0.965*
	(0.015)	(0.015)	(0.013)
Real Cigarette Price	0.976	0.976	0.974
	(0.016)	(0.016)	(0.016)
Prostate Cancer			
SFA Laws, Weighted	1.041*	1.050**	1.040*
	(0.017)	(0.017)	(0.018)
Real Cigarette Price	1.007	1.009	1.007
	(0.016)	(0.016)	(0.016)
Years Since SFA	N	Y	Y
Years Since SFA^2	N	N	Y

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XXXVII: MODEL 4 - CARDIOVASCULAR HOSPITALIZATIONS, AGES 18-64[a,b]

Variables	(1)	(2)	(3)
Acute Myocardial Infarction			
SFA Laws, Weighted	1.002	1.002	0.996
	(0.009)	(0.010)	(0.007)
Real Cigarette Price	0.993	0.993	0.992
	(0.010)	(0.010)	(0.010)
Coronary Atherosclerosis			
SFA Laws, Weighted	1.019	1.021	1.003
	(0.015)	(0.014)	(0.016)
Real Cigarette Price	0.939***	0.939***	0.936***
	(0.015)	(0.015)	(0.015)
Acute Cerebrovascular Disease			
SFA Laws, Weighted	1.003	1.003	0.998
	(0.011)	(0.011)	(0.011)
Real Cigarette Price	1.012	1.012	1.011
	(0.011)	(0.011)	(0.011)
Peripheral & Visceral Atherosclerosis			
SFA Laws, Weighted	1.010	1.006	0.997
	(0.014)	(0.014)	(0.016)
Real Cigarette Price	1.031*	1.030*	1.028
	(0.015)	(0.016)	(0.016)
Artery Aneurysms			
SFA Laws, Weighted	1.005	1.003	1.008
	(0.012)	(0.011)	(0.013)
Real Cigarette Price	0.991	0.990	0.992
	(0.012)	(0.012)	(0.012)
Arterial Embolism			
SFA Laws, Weighted	1.023	1.023	1.009
	(0.017)	(0.018)	(0.020)
Real Cigarette Price	0.968	0.968	0.966
	(0.018)	(0.018)	(0.018)
Hypertension			
SFA Laws, Weighted	1.106*	1.069	1.053
	(0.045)	(0.036)	(0.037)
Real Cigarette Price	0.857**	0.852***	0.850***
	(0.043)	(0.041)	(0.040)
Years Since SFA	N	Y	Y
Years Since SFA^2	N	N	Y

*$p<0.05$, **$p<0.01$, ***$p<0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XXXVIII: MODEL 4 - RESPIRATORY HOSPITALIZATIONS, AGES 18-64[a,b]

Variables	(1)	(2)	(3)
Tuberculosis			
SFA Laws, Weighted	0.872*	0.882**	0.908***
	(0.047)	(0.038)	(0.025)
Real Cigarette Price	0.933*	0.929*	0.937
	(0.031)	(0.031)	(0.033)
COPD			
SFA Laws, Weighted	1.022	1.009	0.997
	(0.015)	(0.014)	(0.013)
Real Cigarette Price	1.038*	1.033*	1.031*
	(0.016)	(0.015)	(0.015)
Asthma			
SFA Laws, Weighted	1.014	1.004	0.990
	(0.016)	(0.016)	(0.014)
Real Cigarette Price	1.004	1.002	0.999
	(0.017)	(0.017)	(0.017)
Years Since SFA	N	Y	Y
Years Since SFA^2	N	N	Y

*$p<0.05$, **$p<0.01$, ***$p<0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XXXIX: MODEL 4 - COUNTERFACTUAL HOSPITALIZATIONS, AGES 18-64[a,b]

Variables	(1)	(2)	(3)
Appendicitis			
SFA Laws, Weighted	0.979	0.983	0.975
	(0.014)	(0.015)	(0.015)
Real Cigarette Price	0.993	0.993	0.991
	(0.013)	(0.013)	(0.013)
Years Since SFA	N	Y	Y
Years Since SFA^2	N	N	Y

*$p<0.05$, **$p<0.01$, ***$p<0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

For adults ages 65 and older in Table XL, changes in the real cigarette price lead to 5% declines in breast cancer and 7% declines in prostate cancer hospitalizations, while smoke-free air laws lead to 3.7% and 1.9% declines, respectively. Similar to Models 1 through 3, older adults continue to experience a greater decrease in breast and prostate cancer hospitalizations than working age adults. For cardiovascular diagnoses, artery aneurysms decline significantly (2.3%), while acute myocardial infarction and acute cerebrovascular disease each decrease modestly after the implementation of smoke-free air legislation. While COPD remains unchanged when controlling for the cumulative effects of smoking bans over time, both tuberculosis and asthma show significant declines of 5.2% and 3.6%, respectively. Appendicitis is again unaffected by either tobacco control policy when controlling for $Years\ Since\ SFA_{it}$ and $Years\ Since\ SFA_{it}^2$.

Tables XLIV through XLVII show the impact of tobacco control policies estimated with Model 2, using data from only the largest tobacco producing states. Unlike earlier findings utilizing data from throughout the country, the results suggest that smoke-free air legislation leads to statistically significant declines in the number of lung cancer hospitalizations for each age group, decreasing 5.8% among all adults, 4.2% among working age adults, and 6.3% among older adults. However, the results suggest smoking bans lead to an increase in prostate cancer and modest declines in the number of breast cancer hospitalizations. A $1.00 increase in the real cigarette price is

TABLE XL: MODEL 4 - CANCER HOSPITALIZATIONS, AGES 65+[a,b]

Variables	(1)	(2)	(3)
Lung Cancer			
SFA Laws, Weighted	1.017	1.017	1.014
	(0.013)	(0.013)	(0.012)
Real Cigarette Price	0.993	0.993	0.992
	(0.013)	(0.013)	(0.013)
Breast Cancer			
SFA Laws, Weighted	0.953**	0.954***	0.963*
	(0.015)	(0.013)	(0.014)
Real Cigarette Price	0.949**	0.949**	0.950**
	(0.016)	(0.016)	(0.016)
Prostate Cancer			
SFA Laws, Weighted	0.993	0.997	0.981
	(0.018)	(0.016)	(0.019)
Real Cigarette Price	0.932***	0.933***	0.930***
	(0.018)	(0.018)	(0.018)
Years Since SFA	N	Y	Y
Years Since SFA^2	N	N	Y

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XLI: MODEL 4 - CARDIOVASCULAR HOSPITALIZATIONS, AGES 65+[a,b]

Variables	(1)	(2)	(3)
Acute Myocardial Infarction			
SFA Laws, Weighted	0.987	0.990	0.987
	(0.011)	(0.011)	(0.008)
Real Cigarette Price	1.008	1.009	1.008
	(0.011)	(0.011)	(0.011)
Coronary Atherosclerosis			
SFA Laws, Weighted	1.003	1.005	0.998
	(0.017)	(0.016)	(0.016)
Real Cigarette Price	0.938***	0.938***	0.937***
	(0.016)	(0.016)	(0.016)
Acute Cerebrovascular Disease			
SFA Laws, Weighted	0.983	0.985	0.983
	(0.011)	(0.010)	(0.010)
Real Cigarette Price	1.027*	1.028*	1.027*
	(0.013)	(0.013)	(0.014)
Peripheral & Visceral Atherosclerosis			
SFA Laws, Weighted	1.014	1.006	0.998
	(0.013)	(0.013)	(0.014)
Real Cigarette Price	1.042**	1.040**	1.039**
	(0.014)	(0.014)	(0.014)
Artery Aneurysms			
SFA Laws, Weighted	0.978*	0.976*	0.977*
	(0.010)	(0.010)	(0.010)
Real Cigarette Price	0.976*	0.975**	0.976**
	(0.009)	(0.009)	(0.009)
Arterial Embolism			
SFA Laws, Weighted	1.005	1.004	1.002
	(0.016)	(0.015)	(0.016)
Real Cigarette Price	0.990	0.990	0.990
	(0.017)	(0.017)	(0.017)
Hypertension			
SFA Laws, Weighted	1.101*	1.073	1.046
	(0.050)	(0.045)	(0.042)
Real Cigarette Price	0.825***	0.822***	0.819***
	(0.043)	(0.042)	(0.042)
Years Since SFA	N	Y	Y
Years Since SFA^2	N	N	Y

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XLII: MODEL 4 - RESPIRATORY HOSPITALIZATIONS, AGES 65+[a,b]

Variables	(1)	(2)	(3)
Tuberculosis			
SFA Laws, Weighted	0.941*	0.941*	0.948*
	(0.024)	(0.023)	(0.026)
Real Cigarette Price	0.880***	0.880***	0.882***
	(0.025)	(0.025)	(0.025)
COPD			
SFA Laws, Weighted	1.011	1.005	0.997
	(0.012)	(0.012)	(0.011)
Real Cigarette Price	1.010	1.009	1.007
	(0.013)	(0.013)	(0.012)
Asthma			
SFA Laws, Weighted	0.986	0.984	0.964*
	(0.015)	(0.014)	(0.014)
Real Cigarette Price	1.019	1.019	1.013
	(0.016)	(0.016)	(0.016)
Years Since SFA	N	Y	Y
Years Since SFA^2	N	N	Y

*$p< 0.05$, **$p< 0.01$, ***$p< 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XLIII: MODEL 4 - COUNTERFACTUAL HOSPITALIZATIONS, AGES 65+[a,b]

Variables	(1)	(2)	(3)
Appendicitis			
SFA Laws, Weighted	1.003	1.004	0.999
	(0.013)	(0.013)	(0.014)
Real Cigarette Price	0.992	0.992	0.991
	(0.011)	(0.011)	(0.011)
Years Since SFA	N	Y	Y
Years Since SFA^2	N	N	Y

*$p< 0.05$, **$p< 0.01$, ***$p< 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XLIV: CANCER DIAGNOSES AMONG TOBACCO PRODUCING STATES[a,b]

Variables	Ages 18+	Ages 18-64	Ages 65+
Lung Cancer			
SFA Laws, Weighted	0.942**	0.958*	0.937**
	(0.020)	(0.020)	(0.022)
Real Cigarette Price	0.943**	0.962	0.943
	(0.020)	(0.025)	(0.029)
Breast Cancer			
SFA Laws, Weighted	0.968	0.967	0.977
	(0.032)	(0.034)	(0.035)
Real Cigarette Price	0.851***	0.855***	0.881**
	(0.031)	(0.034)	(0.037)
Prostate Cancer			
SFA Laws, Weighted	1.105**	1.074*	1.157***
	(0.035)	(0.037)	(0.046)
Real Cigarette Price	0.913*	1.035	0.777***
	(0.041)	(0.044)	(0.049)

*$p<0.05$, **$p<0.01$, ***$p<0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

associated with fewer cancer discharges for each diagnosis and across nearly every age group. For cardiovascular diagnoses, smoking bans have a more mixed effect. Declines are observed for acute cerebrovascular disease (3.4%), artery aneurysms (5.3%), and arterial embolism (4.8%), while increases are occasionally observed for acute myocardial infarction, coronary atherosclerosis, and peripheral and visceral atherosclerosis. Surprisingly, hypertension hospitalizations are unaffected by either tobacco control policy in this subset of states.

TABLE XLV: CARDIOVASCULAR DIAGNOSES AMONG TOBACCO PRODUCING STATES[a,b]

Variables	Ages 18+	Ages 18-64	Ages 65+
Acute Myocardial Infarction			
SFA Laws, Weighted	1.038	1.069***	1.020
	(0.020)	(0.020)	(0.020)
Real Cigarette Price	0.867***	0.861***	0.892***
	(0.022)	(0.021)	(0.029)
Coronary Atherosclerosis			
SFA Laws, Weighted	1.039	1.050*	1.031
	(0.025)	(0.021)	(0.028)
Real Cigarette Price	0.804***	0.821***	0.805***
	(0.023)	(0.024)	(0.027)
Acute Cerebrovascular Disease			
SFA Laws, Weighted	0.966*	0.997	0.951**
	(0.014)	(0.015)	(0.016)
Real Cigarette Price	0.899***	0.900***	0.955**
	(0.018)	(0.021)	(0.017)
Peripheral & Visceral Atherosclerosis			
SFA Laws, Weighted	1.017	0.978	1.044*
	(0.020)	(0.018)	(0.023)
Real Cigarette Price	0.990	0.984	1.037
	(0.029)	(0.028)	(0.032)
Artery Aneurysms			
SFA Laws, Weighted	0.947**	1.009	0.930***
	(0.019)	(0.024)	(0.019)
Real Cigarette Price	0.865***	0.888***	0.874***
	(0.018)	(0.028)	(0.022)
Arterial Embolism			
SFA Laws, Weighted	0.952	0.966	0.942
	(0.025)	(0.029)	(0.029)
Real Cigarette Price	0.867***	0.883**	0.881*
	(0.036)	(0.037)	(0.052)
Hypertension			
SFA Laws, Weighted	1.000	1.008	0.992
	(0.027)	(0.026)	(0.029)
Real Cigarette Price	0.981	0.958	1.056
	(0.035)	(0.032)	(0.050)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XLVI: RESPIRATORY DIAGNOSES AMONG TOBACCO PRODUCING STATES[a,b]

Variables	Ages 18+	Ages 18-64	Ages 65+
Tuberculosis			
SFA Laws, Weighted	1.086	1.175*	0.717**
	(0.075)	(0.086)	(0.081)
Real Cigarette Price	1.074	1.099	1.197
	(0.078)	(0.097)	(0.141)
COPD			
SFA Laws, Weighted	1.015	1.047*	1.002
	(0.023)	(0.024)	(0.024)
Real Cigarette Price	0.916**	0.941	0.926*
	(0.026)	(0.031)	(0.028)
Asthma			
SFA Laws, Weighted	0.981	0.997	0.955
	(0.022)	(0.023)	(0.027)
Real Cigarette Price	0.907***	0.915**	0.862***
	(0.025)	(0.028)	(0.033)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE XLVII: COUNTERFACTUAL DIAGNOSIS AMONG TOBACCO PRODUCING STATES[a,b]

Variables	Ages 18+	Ages 18-64	Ages 65+
Appendicitis			
SFA Laws, Weighted	0.965	0.966	0.913**
	(0.027)	(0.028)	(0.026)
Real Cigarette Price	0.994	1.020	0.874***
	(0.039)	(0.036)	(0.035)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

An increase in the real cigarette price continues to have the largest impact, leading to at least partial declines for every diagnosis, and statistically significant declines for acute myocardial infarction, coronary atherosclerosis, acute cerebrovascular disease, artery aneurysms, and arterial embolism events across all age groups. The effects of smoke-free air legislation on tuberculosis and COPD vary by age group, while an increase in the real cigarette price leads to declines in COPD hospitalizations. Asthma diagnoses also decline for each age group as a result of both tobacco control policies. Appendicitis diagnoses declined significantly for adults ages 65 and older, with no change observed for working age adults or among all adults. These results suggest that the benefits resulting from tobacco control policies in the largest tobacco producing states may be larger than those observed in the United States as a whole.

With 13 individual diagnosis groups across three broad disease categories, the overall effects of smoke-free air legislation and increased cigarette prices on the number of hospitalizations are not clear when observing each diagnosis independently. To obtain a better understanding of the total impact on each disease category, as well as to reduce concerns regarding multiple hypothesis testing and observing a significant association by chance alone, the individual diagnosis groups are aggregated into larger cancer, cardiovascular, and respiratory categories. Each aggregated group is then re-estimated using Model 2, with the results shown in Table XLVIII. Smoke-free air legislation does not

TABLE XLVIII: AGGREGATED DIAGNOSIS CATEGORIES[a,b]

Variables	Ages 18+	Ages 18-64	Ages 65+
Cancer Diagnoses			
SFA Laws, Weighted	1.002	1.004	0.995
	(0.012)	(0.013)	(0.012)
Real Cigarette Price	0.975*	0.988	0.960**
	(0.012)	(0.013)	(0.012)
Cardiovascular Diagnoses			
SFA Laws, Weighted	1.005	1.016	0.998
	(0.012)	(0.012)	(0.012)
Real Cigarette Price	0.960***	0.947***	0.963***
	(0.011)	(0.011)	(0.010)
Respiratory Diagnoses			
SFA Laws, Weighted	1.016	1.017	1.016
	(0.014)	(0.017)	(0.011)
Real Cigarette Price	1.019	1.017	1.019
	(0.014)	(0.017)	(0.012)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

lead to fewer hospitalizations for any disease category, though a $1.00 increase in the real cigarette price leads to significantly fewer cancer and cardiovascular diagnoses. Specifically, cancer hospitalizations decline 2.5% among all adults, 1.2% among working age adults, and 4% among older adults. The largest declines occurred for cardiovascular hospitalizations, which decreased 4%, 5.3%, and 3.7% in each age group, respectively.

The estimates in Table XLVIII were then used to perform simulations predicting the number of cancer and cardiovascular hospitalizations that could have been avoided from 2010 to 2014 if states had followed the Healthy People

TABLE XLIX: PREDICTED REDUCTIONS IN HOSPITALIZATIONS, 2010-2014

Variables	Ages 18+	Ages 18-64	Ages 65+
Cancer Diagnoses	36,693	8,880	30,567
Cardiovascular Diagnoses	477,696	264,377	260,741

2020 guideline and increased the nominal cigarette tax by $1.50 (USDHHS, 2011). The results are shown in Table XLIX, and are slightly underestimated due to the unavailability of data from three states during 2014. They suggest that if states had increased the cigarette tax by $1.50, over 36,000 cancer and 477,000 cardiovascular hospitalizations could have been avoided during this period.

6.1 Sensitivity Analysis

Using the weighted average SFA_{it} variable in Model 2, I first show the degree to which the estimates of smoke-free air legislation are affected by the inclusion of additional covariates in the model. Tables L through LIII display the effect on smoke-free air legislation, while the full results showing the coefficients on each county control variable are shown in Tables LXXIV through LXXXVII in the Appendix. Because much of the existing research includes limited county characteristics, these results may also suggest the extent to which previous studies have been impacted by omitted variable bias, particularly with respect to the county level cigarette price. In each table, column (1) displays the estimated effect of smoke-free air legislation when controlling only for county population, county fixed effects, and year fixed effects. Column (2) includes additional controls for the percentage of the population that is non-white, real median household income, the unemployment rate, the average level of pollution, the number of bars per 1,000 population, and the number of restaurants per 1,000 population. Finally, column (3) includes the variables in column (2), along with additional controls for the county level real cigarette price and the price differential detailed in Section 4.2.

Comparing estimates across columns (1) through (3), the effects of smoke-free air legislation are slightly larger in the simplified model of column (1), where they lead to statistically significant declines in breast cancer, artery aneurysm, tuberculosis, and appendicitis hospitalizations. In column (2), the effects are slightly smaller in size, as some of the variation in smoke-free air legislation that affects each outcome variable is controlled for. Among diagnoses that declined significantly in column (1), only breast cancer and tuberculosis remain statistically significant. In column (3), the impact of smoke-free air legislation is generally smaller in size, as the hypothesized source of omitted variable bias in previous studies, the real cigarette price, is included in the model. In the case of hypertension hospitalizations, the impact of smoke-free air legislation becomes statistically significant.

TABLE L: COMPARISON OF COEFFICIENTS - CANCER DIAGNOSES, AGES 18+[a,b]

Variables	(1)	(2)	(3)
Lung Cancer			
SFA Laws, Weighted	1.007	1.018	1.023
	(0.016)	(0.016)	(0.014)
Real Cigarette Price			0.991
			(0.013)
Breast Cancer			
SFA Laws, Weighted	0.952***	0.959**	0.964**
	(0.014)	(0.014)	(0.013)
Real Cigarette Price			0.965*
			(0.015)
Prostate Cancer			
SFA Laws, Weighted	1.003	1.017	1.025
	(0.015)	(0.016)	(0.016)
Real Cigarette Price			0.974
			(0.016)
Population	Y	Y	Y
County Controls	N	Y	Y
Cigarette Price	N	N	Y

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE LI: COMPARISON OF COEFFICIENTS - CARDIOVASCULAR DIAGNOSES, AGES 18+[a,b]

Variables	(1)	(2)	(3)
Acute Myocardial Infarction			
SFA Laws, Weighted	0.984	0.989	0.991
	(0.010)	(0.010)	(0.010)
Real Cigarette Price			1.000
			(0.010)
Coronary Atherosclerosis			
SFA Laws, Weighted	0.986	1.000	1.010
	(0.017)	(0.016)	(0.017)
Real Cigarette Price			0.939***
			(0.015)
Acute Cerebrovascular Disease			
SFA Laws, Weighted	0.982	0.987	0.986
	(0.013)	(0.013)	(0.012)
Real Cigarette Price			1.022
			(0.013)
Peripheral & Visceral Atherosclerosis			
SFA Laws, Weighted	1.015	1.018	1.014
	(0.015)	(0.015)	(0.013)
Real Cigarette Price			1.039**
			(0.015)
Artery Aneurysms			
SFA Laws, Weighted	0.976*	0.984	0.987
	(0.010)	(0.011)	(0.011)
Real Cigarette Price			0.985
			(0.009)
Arterial Embolism			
SFA Laws, Weighted	0.983	1.002	1.011
	(0.017)	(0.016)	(0.016)
Real Cigarette Price			0.983
			(0.017)
Hypertension			
SFA Laws, Weighted	1.080	1.092	1.110*
	(0.059)	(0.051)	(0.048)
Real Cigarette Price			0.838***
			(0.043)
Population	Y	Y	Y
County Controls	N	Y	Y
Cigarette Price	N	N	Y

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE LII: COMPARISON OF COEFFICIENTS - RESPIRATORY DIAGNOSES, AGES 18+[a,b]

Variables	(1)	(2)	(3)
Tuberculosis			
SFA Laws, Weighted	0.795**	0.894**	0.907*
	(0.056)	(0.035)	(0.037)
Real Cigarette Price			0.913**
			(0.029)
COPD			
SFA Laws, Weighted	1.009	1.014	1.014
	(0.015)	(0.014)	(0.013)
Real Cigarette Price			1.015
			(0.014)
Asthma			
SFA Laws, Weighted	0.999	1.000	1.005
	(0.017)	(0.016)	(0.014)
Real Cigarette Price			1.005
			(0.014)
Population	Y	Y	Y
County Controls	N	Y	Y
Cigarette Price	N	N	Y

*$p< 0.05$, **$p< 0.01$, ***$p< 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE LIII: COMPARISON OF COEFFICIENTS - COUNTERFACTUAL DIAGNOSIS, AGES 18+[a,b]

Variables	(1)	(2)	(3)
Appendicitis			
SFA Laws, Weighted	0.967*	0.977	0.980
	(0.015)	(0.015)	(0.014)
Real Cigarette Price			0.994
			(0.012)
Population	Y	Y	Y
County Controls	N	Y	Y
Cigarette Price	N	N	Y

*$p< 0.05$, **$p< 0.01$, ***$p< 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

Next, the sensitivity of the results to the definition of the real cigarette price are tested. Recall, a county's own cigarette price is included in each model, along with a second variable representing the largest difference between a county's own cigarette price and the lowest price in any neighboring county. Model 2 is used to estimate the effect of each tobacco control policy using the following three definitions of the real cigarette price. First, column (1) uses a county's own cigarette price with no price differential included. This assumes cigarette purchases do not occur across county lines, and these estimates should be biased toward zero if cross border purchases occur. Column (2) employs the default measure of cigarette prices used throughout this study, which includes both a county's own cigarette price as well as a second variable equal to the largest difference between a county's own price and the lowest price of any neighboring county. Finally, column (3) follows Chaloupka (1991) by including a single measure equal to the simple average of the county's own cigarette price and the lowest price in any neighboring county.

The results for each diagnosis group are shown in Tables LIV through LVII. The estimated impact of smoke-free air legislation is consistent for the various definitions of the real cigarette price. The coefficients on the real cigarette price shown in column (1) are generally smaller than those in either columns (2) or (3). This suggests that ignoring the differences in

TABLE LIV: COMPARISON OF CIGARETTE PRICES ON CANCER DIAGNOSES, AGES 18+[a,b]

Variables	Own Price	Own Price w/ Diff.	Average Price
Lung Cancer			
SFA Laws, Weighted	1.023	1.023	1.021
	(0.015)	(0.014)	(0.014)
Real Cigarette Price	0.984	0.991	0.986
	(0.009)	(0.013)	(0.013)
Breast Cancer			
SFA Laws, Weighted	0.964**	0.964**	0.965*
	(0.013)	(0.013)	(0.013)
Real Cigarette Price	0.978	0.965*	0.968*
	(0.015)	(0.015)	(0.015)
Prostate Cancer			
SFA Laws, Weighted	1.025	1.025	1.024
	(0.016)	(0.016)	(0.016)
Real Cigarette Price	0.972*	0.974	0.971
	(0.012)	(0.016)	(0.015)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

price between counties may result in an underestimation of the true impact of cigarette price changes in reducing hospitalizations.

In Models 1 through 4, a county is assumed to be protected by comprehensive smoke-free air legislation when the average level of coverage across all four venues is at least 50% in a given year. Tables LVIII through LXI display the results of Model 2 using alternative levels of minimum coverage before a county is considered protected by smoke-free air legislation. These coverage requirements are equal to at least 25%, 50%, 75%, and 100% of the population across all four venues.

TABLE LV: COMPARISON OF CIGARETTE PRICES ON CARDIOVASCULAR DIAGNOSES, AGES 18+[a,b]

Variables	Own Price	Own Price w/ Diff.	Average Price
Acute Myocardial Infarction			
SFA Laws, Weighted	0.991	0.991	0.990
	(0.010)	(0.010)	(0.010)
Real Cigarette Price	0.990	1.000	0.995
	(0.011)	(0.010)	(0.011)
Coronary Atherosclerosis			
SFA Laws, Weighted	1.010	1.010	1.009
	(0.017)	(0.017)	(0.017)
Real Cigarette Price	0.946***	0.939***	0.937***
	(0.011)	(0.015)	(0.015)
Acute Cerebrovascular Disease			
SFA Laws, Weighted	0.987	0.986	0.984
	(0.012)	(0.012)	(0.012)
Real Cigarette Price	0.997	1.022	1.012
	(0.017)	(0.013)	(0.015)
Peripheral & Visceral Atherosclerosis			
SFA Laws, Weighted	1.014	1.014	1.012
	(0.014)	(0.013)	(0.013)
Real Cigarette Price	1.018	1.039**	1.032*
	(0.015)	(0.015)	(0.015)
Artery Aneurysms			
SFA Laws, Weighted	0.987	0.987	0.987
	(0.010)	(0.011)	(0.010)
Real Cigarette Price	0.989	0.985	0.985
	(0.007)	(0.009)	(0.009)
Arterial Embolism			
SFA Laws, Weighted	1.011	1.011	1.008
	(0.017)	(0.016)	(0.017)
Real Cigarette Price	0.968*	0.983	0.974
	(0.016)	(0.017)	(0.018)
Hypertension			
SFA Laws, Weighted	1.117*	1.110*	1.117*
	(0.053)	(0.048)	(0.052)
Real Cigarette Price	0.899*	0.838***	0.852***
	(0.040)	(0.043)	(0.041)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE LVI: COMPARISON OF CIGARETTE PRICES ON RESPIRATORY DIAGNOSES, AGES 18+[a,b]

Variables	Own Price	Own Price w/ Diff.	Average Price
Tuberculosis			
SFA Laws, Weighted	0.908*	0.907*	0.908*
	(0.037)	(0.037)	(0.037)
Real Cigarette Price	0.895***	0.913**	0.887***
	(0.023)	(0.029)	(0.028)
COPD			
SFA Laws, Weighted	1.014	1.014	1.012
	(0.013)	(0.013)	(0.013)
Real Cigarette Price	1.003	1.015	1.011
	(0.013)	(0.014)	(0.014)
Asthma			
SFA Laws, Weighted	1.005	1.005	1.001
	(0.014)	(0.014)	(0.015)
Real Cigarette Price	0.979	1.005	0.990
	(0.018)	(0.014)	(0.018)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

The results suggest that while the effects of smoke-free air legislation are generally consistent across coverage levels, there is a slight trend upward as the the minimum coverage level increases. For cancer diagnoses, breast cancer declines under each definition of protection, but is only statistically significant under the 50% and 100% coverage levels. Prostate cancer hospitalizations are generally unchanged, while lung cancer diagnoses increase with the coverage definition. Similarly, cardiovascular diagnoses, with the exception of acute myocardial infarction, trend upwards but typically do not become statistically significant. For respiratory diagnoses, tuberculosis

TABLE LVII: COMPARISON OF CIGARETTE PRICES ON COUNTERFACTUAL DIAGNOSIS, AGES 18+[a,b]

Variables	Own Price	Own Price w/ Diff.	Average Price
Appendicitis			
SFA Laws, Weighted	0.981	0.980	0.979
	(0.014)	(0.014)	(0.014)
Real Cigarette Price	0.988	0.994	0.990
	(0.009)	(0.012)	(0.012)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE LVIII: ALTERNATE COVERAGE LEVELS - CANCER DIAGNOSES, AGES 18+[a,b]

Variables	25 Percent	50 Percent	75 Percent	100 Percent
Lung Cancer				
SFA Laws, Weighted	1.018	1.023	1.040**	1.047**
	(0.011)	(0.014)	(0.016)	(0.016)
Real Cigarette Price	0.992	0.991	0.987	0.984
	(0.014)	(0.013)	(0.013)	(0.013)
Breast Cancer				
SFA Laws, Weighted	0.983	0.964**	0.983	0.951**
	(0.013)	(0.013)	(0.016)	(0.018)
Real Cigarette Price	0.962*	0.965*	0.963*	0.971
	(0.016)	(0.015)	(0.016)	(0.016)
Prostate Cancer				
SFA Laws, Weighted	1.016	1.025	0.992	0.997
	(0.013)	(0.016)	(0.017)	(0.019)
Real Cigarette Price	0.975	0.974	0.979	0.978
	(0.016)	(0.016)	(0.016)	(0.016)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE LIX: ALTERNATE COVERAGE LEVELS - CARDIOVASCULAR DIAGNOSES, AGES 18+[a,b]

Variables	25 Percent	50 Percent	75 Percent	100 Percent
Acute Myocardial Infarction				
SFA Laws, Weighted	1.000	0.991	0.993	0.988
	(0.009)	(0.010)	(0.012)	(0.013)
Real Cigarette Price	0.999	1.000	1.000	1.002
	(0.010)	(0.010)	(0.010)	(0.010)
Coronary Atherosclerosis				
SFA Laws, Weighted	1.016	1.010	1.001	1.027
	(0.015)	(0.017)	(0.019)	(0.019)
Real Cigarette Price	0.939***	0.939***	0.940***	0.935***
	(0.015)	(0.015)	(0.015)	(0.014)
Acute Cerebrovascular Disease				
SFA Laws, Weighted	0.983	0.986	1.026	1.032
	(0.010)	(0.012)	(0.014)	(0.017)
Real Cigarette Price	1.022	1.022	1.016	1.013
	(0.013)	(0.013)	(0.013)	(0.013)
Peripheral & Visceral Atherosclerosis				
SFA Laws, Weighted	1.010	1.014	1.032*	1.059***
	(0.012)	(0.013)	(0.014)	(0.016)
Real Cigarette Price	1.039**	1.039**	1.036*	1.028*
	(0.015)	(0.015)	(0.015)	(0.014)
Artery Aneurysms				
SFA Laws, Weighted	0.995	0.987	1.004	1.027
	(0.010)	(0.011)	(0.013)	(0.017)
Real Cigarette Price	0.983	0.985	0.982	0.977*
	(0.010)	(0.009)	(0.009)	(0.009)
Arterial Embolism				
SFA Laws, Weighted	1.001	1.011	1.018	1.035
	(0.015)	(0.016)	(0.017)	(0.023)
Real Cigarette Price	0.984	0.983	0.982	0.977
	(0.017)	(0.017)	(0.017)	(0.018)
Hypertension				
SFA Laws, Weighted	1.104*	1.110*	1.133**	1.170**
	(0.044)	(0.048)	(0.048)	(0.066)
Real Cigarette Price	0.839***	0.838***	0.833***	0.823***
	(0.044)	(0.043)	(0.043)	(0.045)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE LX: ALTERNATE COVERAGE LEVELS - RESPIRATORY DIAGNOSES, AGES 18+[a,b]

Variables	25 Percent	50 Percent	75 Percent	100 Percent
Tuberculosis				
SFA Laws, Weighted	0.939	0.907*	0.922*	0.911**
	(0.034)	(0.037)	(0.036)	(0.030)
Real Cigarette Price	0.903**	0.913**	0.910**	0.912**
	(0.028)	(0.029)	(0.028)	(0.026)
COPD				
SFA Laws, Weighted	1.013	1.014	1.054***	1.026
	(0.012)	(0.013)	(0.016)	(0.019)
Real Cigarette Price	1.016	1.015	1.009	1.012
	(0.014)	(0.014)	(0.013)	(0.013)
Asthma				
SFA Laws, Weighted	1.008	1.005	1.052***	0.997
	(0.012)	(0.014)	(0.016)	(0.018)
Real Cigarette Price	1.004	1.005	0.998	1.006
	(0.015)	(0.014)	(0.014)	(0.014)

*$p<0.05$, **$p<0.01$, ***$p<0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE LXI: ALTERNATE COVERAGE LEVELS - COUNTERFACTUAL DIAGNOSIS, AGES 18+[a,b]

Variables	25 Percent	50 Percent	75 Percent	100 Percent
Appendicitis				
SFA Laws, Weighted	0.991	0.980	0.965*	0.938***
	(0.017)	(0.014)	(0.016)	(0.017)
Real Cigarette Price	0.992	0.994	0.997	1.005
	(0.013)	(0.012)	(0.012)	(0.013)

*$p<0.05$, **$p<0.01$, ***$p<0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

declines under each coverage definition, while COPD and asthma are either unchanged or slightly increase at higher coverage levels. Finally, appendicitis hospitalizations are unaffected for both the 25% and 50% coverage definitions, but decline significantly under the 75% and 100% coverage levels.

While these results suggest that the estimates are similar across various definitions of the treatment variable, they likely represent the presence of more than one effect. It could be that as the coverage level increases from 25% to 100%, the observed changes in hospitalizations are partly due to the lagged impact of an earlier ban covering a single venue. These changes may also reflect the initial impact of new legislation covering multiple venues.

To test for the presence of any pre-treatment changes in hospitalizations, Model 2 is used to estimate the effect of smoke-free air legislation for each individual year prior to and following the enactment of a smoking ban. The coefficients on the four indicator variables leading up to the enactment of a smoke-free air law are shown in Tables LXII through LXV. These pre-treatment changes may occur if individuals self-select into counties based on health preferences prior to smoke-free air legislation becoming law. However, as shown above in Section 5, the nearly identical observable characteristics of counties around the treatment date suggests this is unlikely. While several diagnoses exhibit significant changes in the years leading up to a smoking ban, none appear to be systematic, and only breast cancer increases significantly in the year immediately preceding new legislation.

TABLE LXII: PRE-TREATMENT INDICATOR VARIABLES, AT LEAST 50 PERCENT COVERAGE - CANCER DIAGNOSES, AGES 18+[a,b]

Variables	$(t-4)$	$(t-3)$	$(t-2)$	$(t-1)$
Lung Cancer				
SFA Laws, Weighted	0.970*	0.993	0.987	0.989
	(0.014)	(0.012)	(0.009)	(0.008)
Breast Cancer				
SFA Laws, Weighted	1.013	1.027*	1.013	1.021*
	(0.014)	(0.013)	(0.011)	(0.009)
Prostate Cancer				
SFA Laws, Weighted	0.945**	0.976	0.989	1.001
	(0.019)	(0.016)	(0.012)	(0.009)

*$p< 0.05$, **$p< 0.01$, ***$p< 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE LXIII: PRE-TREATMENT INDICATOR VARIABLES, AT LEAST 50 PERCENT COVERAGE - CARDIOVASCULAR DIAGNOSES, AGES 18+[a,b]

Variables	$(t-4)$	$(t-3)$	$(t-2)$	$(t-1)$
Acute Myocardial Infarction				
SFA Laws, Weighted	1.004	1.009	0.999	0.993
	(0.009)	(0.007)	(0.005)	(0.004)
Coronary Atherosclerosis				
SFA Laws, Weighted	0.983	0.999	0.991	0.997
	(0.017)	(0.013)	(0.010)	(0.006)
Acute Cerebrovascular Disease				
SFA Laws, Weighted	1.013	1.025**	1.011	1.003
	(0.012)	(0.009)	(0.006)	(0.004)
Peripheral & Visceral Atherosclerosis				
SFA Laws, Weighted	1.005	1.007	0.998	0.994
	(0.018)	(0.014)	(0.010)	(0.007)
Artery Aneurysms				
SFA Laws, Weighted	0.995	1.016	1.002	1.008
	(0.014)	(0.010)	(0.009)	(0.008)
Arterial Embolism				
SFA Laws, Weighted	1.016	0.996	0.986	0.998
	(0.020)	(0.015)	(0.015)	(0.013)
Hypertension				
SFA Laws, Weighted	0.929*	0.965	0.970	0.992
	(0.027)	(0.022)	(0.017)	(0.010)

*$p< 0.05$, **$p< 0.01$, ***$p< 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE LXIV: PRE-TREATMENT INDICATOR VARIABLES, AT LEAST 50 PERCENT COVERAGE - RESPIRATORY DIAGNOSES, AGES 18+[a,b]

Variables	$(t-4)$	$(t-3)$	$(t-2)$	$(t-1)$
Tuberculosis				
SFA Laws, Weighted	1.006	1.055	1.023	1.028
	(0.036)	(0.036)	(0.023)	(0.023)
COPD				
SFA Laws, Weighted	0.980	0.990	1.001	0.990
	(0.012)	(0.009)	(0.007)	(0.005)
Asthma				
SFA Laws, Weighted	0.979	0.990	0.998	0.994
	(0.014)	(0.011)	(0.009)	(0.008)

*$p<0.05$, **$p<0.01$, ***$p<0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE LXV: PRE-TREATMENT INDICATOR VARIABLES, AT LEAST 50 PERCENT COVERAGE - COUNTERFACTUAL DIAGNOSIS, AGES 18+[a,b]

Variables	$(t-4)$	$(t-3)$	$(t-2)$	$(t-1)$
Appendicitis				
SFA Laws, Weighted	1.024	1.034**	1.009	1.002
	(0.016)	(0.012)	(0.009)	(0.007)

*$p<0.05$, **$p<0.01$, ***$p<0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

A potential source of the pre-treatment change in hospitalizations results from the definition of smoke-free air coverage used in this study. If a county enacts a single smoking ban, the average level of protection across all four venues is equal to 25%, and any resulting decline in the number of hospitalizations is not attributed to the smoke-free air policy. If single venue bans provide measurable health benefits at the county level, and if these bans precede the enactment of smoking restrictions in additional venues, this may partially explain the statistically significant pre-treatment changes shown above. This would also suggest that the estimates of Models 1 through 4 underestimate the true impact of smoke-free air legislation.

Using the 25% coverage definition, Model 2 is then re-estimated with individual indicator variables for each year prior to and following the enactment of smoke-free air legislation. Tables LXVI through LXIX show the results of the four indicator variables leading up to the enactment of a smoking ban. When using this lower threshold of smoke-free air coverage, both acute cerebrovascular disease and hypertension show significant changes in the years leading up to the treatment date, although with reduced significance and in opposite directions.

The coefficient estimates and confidence intervals for individual years leading up to and following the enactment of smoke-free air legislation, using both the 25% and 50% coverage definitions, are shown graphically in Figures 7 through 20 in the Appendix. While indicators for all years prior

TABLE LXVI: PRE-TREATMENT INDICATOR VARIABLES, AT LEAST 25 PERCENT COVERAGE - CANCER DIAGNOSES, AGES 18+[a,b]

Variables	$(t-4)$	$(t-3)$	$(t-2)$	$(t-1)$
Lung Cancer				
SFA Laws, Weighted	0.988	0.996	1.001	1.003
	(0.012)	(0.011)	(0.008)	(0.007)
Breast Cancer				
SFA Laws, Weighted	1.005	1.013	1.009	1.012
	(0.015)	(0.013)	(0.011)	(0.008)
Prostate Cancer				
SFA Laws, Weighted	0.950**	0.967*	0.988	1.004
	(0.016)	(0.014)	(0.011)	(0.009)

*$p< 0.05$, **$p< 0.01$, ***$p< 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE LXVII: PRE-TREATMENT INDICATOR VARIABLES, AT LEAST 25 PERCENT COVERAGE - CARDIOVASCULAR DIAGNOSES, AGES 18+[a,b]

Variables	$(t-4)$	$(t-3)$	$(t-2)$	$(t-1)$
Acute Myocardial Infarction				
SFA Laws, Weighted	1.018	1.014	1.007	0.995
	(0.010)	(0.008)	(0.006)	(0.004)
Coronary Atherosclerosis				
SFA Laws, Weighted	0.983	0.991	0.994	0.992
	(0.014)	(0.010)	(0.008)	(0.006)
Acute Cerebrovascular Disease				
SFA Laws, Weighted	1.017	1.033***	1.020**	1.011*
	(0.010)	(0.008)	(0.007)	(0.005)
Peripheral & Visceral Atherosclerosis				
SFA Laws, Weighted	1.015	1.014	1.002	1.002
	(0.015)	(0.013)	(0.010)	(0.007)
Artery Aneurysms				
SFA Laws, Weighted	0.988	1.002	0.998	1.004
	(0.013)	(0.009)	(0.009)	(0.008)
Arterial Embolism				
SFA Laws, Weighted	1.021	1.008	0.994	1.001
	(0.018)	(0.015)	(0.014)	(0.012)
Hypertension				
SFA Laws, Weighted	0.902**	0.931**	0.960*	0.976*
	(0.033)	(0.023)	(0.019)	(0.012)

*$p< 0.05$, **$p< 0.01$, ***$p< 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE LXVIII: PRE-TREATMENT INDICATOR VARIABLES, AT LEAST 25 PERCENT COVERAGE - RESPIRATORY DIAGNOSES, AGES 18+[a,b]

Variables	$(t-4)$	$(t-3)$	$(t-2)$	$(t-1)$
Tuberculosis				
SFA Laws, Weighted	1.015	1.041	0.989	0.997
	(0.037)	(0.028)	(0.020)	(0.015)
COPD				
SFA Laws, Weighted	0.990	0.994	1.003	1.000
	(0.012)	(0.010)	(0.008)	(0.005)
Asthma				
SFA Laws, Weighted	1.002	0.997	1.011	1.010
	(0.014)	(0.011)	(0.010)	(0.007)

*$p< 0.05$, **$p< 0.01$, ***$p< 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

TABLE LXIX: PRE-TREATMENT INDICATOR VARIABLES, AT LEAST 25 PERCENT COVERAGE - COUNTERFACTUAL DIAGNOSIS, AGES 18+[a,b]

Variables	$(t-4)$	$(t-3)$	$(t-2)$	$(t-1)$
Appendicitis				
SFA Laws, Weighted	1.012	1.022	1.006	1.009
	(0.017)	(0.014)	(0.010)	(0.007)

*$p< 0.05$, **$p< 0.01$, ***$p< 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: County Controls, County FE, Year FE.

to and following a smoking ban were included in the estimation, only the coefficients for four years preceding and 10 years following a smoking ban are shown. In all cases, the year in which the law is enacted serves as the baseline comparison. The trends differ slightly based on the coverage definition used, with a slightly more consistent decline occurring under the 25% definition. A general decline in observed for each cancer diagnosis, as well as acute myocardial infarction, acute cerebrovascular disease, arterial embolism, and tuberculosis. However, hypertension, COPD, and asthma hospitalizations exhibit a consistent increase regardless of the treatment definition. Similar to the lagged values of smoke-free air legislation, cigarette prices, and air pollution in Section 6 above, the longer term effects are less precisely estimated, evidenced by the larger confidence intervals of each coefficient.

Finally, Tables LXX through LXXIII display the significance levels of coefficients from Model 2 using the default p-values and corrected q-values from Benjamini and Hochberg (BH) and Benjamini, Krieger, and Yekutieli (BKY). The Bonferroni-adjusted critical values, accounting for 14 diagnosis groups estimated across three age groups, are 0.0012 instead of 0.05, 0.0002 instead of 0.01, and 0.00002 instead of 0.001. Several diagnoses remain significant under the q-value adjustments, though typically at a lower significance level. Using the Bonferroni-adjusted critical values, a $1.00 increase in the real cigarette price leads to significant declines for hypertension at the 5% level and coronary atherosclerosis at the 1% level.

TABLE LXX: COMPARISON OF SIGNIFICANCE VALUES, CANCER DIAGNOSES

Outcome	Original p-value	BH q-value	BKY q-value
Lung Cancer			
SFA Laws, Weighted	0.1099	0.276	0.226
Real Cigarette Price	0.4967	0.633	0.463
Breast Cancer			
SFA Laws, Weighted	0.0091**	0.055	0.050*
Real Cigarette Price	0.0255*	0.094	0.074
Prostate Cancer			
SFA Laws, Weighted	0.1143	0.276	0.226
Real Cigarette Price	0.1147	0.276	0.226

*$p, q < 0.05$, **$p, q < 0.01$, ***$p, q < 0.001$

TABLE LXXI: COMPARISON OF SIGNIFICANCE VALUES, CARDIOVASCULAR DIAGNOSES

Outcome	Original p-value	BH q-value	BKY q-value
Acute Myocardial Infarction			
SFA Laws, Weighted	0.3594	0.530	0.408
Real Cigarette Price	0.9722	0.973	0.704
Coronary Atherosclerosis			
SFA Laws, Weighted	0.5450	0.674	0.508
Real Cigarette Price	0.0001***	0.004**	0.004**
Acute Cerebrovascular Disease			
SFA Laws, Weighted	0.2409	0.413	0.353
Real Cigarette Price	0.0905	0.254	0.204
Peripheral & Visceral Atherosclerosis			
SFA Laws, Weighted	0.2951	0.460	0.381
Real Cigarette Price	0.0075**	0.049*	0.044*
Artery Aneurysms			
SFA Laws, Weighted	0.2190	0.396	0.341
Real Cigarette Price	0.1050	0.276	0.226
Arterial Embolism			
SFA Laws, Weighted	0.5116	0.642	0.473
Real Cigarette Price	0.3248	0.497	0.402
Hypertension			
SFA Laws, Weighted	0.0170*	0.065	0.058
Real Cigarette Price	0.0006***	0.008**	0.008**

*$p, q < 0.05$, **$p, q < 0.01$, ***$p, q < 0.001$

TABLE LXXII: COMPARISON OF SIGNIFICANCE VALUES, RESPIRATORY DIAGNOSES

Outcome	Original p-value	BH q-value	BKY q-value
Tuberculosis			
SFA Laws, Weighted	0.0168	0.065	0.058
Real Cigarette Price	0.0038**	0.028*	0.025*
COPD			
SFA Laws, Weighted	0.2956	0.460	0.381
Real Cigarette Price	0.2623	0.441	0.381
Asthma			
SFA Laws, Weighted	0.7134	0.789	0.602
Real Cigarette Price	0.7466	0.805	0.607

*$p, q<$ 0.05, **$p, q<$ 0.01, ***$p, q<$ 0.001

TABLE LXXIII: COMPARISON OF SIGNIFICANCE VALUES, COUNTERFACTUAL DIAGNOSIS

Outcome	Original p-value	BH q-value	BKY q-value
Appendicitis			
SFA Laws, Weighted	.1448	0.297	0.247
Real Cigarette Price	.6176	0.721	0.560

*$p, q<$ 0.05, **$p, q<$ 0.01, ***$p, q<$ 0.001

7 DISCUSSION

This study analyzes the impact of comprehensive smoke-free air legislation and county level cigarette prices on the number of cancer, cardiovascular, and respiratory hospitalizations in the United States. Examining up to 80% of adult hospitalizations, while controlling for a rich set of county characteristics, produces estimates that more closely reflect the general population and are less likely to suffer from omitted variable bias. Additionally, an expanded set of outcome variables is examined, providing new insight into the effects of tobacco control policies on human health.

The existing literature suggests that smoke-free air legislation and cigarette taxation reduce smoking prevalence, cigarette consumption, and exposure to secondhand smoke, all of which lead to improved health outcomes among smokers and non-smokers. Previous research examining the impact of smoke-free air legislation on hospitalization rates for cardiovascular and respiratory conditions find wide ranging effects. Declines in acute myocardial infarction and asthma hospitalizations range from 47% and 22% declines, respectively, to moderate increases. However, these estimates may not be representative of the general population, and omit the impact of cigarette prices, an effective tobacco control policy. The results of this study suggest that cancer, cardiovascular, and respiratory diagnoses decline after the implementation of smoke-free air legislation and cigarette taxes, though the results are often driven by a select group of diagnoses. For respiratory conditions, tuberculosis hospitalizations consistently decline in response to each policy, while changes in COPD and asthma depend on model specification and subgroup analysis by age. Two key insights from this study relate to the immediate declines observed in breast cancer hospitalizations, as well as the delayed effects in various diagnoses. Estimates from Model 2 suggest that smoke-free air legislation leads to 3.6% fewer breast cancer hospitalizations among all adults, and a 4.7% decline among adults ages 65 and older. Further, a $1.00 increase in the real cigarette price leads to similar declines of 3.5% and 5.1% for each age group, respectively. When estimating the lagged effect of each tobacco control policy, changes in the real cigarette price lead to significant declines in lung cancer, breast cancer, acute myocardial infarction, coronary atherosclerosis, artery aneurysms, and hypertension, as well as modest declines in prostate cancer, acute cerebrovascular disease, arterial embolism, tuberculosis, COPD, and asthma.

Results from Model 3 showed that the relative gains made in the first year after a smoking ban was enacted are similar in size to the changes that occur in the following years. For cancer diagnoses in particular, larger improvements in health are generally expected to occur over the long run, as the increased relative risk among former smokers can remain for decades. While lung and prostate cancer remained elevated, breast cancer hospitalizations exhibited both short and medium run declines. Among cardiovascular diagnoses, most remain unchanged between the first year after a smoking ban occurs and two or more years later. However, the results suggest that the increase in hypertension hospitalizations found throughout this study result from the changes that occur two or more years after a smoking ban is enacted. This is consistent with previous research suggesting that smoking cessation is associated with weight gain, which leads to declines in health and is more likely to accrue over time. For respiratory diagnoses, the effect on tuberculosis varies by age subgroup, with older adults benefiting during the first year after a smoking ban, and working age adults in later years.

Once controlling for the cumulative effects of smoke-free air legislation over time in Model 4, several cardiovascular and respiratory diagnoses exhibited modest declines, including acute myocardial infarction, acute cerebrovascular disease, artery aneurysms, and asthma, with the largest effects observed for adults ages 65 and older. These findings, along with the coefficients on $\textit{Years Since SFA}_{it}$ and $\textit{Years Since SFA}^2_{it}$ (not shown), suggest that hospitalizations for these diagnoses initially decrease in response to smoke-free air legislation, but the total effect is overshadowed by the increasing hospitalization rate in the years that follow.

The results also suggest that some of the largest improvements in health occurred among tobacco producing states. Implementing additional comprehensive smoke-free air legislation and cigarette taxation would lead to significant declines in cancer, cardiovascular, and respiratory hospitalizations among these states. When examining aggregated diagnosis groups, an increase in the real cigarette price led to significant improvements in both cancer and cardiovascular hospitalizations. This was reiterated by the marked decline in predicted hospitalizations that could have been avoided if states had followed the Healthy People 2020 guideline by raising the cigarette tax \$1.50 above the current level.

Several specification tests were then performed to estimate the presence of any pre-treatment changes in the number of hospitalizations for each diagnosis. Results suggest there is generally no significant change in health outcomes leading up to the enactment of smoke-free air legislation. An examination of the observable characteristics within treated counties before and after smoke-free air legislation is enacted also suggests no significant changes occur.

Despite examining a large number of diagnoses in this study, no adjustments were made to the p-values to account for multiple hypothesis testing. However, a comparison of the results from Model 2 with p-value corrections and reduced critical values showed how the significance levels varied under alternate adjustment methods. While the coefficients that were originally significant at the 0.1% and 1% level remained statistically different from zero, those at the 5% level were often no longer statistically significant under each alternative method.

Similar to previous research, this study has several limitations. First, individual exposure to secondhand smoke is not observable and is assumed to be constant within a county and identical across individuals. Second, individuals are assumed to be affected only by tobacco control policies in their county of residence, and the impact of neighboring county policies are assumed to be zero. Also, this study does not control for alternative tobacco control policies such as advertising bans or public awareness campaigns which may reduce smoking prevalence, cigarette consumption, and exposure to secondhand smoke, leading to fewer hospitalizations. If these programs are enacted simultaneously with smoke-free air legislation or increased cigarette taxes, this will bias the estimates in this study away from zero, giving smoking bans and cigarette taxes the appearance of being more beneficial than they actually are. Additionally, the presence of informal smoking bans prior to the enactment of smoke-free air legislation, particularly in public or private workplaces, will bias the estimates downward toward zero, as the true impact of a smoking ban should be larger.

Despite these limitations, the findings of this study have important policy implications. Nearly 42% of the population remains unprotected by smoke-free air legislation across all four venues, and millions of consumers face relatively low cigarette prices across many states. Expanding coverage of smoke-free air legislation and increasing the real cigarette price, particularly among tobacco producing states, would do much to reduce the number of cancer, cardiovascular, and respiratory hospitalizations among adults in the United States.

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Rhode Island Department of Health, Center for Health Data & Analysis. Providence, RI.

South Carolina Revenue and Fiscal Affairs Office. Columbia, SC.

St. Paul Group, The. Baltimore, MD.

Tennessee Department of Health. Nashville, TN.

Texas Department of State Health Services. Austin, TX.

University of Nevada, Las Vegas, Center for Health Information Analysis. Las Vegas, NV.

Utah Department of Health, Office of Health Care Statistics. Salt Lake City, UT.

Washington State Department of Health, Division of Disease Control and Health Statistics. Olympia, WA.

Vermont Department of Health, Division of Health Surveillance. Burlington, VT.

Virginia Health Information. Richmond, VA.

West Virginia Health Care Authority. Charleston, WV.

Wisconsin Hospital Association. Madison, WI.

Wyoming Department of Health. Cheyenne, WY.

APPENDIX

TABLE LXXIV: MODEL 2, COMPARISON OF COEFFICIENTS - LUNG CANCER[a,b]

Variables	(1)	(2)	(3)
SFA Laws	1.007	1.018	1.023
	(0.016)	(0.016)	(0.014)
$PM_{2.5}$ Concentration		1.000	0.999
		(0.002)	(0.002)
Percent of Population, Non-White		0.992*	0.991*
		(0.003)	(0.003)
Unemployment Rate		1.014***	1.014***
		(0.003)	(0.003)
Real Median HHI (in thousands)		1.006***	1.007***
		(0.001)	(0.002)
Number of Bars per 1,000		1.007	0.998
		(0.045)	(0.043)
Number of Restaurants per 1,000		0.895***	0.897***
		(0.021)	(0.022)
Price Differential			0.985
			(0.015)
Real Cigarette Price			0.991
			(0.013)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: Population, County FE, Year FE.

TABLE LXXV: MODEL 2, COMPARISON OF COEFFICIENTS - BREAST CANCER[a,b]

Variables	(1)	(2)	(3)
SFA Laws	0.952***	0.959**	0.964**
	(0.014)	(0.014)	(0.013)
$PM_{2.5}$ Concentration		1.004	1.003
		(0.002)	(0.002)
Percent of Population, Non-White		1.002	1.002
		(0.005)	(0.005)
Unemployment Rate		1.000	1.000
		(0.004)	(0.004)
Real Median HHI (in thousands)		1.007***	1.008***
		(0.002)	(0.002)
Number of Bars per 1,000		1.030	1.002
		(0.078)	(0.075)
Number of Restaurants per 1,000		0.920***	0.924**
		(0.023)	(0.023)
Price Differential			1.036*
			(0.018)
Real Cigarette Price			0.965*
			(0.015)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: Population, County FE, Year FE.

TABLE LXXVI: MODEL 2, COMPARISON OF COEFFICIENTS - PROSTATE CANCER[a,b]

Variables	(1)	(2)	(3)
SFA Laws	1.003	1.017	1.025
	(0.015)	(0.016)	(0.016)
$PM_{2.5}$ Concentration		1.005	1.003
		(0.002)	(0.003)
Percent of Population, Non-White		0.984***	0.983***
		(0.005)	(0.005)
Unemployment Rate		1.012**	1.012**
		(0.004)	(0.004)
Real Median HHI (in thousands)		1.009***	1.009***
		(0.002)	(0.002)
Number of Bars per 1,000		1.074	1.052
		(0.077)	(0.075)
Number of Restaurants per 1,000		0.931**	0.934*
		(0.025)	(0.025)
Price Differential			0.995
			(0.021)
Real Cigarette Price			0.974
			(0.016)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: Population, County FE, Year FE.

TABLE LXXVII: MODEL 2, COMPARISON OF COEFFICIENTS - ACUTE MYOCARDIAL INFARCTION[a,b]

Variables	(1)	(2)	(3)
SFA Laws	0.984	0.989	0.991
	(0.010)	(0.010)	(0.010)
$PM_{2.5}$ Concentration		1.004*	1.003
		(0.002)	(0.002)
Percent of Population, Non-White		0.998	0.997
		(0.004)	(0.004)
Unemployment Rate		1.002	1.002
		(0.003)	(0.003)
Real Median HHI (in thousands)		1.002	1.002
		(0.001)	(0.001)
Number of Bars per 1,000		1.042	1.040
		(0.037)	(0.038)
Number of Restaurants per 1,000		0.928**	0.930**
		(0.022)	(0.022)
Price Differential			0.972
			(0.016)
Real Cigarette Price			1.000
			(0.010)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: Population, County FE, Year FE.

TABLE LXXVIII: MODEL 2, COMPARISON OF COEFFICIENTS - CORONARY ATHEROSCLEROSIS[a,b]

Variables	(1)	(2)	(3)
SFA Laws	0.986	1.000	1.010
	(0.017)	(0.016)	(0.017)
$PM_{2.5}$ Concentration		1.010***	1.008**
		(0.003)	(0.003)
Percent of Population, Non-White		0.983***	0.982***
		(0.005)	(0.005)
Unemployment Rate		1.009*	1.009*
		(0.004)	(0.004)
Real Median HHI (in thousands)		1.002	1.003
		(0.002)	(0.002)
Number of Bars per 1,000		1.003	0.957
		(0.063)	(0.059)
Number of Restaurants per 1,000		0.832***	0.839***
		(0.026)	(0.026)
Price Differential			1.021
			(0.026)
Real Cigarette Price			0.939***
			(0.015)

*$p< 0.05$, **$p< 0.01$, ***$p< 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: Population, County FE, Year FE.

TABLE LXXIX: MODEL 2, COMPARISON OF COEFFICIENTS - ACUTE CEREBROVASCULAR DISEASE[a,b]

Variables	(1)	(2)	(3)
SFA Laws	0.982	0.987	0.986
	(0.013)	(0.013)	(0.012)
$PM_{2.5}$ Concentration		0.999	0.998
		(0.002)	(0.002)
Percent of Population, Non-White		1.005	1.004
		(0.004)	(0.003)
Unemployment Rate		1.002	1.002
		(0.003)	(0.003)
Real Median HHI (in thousands)		1.005***	1.005**
		(0.002)	(0.002)
Number of Bars per 1,000		1.069	1.086
		(0.050)	(0.050)
Number of Restaurants per 1,000		0.913***	0.913***
		(0.022)	(0.022)
Price Differential			0.944**
			(0.018)
Real Cigarette Price			1.022
			(0.013)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: Population, County FE, Year FE.

TABLE LXXX: MODEL 2, COMPARISON OF COEFFICIENTS - PERIPHERAL AND VISCERAL ATHEROSCLEROSIS[a,b]

Variables	(1)	(2)	(3)
SFA Laws	1.015	1.018	1.014
	(0.015)	(0.015)	(0.013)
$PM_{2.5}$ Concentration		0.995*	0.995*
		(0.002)	(0.002)
Percent of Population, Non-White		0.991	0.991
		(0.006)	(0.006)
Unemployment Rate		1.006	1.006
		(0.005)	(0.005)
Real Median HHI (in thousands)		1.003	1.003
		(0.002)	(0.002)
Number of Bars per 1,000		0.850*	0.875*
		(0.054)	(0.053)
Number of Restaurants per 1,000		0.862***	0.860***
		(0.027)	(0.027)
Price Differential			0.950***
			(0.014)
Real Cigarette Price			1.039**
			(0.015)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: Population, County FE, Year FE.

TABLE LXXXI: MODEL 2, COMPARISON OF COEFFICIENTS - ARTERY ANEURYSMS[a,b]

Variables	(1)	(2)	(3)
SFA Laws	0.976*	0.984	0.987
	(0.010)	(0.011)	(0.011)
$PM_{2.5}$ Concentration		1.003	1.003
		(0.002)	(0.002)
Percent of Population, Non-White		0.989**	0.988**
		(0.004)	(0.004)
Unemployment Rate		1.011***	1.011***
		(0.003)	(0.003)
Real Median HHI (in thousands)		1.004**	1.005**
		(0.002)	(0.002)
Number of Bars per 1,000		1.011	0.999
		(0.049)	(0.049)
Number of Restaurants per 1,000		0.935**	0.937**
		(0.023)	(0.023)
Price Differential			1.013
			(0.020)
Real Cigarette Price			0.985
			(0.009)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: Population, County FE, Year FE.

TABLE LXXXII: MODEL 2, COMPARISON OF COEFFICIENTS - ARTERIAL EMBOLISM[a,b]

Variables	(1)	(2)	(3)
SFA Laws	0.983	1.002	1.011
	(0.017)	(0.016)	(0.016)
$PM_{2.5}$ Concentration		1.016***	1.014***
		(0.003)	(0.002)
Percent of Population, Non-White		0.989*	0.988*
		(0.005)	(0.005)
Unemployment Rate		1.009*	1.010*
		(0.004)	(0.004)
Real Median HHI (in thousands)		1.002	1.002
		(0.002)	(0.002)
Number of Bars per 1,000		1.148*	1.127
		(0.077)	(0.078)
Number of Restaurants per 1,000		0.854***	0.858***
		(0.035)	(0.036)
Price Differential			0.961
			(0.023)
Real Cigarette Price			0.983
			(0.017)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: Population, County FE, Year FE.

TABLE LXXXIII: MODEL 2, COMPARISON OF COEFFICIENTS - HYPERTENSION[a,b]

Variables	(1)	(2)	(3)
SFA Laws	1.080	1.092	1.110*
	(0.059)	(0.051)	(0.048)
$PM_{2.5}$ Concentration		1.013***	1.008*
		(0.004)	(0.003)
Percent of Population, Non-White		1.013	1.013
		(0.010)	(0.009)
Unemployment Rate		1.000	1.001
		(0.008)	(0.008)
Real Median HHI (in thousands)		0.988*	0.992
		(0.005)	(0.004)
Number of Bars per 1,000		0.691*	0.614*
		(0.129)	(0.117)
Number of Restaurants per 1,000		0.692***	0.715***
		(0.070)	(0.064)
Price Differential			1.171**
			(0.065)
Real Cigarette Price			0.838***
			(0.043)

*$p< 0.05$, **$p< 0.01$, ***$p< 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: Population, County FE, Year FE.

TABLE LXXXIV: MODEL 2, COMPARISON OF COEFFICIENTS - TUBERCULOSIS[a,b]

Variables	(1)	(2)	(3)
SFA Laws	0.795**	0.894**	0.907*
	(0.056)	(0.035)	(0.037)
$PM_{2.5}$ Concentration		1.033***	1.028***
		(0.005)	(0.004)
Percent of Population, Non-White		1.032***	1.030***
		(0.009)	(0.009)
Unemployment Rate		0.973***	0.972***
		(0.007)	(0.007)
Real Median HHI (in thousands)		1.013***	1.012***
		(0.003)	(0.003)
Number of Bars per 1,000		0.753	0.693
		(0.212)	(0.198)
Number of Restaurants per 1,000		0.574***	0.591***
		(0.035)	(0.038)
Price Differential			0.960
			(0.038)
Real Cigarette Price			0.913**
			(0.029)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: Population, County FE, Year FE.

TABLE LXXXV: MODEL 2, COMPARISON OF COEFFICIENTS - COPD[a,b]

Variables	(1)	(2)	(3)
SFA Laws	1.009	1.014	1.014
	(0.015)	(0.014)	(0.013)
$PM_{2.5}$ Concentration		0.997	0.997
		(0.002)	(0.002)
Percent of Population, Non-White		0.993	0.993*
		(0.004)	(0.004)
Unemployment Rate		1.007*	1.007*
		(0.003)	(0.003)
Real Median HHI (in thousands)		0.999	0.999
		(0.001)	(0.002)
Number of Bars per 1,000		0.998	1.006
		(0.054)	(0.054)
Number of Restaurants per 1,000		0.880***	0.880***
		(0.020)	(0.020)
Price Differential			0.971
			(0.018)
Real Cigarette Price			1.015
			(0.014)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: Population, County FE, Year FE.

TABLE LXXXVI: MODEL 2, COMPARISON OF COEFFICIENTS - ASTHMA[a,b]

Variables	(1)	(2)	(3)
SFA Laws	0.999	1.000	1.005
	(0.017)	(0.016)	(0.014)
$PM_{2.5}$ Concentration		0.997	0.995*
		(0.003)	(0.002)
Percent of Population, Non-White		1.016***	1.015**
		(0.005)	(0.004)
Unemployment Rate		1.005	1.005
		(0.004)	(0.004)
Real Median HHI (in thousands)		0.998	0.999
		(0.002)	(0.002)
Number of Bars per 1,000		0.956	0.959
		(0.072)	(0.072)
Number of Restaurants per 1,000		0.910**	0.913***
		(0.027)	(0.025)
Price Differential			0.952**
			(0.018)
Real Cigarette Price			1.005
			(0.014)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: Population, County FE, Year FE.

TABLE LXXXVII: MODEL 2, COMPARISON OF COEFFICIENTS - APPENDICITIS[a,b]

Variables	(1)	(2)	(3)
SFA Laws	0.967*	0.977	0.980
	(0.015)	(0.015)	(0.014)
$PM_{2.5}$ Concentration		1.004	1.004
		(0.003)	(0.003)
Percent of Population, Non-White		1.006	1.005
		(0.005)	(0.005)
Unemployment Rate		1.005	1.005
		(0.005)	(0.005)
Real Median HHI (in thousands)		1.006***	1.006***
		(0.002)	(0.002)
Number of Bars per 1,000		0.927	0.922
		(0.050)	(0.048)
Number of Restaurants per 1,000		1.028	1.031
		(0.032)	(0.032)
Price Differential			0.987
			(0.015)
Real Cigarette Price			0.994
			(0.012)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

[a]Robust standard errors in parentheses.

[b]Not shown: Population, County FE, Year FE.

Figure 7: Years Relative to SFA Law, Lung Cancer

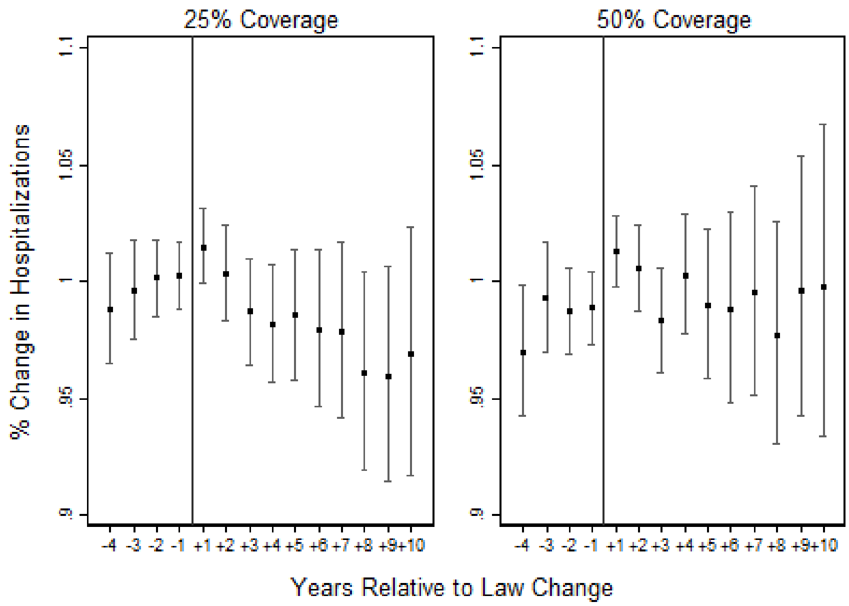


Figure 8: Years Relative to SFA Law, Breast Cancer

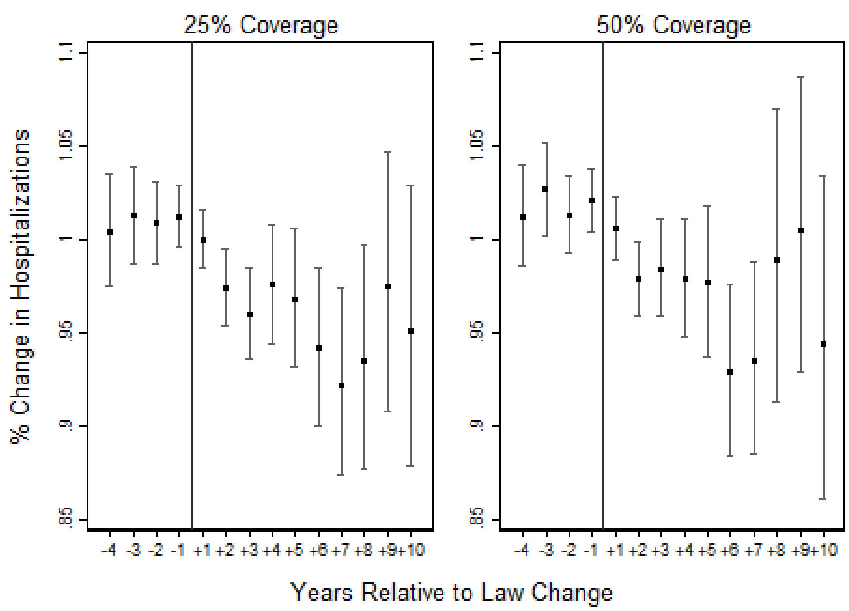


Figure 9: Years Relative to SFA Law, Prostate Cancer

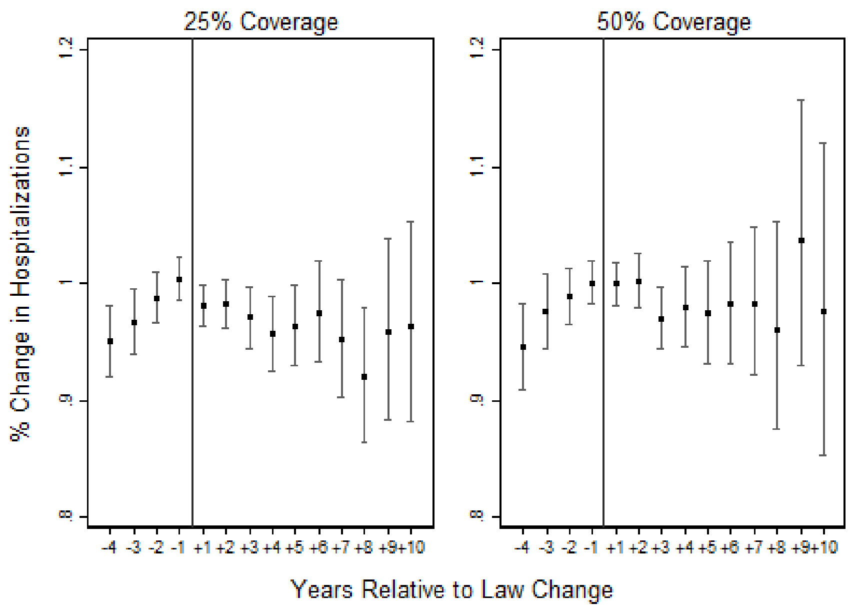


Figure 10: Years Relative to SFA Law, Acute Myocardial Infarction

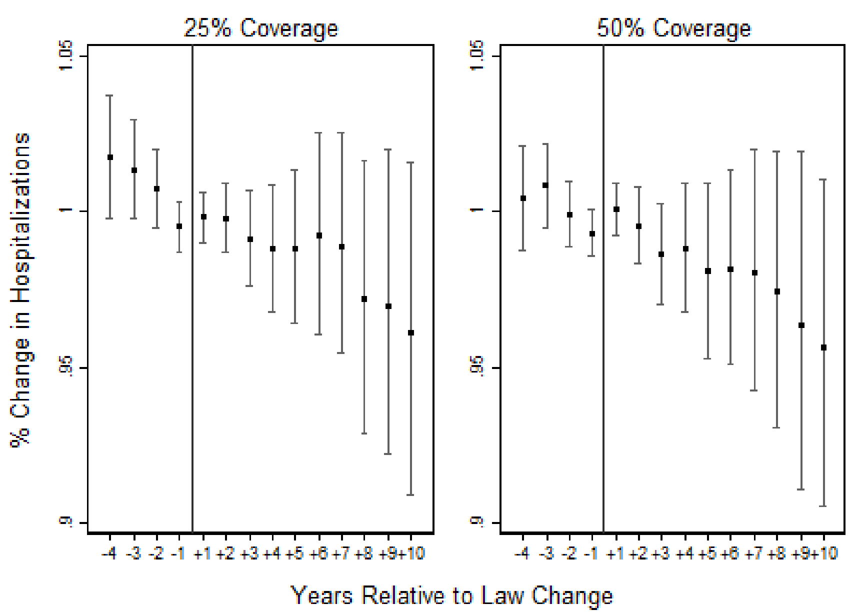


Figure 11: Years Relative to SFA Law, Coronary Atherosclerosis

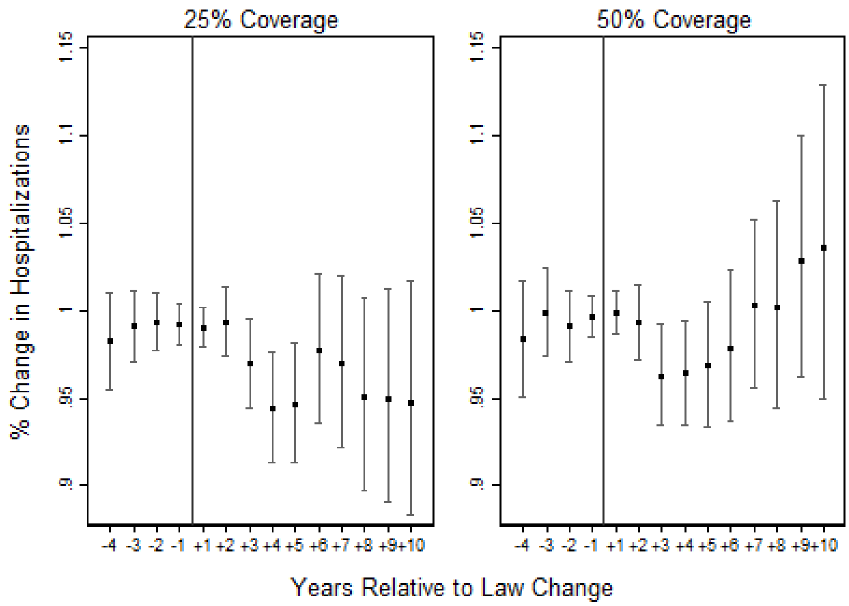


Figure 12: Years Relative to SFA Law, Acute Cerebrovascular Disease

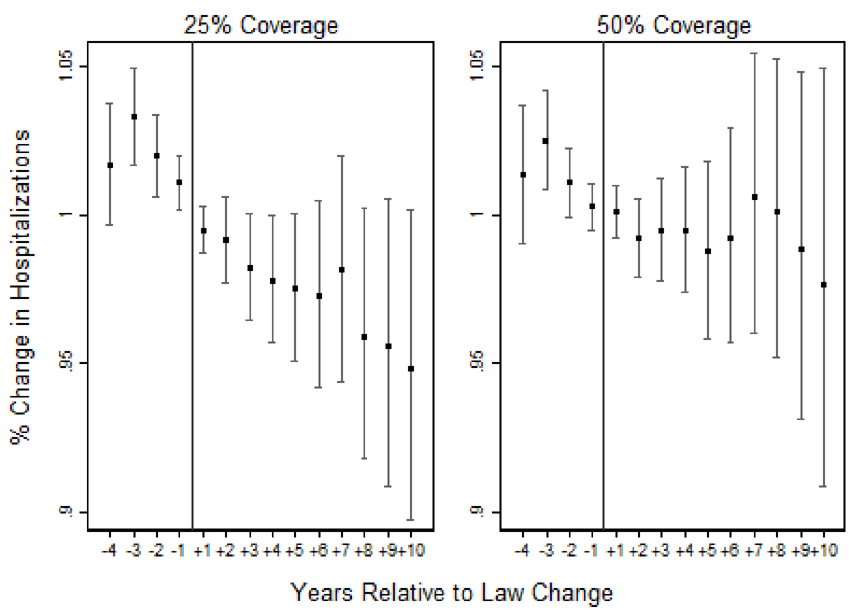


Figure 13: Years Relative to SFA Law, Peripheral & Visceral Atherosclerosis

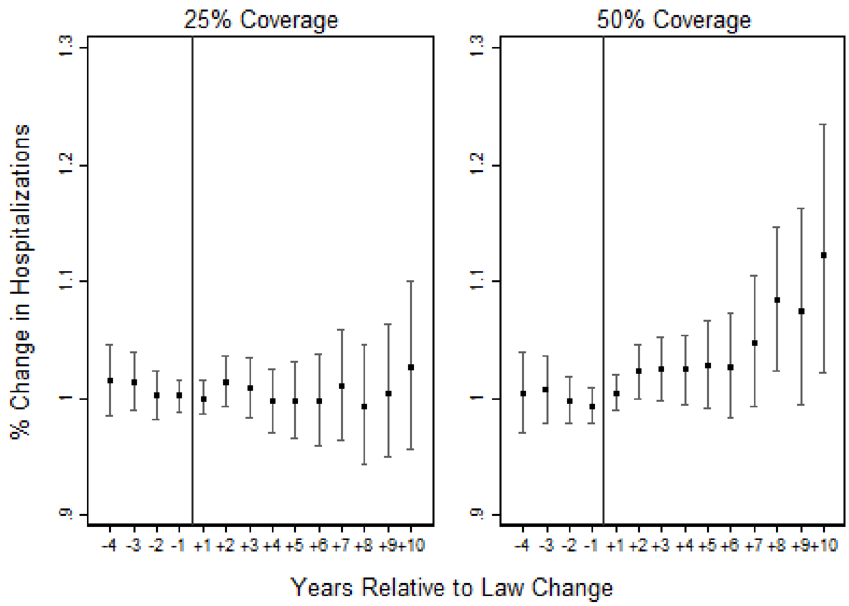


Figure 14: Years Relative to SFA Law, Artery Aneurysms

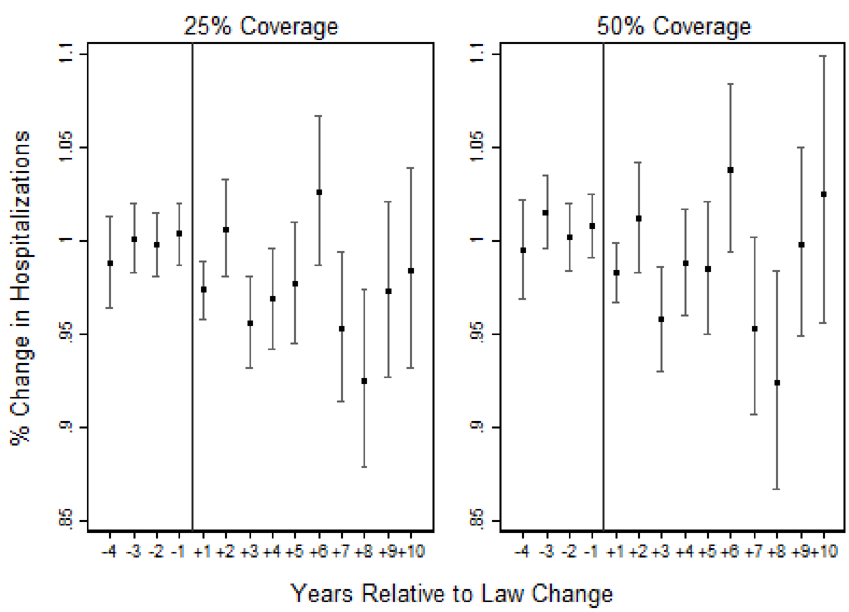


Figure 15: Years Relative to SFA Law, Arterial Embolism

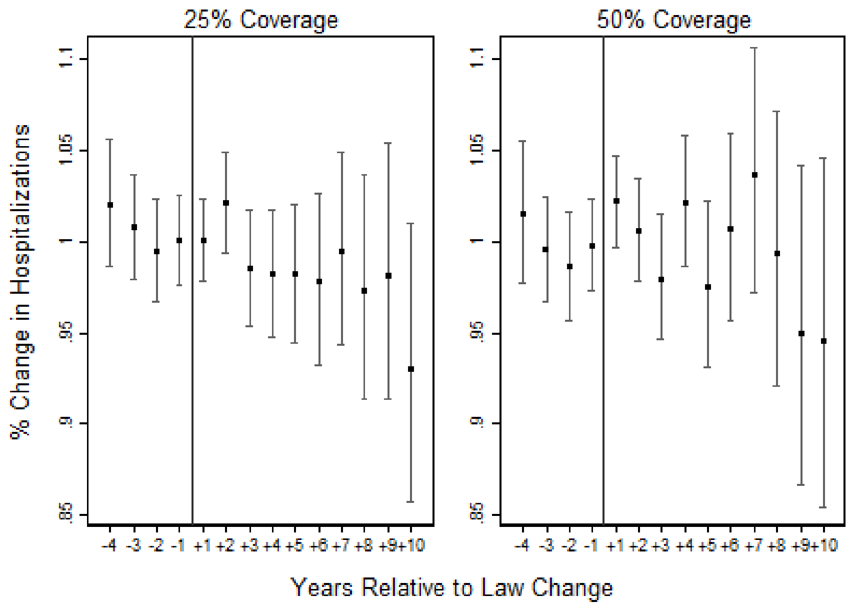


Figure 16: Years Relative to SFA Law, Hypertension

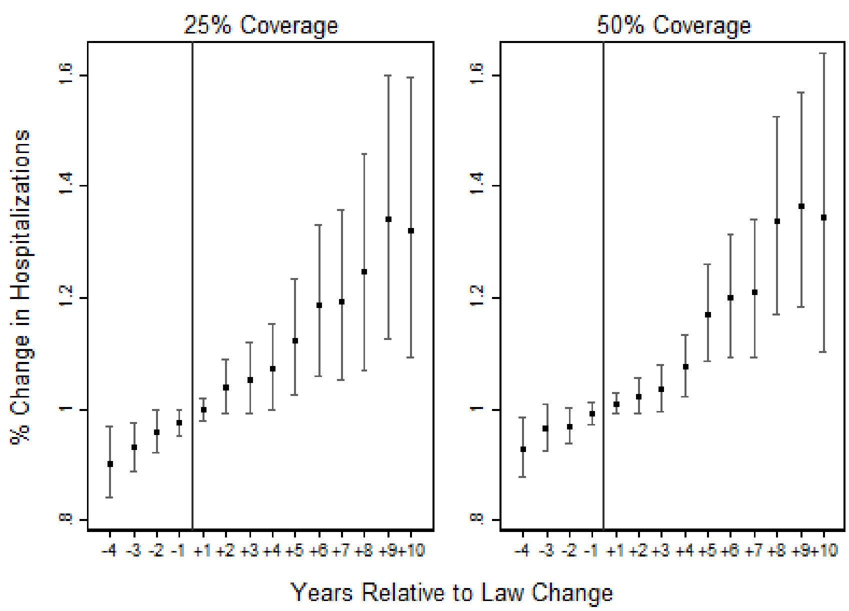


Figure 17: Years Relative to SFA Law, Tuberculosis

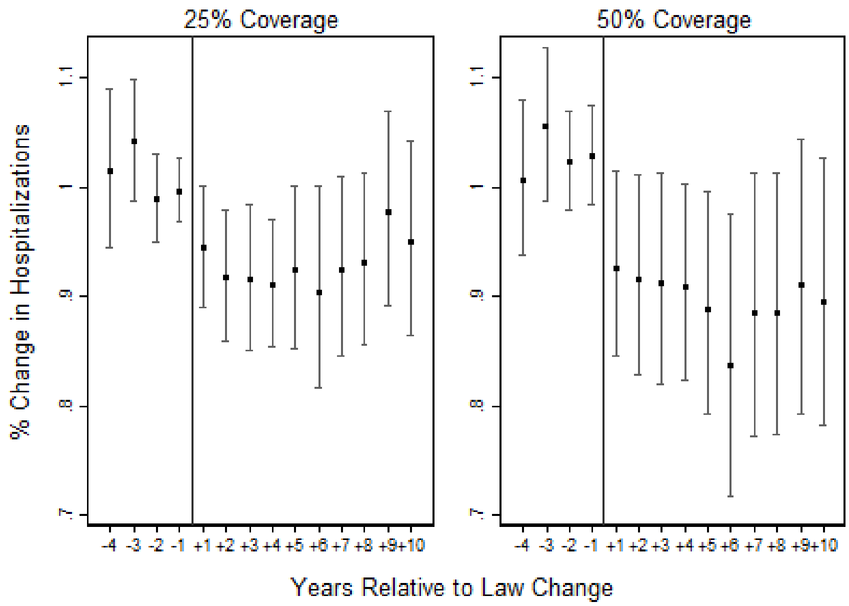


Figure 18: Years Relative to SFA Law, COPD

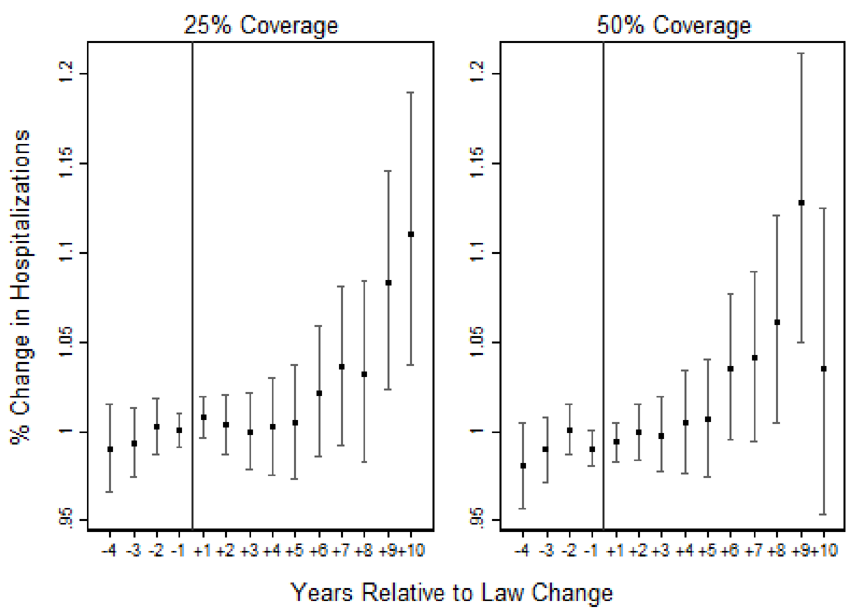


Figure 19: Years Relative to SFA Law, Asthma

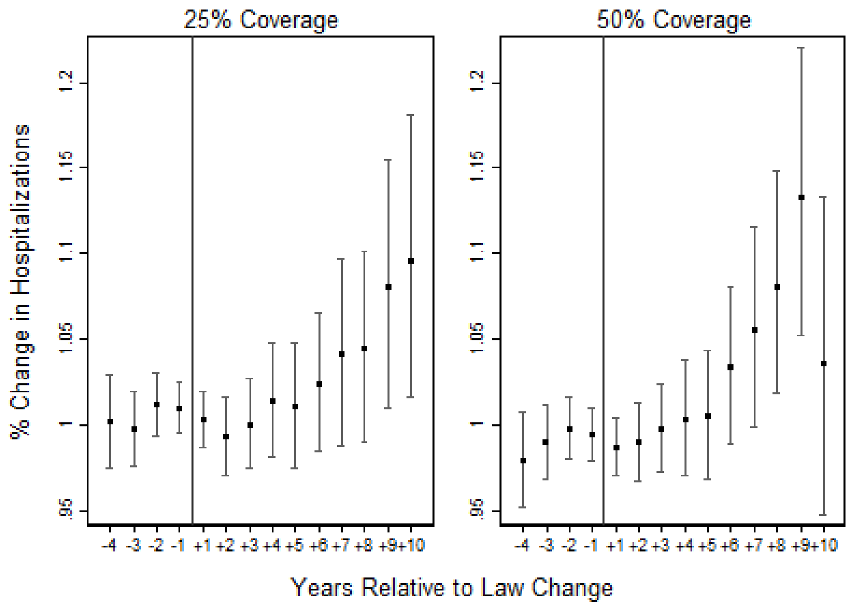
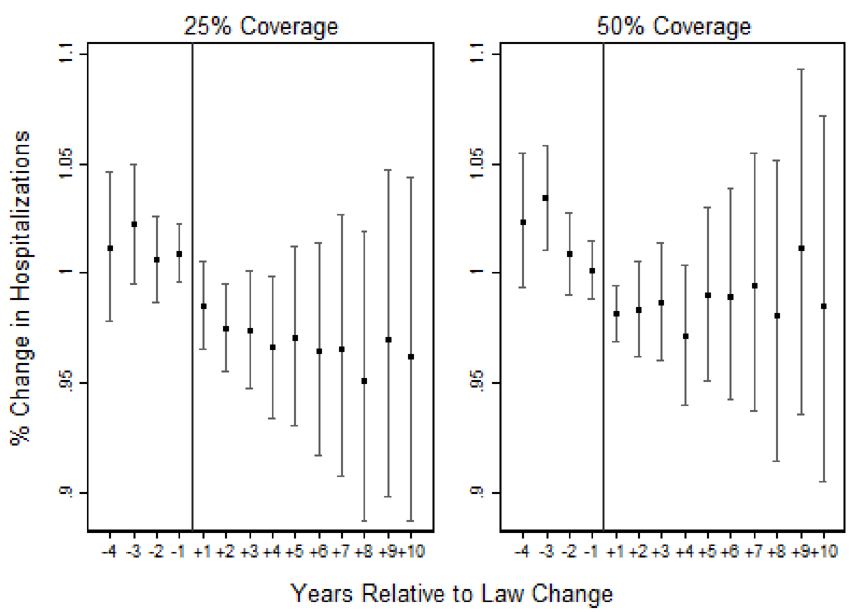


Figure 20: Years Relative to SFA Law, Appendicitis



VITA

Jonathan Oliver

Education

University of Illinois at Chicago

Ph.D., Economics (2018)

M.A., Economics (2014)

B.A., Economics (2011)

B.A., Psychology (2011)

Research Experience

"The Impact of Smoke-Free Air Legislation and Cigarette Prices on Hospitalizations in the United States" (In Progress)

This paper examines the effect of tobacco control policies on cancer, cardiovascular, and respiratory hospitalizations among adults in the United States. I built a unique dataset of county level hospitalizations from 40 states covering the years 1991-2014, resulting in the largest examination of tobacco control policies in the United States to date. To measure these effects, I employ a Poisson model with county and year fixed effects, while controlling for county demographic, economic, and environmental characteristics. Results suggest that smoke-free air legislation and cigarette taxation are effective methods of reducing the number of hospitalizations for cancer, cardiovascular, and respiratory conditions.

"The Impact of Smoke-Free Air Legislation in California Correctional Institutions" (In Progress)

Using a unique dataset of hospital discharge and inmate disciplinary data, this paper examines the impact of smoke-free air legislation on inmate health and behavioral outcomes in the California Department of Corrections and the Federal Bureau of Prisons from 1995-2014. I use a difference-in-difference estimator, taking advantage of a 2005 policy change prohibiting tobacco use in all state-run institutions while exempting nearby federal correctional facilities. Outcome variables include the number of monthly cases of asthma, COPD, and adverse behavioral events among inmates at the facility level.

"Public Housing Demolitions and Changes in School Quality" (2014)

This paper examines whether public housing demolitions in the city of Chicago led to short-run changes in student test scores at the school level. I employ a difference-in-difference estimator, comparing the standardized test scores of 3rd and 7th grade students in schools affected by student displacement with unaffected schools located nearby. Results suggest that at the school level, there is no change in test scores resulting from public housing demolitions.

"The Impact of Comprehensive Smoke-Free Air Legislation in Illinois" (2013)

This study measures the impact of smoke-free air legislation on the number of hospitalizations for acute myocardial infarction and acute cerebrovascular disease in Illinois. Using longitudinal panel data from the city of Chicago and the surrounding seven collar counties from 1994-2010, I estimate a fixed effects regression model with county demographic and economic controls. Results suggest that smoke-free air legislation leads to a 3% reduction in acute myocardial infarction hospitalizations, and has no effect on acute cerebrovascular disease hospitalizations.

Professional Presentations

UIC Economics Research Lunch, 2017

UIC Graduate Student Research Seminar, 2017

Other Experience

Volunteer Tutor 2017 - Present

Federal Bureau of Prisons, Metropolitan Correctional Center, Chicago, IL

Teaching Experience

Lecturer — 2015 - Present

Statistics for Economics, Fall 2017

Economics of Sports & Entertainment, Spring 2017

Statistics for Economics, Fall 2016

Economics of Sports & Entertainment, Summer 2016

Economics of Sports & Entertainment, Spring 2016

Intermediate Microeconomics, Fall 2015

Recitation Instructor/Teaching Assistant — 2011 - 2015

Business Conditions Analysis, Spring 2015

Principles of Macroeconomics, Fall 2014

International Economics, Spring 2014

Principles of Microeconomics, Fall 2013

Principles of Economics, Spring 2013

Principles of Economics, Fall 2012

Principles of Economics, Spring 2012

Principles of Economics, Fall 2011

References

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