DO TAXES REDUCE ADULT SMOKING? ANALYZING THE ROLE OF EXCISE TAXES IN SMOKING PARTICIPATION AND CESSATION ACTIVITIES

By

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Abstract

This Major Research Project studies the association between increases in state-level taxes and smoking participation as well as the relationship between tax increases and smoking cessation of adults aged 18-59 in the United States of America. This paper follows similar empirical strategies utilized in the existing literature while exploring more recent data and methods. I implemented a probit model that illustrates the relationship between smoking participation and excise taxes. Additionally, I split the sample into five different age groups to test the price responsiveness in each age group. The goal of this study was to see if further cigarette taxation is still an effective policy to reduce smoking and whether or not different age groups respond differently to price changes. My estimates suggest that tax increases have little to no effect on participation with everyday smokers as most results are small and statistically insignificant. With a participation elasticity of -.0220489 for everyday smokers aged 18-59, my results show that excise taxes do not significantly decrease smoking participation rates among adults. However, I did find evidence that adults smoking cessation behaviors are positively influenced by tax increases. Meaning, excise taxes are still an important factor in an individual's decision to quit smoking. My preferred model specification yields an elasticity of .0316719 and is statistically significant. Furthermore, I did not find any evidence that different age group's participation habits are influenced differently by excise taxes. I did find that adults aged 24-54 are more likely to quit smoking as a response to tax increases than adults aged 55-59. As estimates show positive statistically significant marginal effects and elasticities for adults aged 24-54. Alternatively, estimates for the age group 55-59 show negative and statistically significant marginal effects and elasticities.

1. Introduction

Implementing excise taxes to reduce tobacco consumption has been largely regarded as a successful policy for some time in multiple countries[1]. Intuitively, the statement that higher taxes will lead to less consumption of tobacco is sound as tobacco is not a necessity. Therefore, economic rationale says tobacco should be taxed. Theoretical work on taxes suggests that everything should be taxed while concentrating on inelastic goods. Policies that continue to raise taxes are usually justified in the general public for the perceived public health improvements that come with reduced cigarette consumption for smokers and non-smokers such as a reduction in second-hand smoke. In the United States as of 2014, there are 16 million Americans who live with a serious disease caused by smoking[2]. Also, it has been proposed that reinvesting the revenue made from high excise taxes on tobacco towards other public health initiatives will continue to educate citizens on healthy lifestyle choices and the dangers of smoking. Since higher tobacco taxes are generally supported by the majority of the population, the tax can be used as a tool to gain revenue outside of the traditional methods of government revenue collection. such as income tax, property tax, and sales tax. Non-traditional sources of revenue, such as excise taxes, can be useful in economic recovery periods just after recessions. As DeCicca and Mcleod[3] show, there were such large tax increases from

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[1] Chaloupka, F. J., Yurekli, A., & Fong, G. T. (2012). Tobacco taxes as a tobacco control strategy. *Tobacco Control, 21*(2), 172-180. doi:10.1136/tobaccocontrol-2011-050417

[2] U.S. Department of Health and Human Services. The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General. Atlanta: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2014

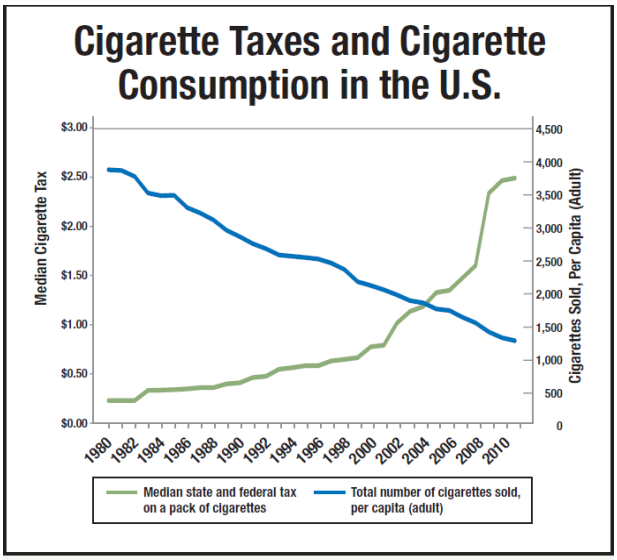
[3] Decicca, Philip, and Logan Mcleod. "Cigarette Taxes and Older Adult Smoking: Evidence from Recent Large Tax Increases." *SSRN Electronic Journal*, 2007. doi:10.2139/ssrn.992521.

2001-2005 in part due to budget shortfalls that resulted from the 2001 recession. Furthermore, smoking control policies should be put in place to help minimize the direct and indirect costs imposed on non-consenting individuals[4]. The purpose of this analysis will be to determine whether continued tax increases after 2005, when the majority of states have had at least one large tax increase in their history, still have an effect smoking participation and cessation behaviors

Empirically, the research on how increases in taxes affect participation rates of smoking is plentiful. The majority of empirical studies focus on the price responsiveness of youth and young adult smokers as there is strong evidence that the younger population are more price sensitive to cigarette price increases than adults. However, empirical evidence on whether adult smokers change consumption behaviours is not as concrete. Causal inspection of trends in tobacco taxes and tobacco use does not suggest a strong inverse relationship between taxes and consumption. This is especially prevalent in more recent years as tobacco taxes have increased dramatically but consumption has been decreasing at a relatively steady state since the 1980s. This can be seen in the graph below which shows the average tax rate in the United States as well as the average cigarette consumption in the united states. My empirical sample, which consists of the years 2006-2010, is illustrated in this figure below.

[4] Jha PChaloupka FJeds. *Curbing the Epidemic: Governments and the Economics of Tobacco Control.* Washington, DC World Bank1999;3- 4

Figure 1:



SOURCES: AMERICAN LUNG SOCIETY; CENTERS FOR DISEASE CONTROL; AND *THE TAX BURDEN ON TOBACCO*, BY ORZECHOWSKI & WALKER[5]

Given that the long run trend of consumption in the United States does not show a significant structural break when taxes are increased significantly, as seen in figure 1, this research is both novel and important. Moreover, because the data I have collected is from 2006-2010, My research builds on specific work that has studied the effect of tax increases on smoking participation among adults. To my knowledge, there has not been a study that analysis adults' responsiveness to recent tax increases in the years of 2006-2010 in the United States. This research addresses and engages with a significant gap within existing literature. In other words, this study will also try to analyze if increasing excise taxes further

[5] Orzechowski and Walker. "The Tax Burden on Tobacco". Center for disease control and prevention. 141, Accessed July 8, 2018. https://www.healthdata.gov/dataset/tax-burden-tobacco-volume-51-1970-2016

is still as effective of a policy, or whether it is outdated. Specifically, because of Decicca and Mcleod[6] who found a relationship between smoking participation and increasing tobacco taxes among adults aged 45-59 from 2001-2005. To do so, I exploit similarly large tax increases enacted from 2006-2010. It is possible that results could be attributed to factors such as brand loyalty and addictiveness. Finally, this study may also serve as a policy evaluation tool. that is, this analysis could provide insight into whether excise taxes are still an effective policy tool to reduce cigarette consumption. While cigarette taxes may have been effective in the past, according to previous research, the adults that would have stopped in response to excise taxes already have stopped consuming cigarettes and any other taxation of tobacco will not have the same effect to participation. This would mean that taxes are no longer the most effective way to control for smoking consumption or participation for adults and other alternative policies should be discussed.

This paper will proceed as follows. First, there will be a brief literature review summarizing results from other studies that have studied the effect of cigarette taxes. Second, there will be a section explaining the data that was used during the empirical approach. Third, there will be a section outlining my empirical strategy and a definition of my preferred model. Next, there will be a results section where my findings will be summarized and interpreted. Lastly, there will be a discussion and conclusion section discussing the policy implications my findings represent and ideas for further research.

2. Literature Review

In this section, previous studies that have been done on the association of adult consumption and tax increases will be summarized in terms of their methodology, findings,

[6] Decicca, Philip, and Logan Mcleod. "Cigarette Taxes and Older Adult Smoking: Evidence from Recent Large Tax Increases." *SSRN Electronic Journal*, 2007. doi:10.2139/ssrn.992521.

and any limitations that may be present. First, there is more literature available about how teenagers' consumption is affected when taxes are increased than there is for adults. That is, the literature on how adults are affected by tax increases are more varied and not as plentiful. The literature about teenagers also forms more of a consensus that teenagers reduce consumption when taxes rise. However, there is some contradictory evidence.

First, Gallet and List[7] perform a meta-analysis of elasticities to attempt to evaluate a comprehensive review of empirical methods present in the literature. In this paper, it is mentioned that evidence that tobacco taxes reduce adult smoking is sparse. Gallet and list reported a median price elasticity for adults aged 24 and older of -0.32 with great variation among individual estimates. Of the studies that were reviewed adult smoking participation price elasticities ranged from -0.74 to 0.006 and adult smoking intensity elasticities ranged from -0.028 to 0.01. While meta-analysis is a good strategy to account for nuances in the literature, meta-analysis is still subject to specification errors and there is debate over which explanatory variables should be used. This paper also summarized the disparity of results within the literature as it reported a large range of elasticities found in other studies.

Using 1995-2007 data from the current population survey on tobacco use supplements Callison and Kaestner[8] used a two-way fixed effect model as well as a paired difference in difference technique to estimate the association between increasing state-level taxes and cigarette consumption amongst adults. Their estimates state that for adults the association between price increases and either smoking propensity or smoking intensity is a small usually negative and usually statistically insignificant effect.

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[7] Gallet, Craig A., and John A. List. "Cigarette Demand: A Meta-analysis of Elasticities." *Health Economics* 12, no. 10 (2003): 821-35. doi:10.1002/hec.765.

[8] Callison, Kevin, and Robert Kaestner. "Do Higher Tobacco Taxes Reduce Adult Smoking? New Evidence of the Effect of Recent Cigarette Tax Increases on Adult Smoking." 2012. Accessed July 10, 2018. doi:10.3386/w18326.

So, these findings concluded that large increases in taxes would be associated with a very small decrease in cigarette consumption. The difficulty in using quasi-experimental approaches such as a difference in difference model and a fixed effects model is that it is difficult to detect causal low elasticities. Another limitation of this paper is that is difficult to distinguish any difference from zero as there are many statistically insignificant results. However, this just implies that it would take an astronomical tax increase to have any meaningful effect on cigarette consumption among adults. DeCicca and McLeod[9] estimated the association between tax increases and smoking participation among adults 45-59- and 45-64-years old adults using data from the BRFSS. This study is useful because it is one of the only studies that use more recent data while analyzing a period where there were higher than average tax increases during the time the analyses takes place between the years 2000-2005. They estimate a standard fixed effects model controlling for other state-level smoking policies implemented by the same period. Their findings show that there is indeed an inverse relationship between consumption and tax increases among the age group of 45-64. Their findings estimate that a $1 increase in tax equates to a 1-1.5% decrease in daily smoking participation among these age groups. This result makes sense since this study was done in the period with the largest tax increases at the state-level. We can assume, based on this study, that individuals will be more sensitive to larger tax increases. However, this paper also illustrates the lack of consensus in the literature in the sense that previous studies generally report lower elasticities for older adults than the ones Decicca and Mcleod find. The analysis suggests one reason this may be happening is that older individuals can still receive strong health benefits from quitting smoking. Also, when people age, they tend to care

[9] Decicca, Philip, and Logan Mcleod. "Cigarette Taxes and Older Adult Smoking: Evidence from Recent Large Tax Increases." *SSRN Electronic Journal*, 2007. doi:10.2139/ssrn.992521.

more about their health. In other words, this paper suggests that older adults may take health reasons into greater consideration when trying to quit smoking.

Franz[10] used data from the behavioral risk factor surveillance system from 1993-2000 to estimate price responsiveness between different age groups. Using a weighted least squares regression framework. This study also concludes that younger individuals are more responsive to price increases than older individuals. Although the changes in older individual's smoking behavior are still statistically significant.

Tauras[11] using a similar empirical quasi-experimental approach and data from the current population survey examines the impact of cigarette prices and smoke-free air laws on smoking propensity and intensity among adults. The author estimates a participation price elasticity of -0.12 and intensity elasticity estimates of -0.07.

Farrelly et al[12] studied the response by adults to increases in cigarette taxes by sociodemographic characteristics again by using a two-part estimation procedure to find smoking participation and smoking intensity. They used 14 years (1976-1980,1983,1985, and 1897-1993) of data from the national health survey to estimate the price sensitivity of different demographics. The findings suggest that adults with income below the minimum income, women, young adults, African Americans, and Hispanics are the most responsive to cigarette price increases. This is a short-term study and long-term addiction is not considered in the model.

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[10] Franz, G.a. "Price Effects on the Smoking Behaviour of Adult Age Groups." *Public Health* 122, no. 12 (2008): 1343-348. Accessed July 10, 2018. doi:10.1016/j.puhe.2008.05.019.
[11] Tauras, John A. "Smoke-Free Air Laws, Cigarette Prices, And Adult Cigarette Demand." *Economic Inquiry* 44, no. 2 (2006): 333-42. doi:10.1093/ei/cbj028.
[12] Farrelly, Matthew C., Jeremy W. Bray, Terry Pechacek, and Trevor Woollery. "Response by Adults to Increases in Cigarette Prices by Sociodemographic Characteristics." *Southern Economic Journal* 68, no. 1 (2001): 156. Accessed July 10, 2001. doi:10.2307/1061518.

Evans and Farrelly[13] estimate whether adult smokers alter their smoking behavior when faced with higher taxes using data from the 1979 and the 1987 National Health Interview Survey. Using two staged probit and demand model their findings suggest that the number of cigarettes consumed decreased, individuals started smoking cigarettes with higher tar and nicotine content. So, tar and nicotine intake are unaffected from tax increases. They also find that smokers aged 18-24 are much more price responsive to tax increases. Also, the authors imply that to optimize health benefits taxation should be applied based on tar and nicotine content and not the current strategy of taxing all cigarettes equally.

From a previous MA essay Hicks[14] studied consumer's behavioural response of tobacco taxation in Canada using monthly micro-level data from 2000-2010. Hicks reported intensive and extensive margin elasticities of -0.087 and –0.03 respectively and found that individuals who hold a university degree are more responsive to tobacco taxes. He also tested whether taxes included in the posted price are more salient than the sales taxes added at the register. His findings show that individuals who do not possess a university degree fully internalize taxes at the register and individuals with a university degree do not which has implications for the regressively of the tax. Similarly, when using recent American micro-level data from the BRFSS I find that excise taxes at best have a very small negative effect on smoking participation in the United States. However, I do find that excise taxes at the state level still have a positive effect on cessation decisions by testing the effect of excise taxes on former smoker status. My paper contributes insights using recent American data that was seldom used in previous research. Also, my analysis

[13] Evans, William N., and Matthew C. Farrelly. "The Compensating Behavior of Smokers: Taxes, Tar, and Nicotine." *The RAND Journal of Economics* 29, no. 3 (1998): 578. Accessed July 10, 2018. doi:10.2307/2556105.

[14] Hicks, Jeffrey. "Tobacco Tax in Canada: An analysis of elasticities and salience". *Queen's University*. Retrieved from http://qed.econ.queensu.ca/ma_essay/files/476.pdf.

contributes evidence that suggests there is not a significant difference in the price responsiveness between several different age groups but does show evidence that older people are less likely to quit in response to taxes.

Lewit and Coate (1982)[15] found that younger individuals were more price responsive than older individuals. Using data from the 1976 National Health Interview Survey they found that smokers over the age of 35 reported a price elasticity of -0.15 and a smoking intensity elasticity of -0.07. while estimating a price elasticity of all adult smokers of -0.42.

There have also been numerous studies that aim to estimate the association between raising cigarette prices and teenage smoking participation. Lewit et al. (1981)[16], Chaloupka and Wechsler (1997)[17], Tauras and Chaloupka (1999)[18], Gruber and Zinman (2001)[19], and Carpenter and Cook (2007)[20] using similar empirical designs all find that there is evidence of substantial price sensitivity among teenage smokers when the price of cigarettes increases. However, there are still some studies among the literature for teenage smokers that found smaller elasticities for teenagers. For example, studies such

[15] Lewit, Eugene, and Douglas Coate. "The Potential for Using Excise Taxes to Reduce Smoking." 1981. Accessed July 10, 2018. doi:10.3386/w0764.
[16] Lewit, Eugene, Douglas Coate, and Michael Grossman. "The Effects of Government Regulation on Teenage Smoking." 1981. Accessed July 10, 2018. doi:10.3386/w0655.
[17] Chaloupka, F.J., Wechsler, H., 1997. Price, tobacco control policies and smoking among young adults. Journal of Health Economics 16, 359–373.
[18] Tauras, John, and Frank Chaloupka. "Determinants of Smoking Cessation: An Analysis of Young Adult Men and Women." 1999. doi:10.3386/w7262.
[19] Gruber, Jonathan. "Risky Behavior Among Youths: An Economic Analysis." 2001. Accessed July 10, 2018. doi:10.3386/w7781.
[20] Carpenter, Christopher, and Philip Cook. "Cigarette Taxes and Youth Smoking: New Evidence from National, State, & Local Youth Risk Behavior Surveys." 2007. Accessed July 10, 2018. doi:10.3386/w13046.

as Wasserman et al (1991)[21], and DeCicca et al. (2002)[22] provide evidence that teenagers are not very price sensitive when cigarette prices increase.

This review demonstrates that there is little consensus among the literature. Also, there seems to be a lack of literature on the topic that uses recent data apart from Callison and Keastner (2013) and DeCicca and Mcleod (2008). My research can add to the existing literature in the following ways. I am performing my analysis with more recent data from 2006-2010. Also, I hope to show how effective large tax increases are in reducing smoking participation when the vast majority of states have already increased taxes by a large amount in their history. As of yet, I have not come across any research that uses data that is that recent for the United States.

3. Data

3.1 Behavioural Risk Factor Surveillance Survey Data

The data being used for this analysis is collected from the BRFSS (the Behavioural Risk Factor Surveillance Survey). The BRFSS is a health-related telephone survey that collects individual-level data about American residents regarding their health-related risk behaviours and health conditions[23]. The data is collected by the CDC (Center for Disease Control and Prevention) and began in 1984. Since then, it has been expanded to all fifty

[21] Wasserman, Jeffrey, Willard G. Manning, Joseph P. Newhouse, and John D. Winkler. "The Effects of Excise Taxes and Regulations on Cigarette Smoking." *Journal of Health Economics* 10, no. 1 (1991): 43-64. Accessed July 10, 2018. doi:10.1016/0167-6296(91)90016-g.
[22] Decicca, Philip, Donald Kenkel, and Alan Mathios. "Putting Out the Fires: Will Higher Taxes Reduce the Onset of Youth Smoking?" *Journal of Political Economy* 110, no. 1 (2002): 144-69. Accessed July 10, 2018. doi:10.1086/324386.
[23] "Behavioral Risk Factor Surveillance System." Centers for Disease Control and Prevention. August 29, 2017. Accessed June 30, 2018. https://www.cdc.gov/brfss/data_documentation/index.htm.

states, Washington D.C, and three American territories[24]. The survey is conducted annually. The states use a standardized core questionnaire, optional modules, and state-added questions. The survey is conducted using Random Digit Dialing (RDD) techniques on landline phones. As stated, the data being used in this essay was collected from 2006-2010 the state level. My variables of interest in this dataset include smoker status. This variable contains information concerning whether an individual is a current smoker, some day smoker, former smoker or non-smoker. I was also interested in various demographic variables such as age, race, gender, income, employment, education, and general health conditions. All the data used in this analysis was data gathered using the main questionnaire in the BRFSS survey. As such, additional modules were not needed for this analysis. This dataset also contains information on whether the individual has smoked over 100 cigarettes in their lifetime. This sample contains micro-level survey data and individual responders are anonymous as the respondents are classified by state and not by specific geographical location. The BRFSS is a publicly available dataset so no permission was needed to use it. My full sample contains individuals aged 18-59 and 1,288,984 observations. The population weights used in this analysis are the weights provided by the BRFSS, each wave of the survey I utilize in this analysis uses an identical calculation to obtain population weights. Regrettably, this survey does not ask the question concerning how many cigarettes are smoked by an individual per day. While I will not be able to test the effect increasing cigarette taxes has on the quantity of cigarettes smoked. There is increasing evidence that individuals who do smoke less are turning to “harder” or longer cigarettes as evidenced by increasing tar and nicotine levels in smokers’ blood after

[24] "Behavioral Risk Factor Surveillance System." Centers for Disease Control and Prevention. August 29, 2017. Accessed June 30, 2018. https://www.cdc.gov/brfss/data_documentation/index.htm.

tax increases[25]. As Adda and Cornaglia suggests, this may offset some of the health benefits one may receive from smoking fewer cigarettes and that excise taxes may not improve help as much as one thought.

3.2 State Tax Data

In addition to the BRFSS, I have also obtained every excise tax increase implemented by each state spanning from 2000-2018. This information is made publicly available through the "Campaign for Tobacco Free Kids"[26]. The Campaign for Tobacco Free Kids is an advocacy group aiming to reduce the consumption of tobacco products worldwide. The tax is measured as a lump sum (in USD) per pack of 20 cigarettes. Also, this dataset communicates the total excise tax in each state after the tax increase was implemented. Using this information, I will be able to identify all the tax increases during the years from 2006-2010. All the tax values I use in this analysis are valued in 2006 dollars. The trend of drastic increases between 2001-2005 continues between 2006-2010. This will allow me to test whether the continued increasing of state taxes will continue to have an effect on smoking prevalence when previous increases have already taken place. The following table shows state tax increases of at least 50 cents per pack between 2006 and 2010.

Along with the tax increase information, I utilize Orzechowski and Walker[27] to obtain before and after increase values of each state's excise tax on tobacco. Since the data I collected from the Campaign for Tobacco Free Kids and the BRFSS includes the

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[25] Adda, J., & Cornaglia, F. (2013). Taxes, Cigarette Consumption, and Smoking Intensity: Reply. *American Economic Review, 103*(7), 3102-3114. doi:10.1257/aer.103.7.3102

[26] "Index of /assets/factsheets." Campaign for Tobacco-Free Kids. Accessed June 27, 2018. https://www.tobaccofreekids.org/assets/factsheets.

[27] .Orzechowski and walker "The Tax Burden on Tobacco." *Volume 51* (2016). Accessed July 4, 2018.

month that the tax was enacted and the month of each interview. A monthly state tax dataset can be constructed and then merged with the BRFSS data to analyze how smoking participation and cessation is affected in the period after a tax increase. An advantage to using the BRFSS dataset is that it contains the day and month each interview took place. With this information, I will be able to incorporate month fixed effects as well as year fixed effects.

As of July 1st, 2010, the average state tax per pack of 20 cigarettes is $1.44. This average is much higher than the reported average tax in 2006 of $0.941 both averages were calculated using a CDC survey of changes in state excise taxes between 2009-2010 and 2005-2006 respectively[28]. This increase is not the largest period of tax increase in the history of the United States. However, still sufficiently large enough to perform this analysis.

Table 1

State	Tax Increase (cents)	Resulting tax (cents)	Date Implemented
Arizona	82	200	December 2006
Vermont	60	179	July 2006
Delaware	60	115	July 2007
Iowa	100	136	March 2007
South Dakota	100	153	January 2007
Texas	100	141	January 2007

[28] "State cigarette excise taxes - United States, 2010-2011." Centers for Disease Control and Prevention. March 30, 2012. https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6112a1.htm

Washington D.C	100	200	October 2008
Maryland	100	200	January 2008
Massachusetts	100	251	July 2008
New York	100	275	June 2008
Wisconsin	100	177	January 2008
Arkansas	56	115	March 2009
Connecticut	100	300	October 2009
Washington D.C	50	250	October 2009
Florida	100	133.9	July 2009
Hawaii	60	260	July 2009
Mississippi	50	68	May 2009
Puerto Rico	100	223	June 2009
Rhode Island	100	346	April 2009
Wisconsin	75	252	September 2009
New Mexico	75	166	July 2010
New York	160	435	July 2010
South Carolina	50	57	July 2010
Utah	100.5	170	July 2010
Washington	100	302.5	May 2010

Notes: The above table contains all tax increases greater than 50 cents from 2006-2010

3.3 Public Smoking Policy

Additionally, I have obtained information on which states have enacted policy that bans smoking at every public workplace, restaurants, gambling establishments, bars and hotels[29]. This data was acquired via the "American Nonsmokers' Rights Foundation". Overall as of 2010, there were 35 states that have enacted a smoking ban in at least one of the aforementioned categories. That figure has since risen to 36 states. For this analysis, I only include workplace smoking bans and bans in restaurants in my preferred model specification as the majority of states did not have smoking bans enacted for bars, hotels and gambling establishments in the time period included in my analysis.

4. Descriptive Statistics

Table 2

Smoking Participation Means by Year

	2006	2007	2008	2009	2010
Everyday	0.162	0.1564	0.1494	0.1418	0.136
At least some days	0.222	0.218	0.209	0.202	0.192

Focusing on the time pattern of smoking in this data set certainly suggests that tax increases (among other factors) during the timeframe may affect smoking participation or

[29] American Nonsmokers' Rights Foundation. (n.d.). Retrieved from https://no-smoke.org/

cessation. As we can see from table 2 the fraction of everyday smokers fell from approximately 0.162 in 2006 to 0.136 in 2010. From the beginning of this dataset to the end the smoking participation rate for everyday smokers declines every year. The most dramatic decrease in the percentage of people that smoke everyday takes place in 2009. This makes sense because in the tax increase data table shown above it is shown that the most dramatic tax increases occurred in 2009[30] which could have contributed to the consistent fall in participation. The smoking on at least some days participation numbers provide a similar decrease to the one seen for everyday smokers. More rigorous empirical testing needs to be done in order to establish if there is a statistically significant link between the tax increases and smoking participation. There could be other factors that contribute to declines in participation such as other tobacco control policies, the increase in demand of electronic cigarettes, increased health awareness in the general adult population of adults, and increased negative societal pressure put on smokers. Additionally, these means reported further illustrate that while smoking means are consistently decreasing over time the decreases are rather small and consistent even though this time period experienced large tax increases in various states.

In Table 3 I illustrate the descriptive statistics of all of the variables used in my analysis. All of the descriptive statistics were calculated using the full sample size of 1,288,984 respondents

[30] Arkansas, Connecticut, Washington D.C, Florida, Hawaii, Mississippi, Puerto Rico, and Wisconsin all raised taxes by $1.00 per pack of cigarettes

Table 3

Descriptive statistics for BRFSS variables

Variable	Mean	Standard Deviation	Min	Max
Probability of everyday smoker	.159	.365	0	1
Probability of at least some day smoker	.213	.409	0	1
Probability of former smoker	.222	.415	0	1
Age	43.17	11.48	18	59
Race				
White	.752		0	1
Black	.087		0	1
Asian	.002		0	1
Native Indian	.019		0	1
Hispanic	.089		0	1
Native Hawaiian	.017		0	1
Multiracial	.019		0	1
Other	.006		0	1
Gender				
Male	.386		0	1
Female	.614		0	1
Education				
No school	.001		0	1
Elementary	.021		0	1
Some high school	.054		0	1
High school graduate	.275		0	1
Some college	.278		0	1

College graduate	.369	0	1
Employment status			
Employed	.615	0	1
Self-employed	.104	0	1
Unemployed <1 year	.028	0	1
Unemployed >1 year	.037	0	1
Homemaker	.081	0	1
Student	.027	0	1
Unable to work	.071	0	1
Retired	.033	0	1
Income			
Less than $10,00	.046	0	1
$10,000-$15,000	.039	0	1
$15,000-$20,000	.054	0	1
$20,000-$25,000	.069	0	1
$25,000-$35,000	.093	0	1
$35,000-$50,000	.137	0	1
$50,000-$75,000	.167	0	1
>$75,000	.291	0	1
General Health			
Excellent	.412	0	1
Very good	.345	0	1
Good	.289		
Fair	.105		
Poor	.042	0	1

Marital status			
Married	.600	0	1
Divorced	.141	0	1
Widowed	.028	0	1
Separated	.028	0	1
Never married	.166	0	1
Unmarried couple	.033	0	1
Observations	1,288,984		

Only complete cases were used in this analysis. Any respondents with missing information were deleted from the sample

5. Methodology

Next, I will describe my strategy for identifying the relationship between the increase of state taxes, participation and cessation activities while also looking at possible differences between age groups. There is a general consensus in the literature that cross-sectional analysis of this topic will likely be subject to omitted variable bias. Such bias could include unobserved state-specific sentiment and may be correlated with the level of state taxes in a state or the smoking participation in that state. There may also be heterogeneity present in the model. In order to account for possible problems such as these, I include state-level specific effects. The state-level fixed effects variable should remove any correlation between the error term and the tax variable. I will also add monthly fixed effects and yearly fixed effects. The fixed effects along with many covariates such as age, income, education level, marital status, gender, race, general health status, and employment status should remove any omitted variable bias.

I utilized a probit model to estimate the probability of choosing to smoke before and after-tax increases, then I will use the same probit model to estimate the probability

of someone being a former smoker before and after-tax increases. Then I will repeat the tests for a set of five different age groups to determine if behaviors change in different age groups. The main probit model specification is as follows.

$$S_{imtj} = F(\alpha + \beta_0 X_{mtj} + \beta_1 T_{mtj} + \beta_{-2} P_{mtj} + \sigma_j + \lambda_m + \nu_t + \epsilon_{imtj}) \quad (1)$$

Where S is the dependent variable and the probability that an individual is a current smoker. In the first set of estimates, it will equal one for everyday smokers and zero otherwise when testing the effect of tax increases on everyday smokers. In the next set of estimates, I relax the definition of a current smoker somewhat which means S will equal to one if an individual smoke at least on some days and has smoked at least 100 cigarettes. This allowed me to test whether taxes have an impact when adding casual smokers' smokers to the dependent variable. In my last variation, I define S as the probability that an individual is a former smoker. Meaning that S will equal 1 if an individual is a former smoker. As for the subscripts, i represents the individual, j represents the state the individual resides in, m represents the month that the interview took place and t represents the year the interview took place. T represents the main independent variable of interest which is state-level excise taxes. P represents another set of smoking regulations. The variable P can be defined as two separate indicators for whether there is a ban on smoking in private workplaces and whether there is a ban on smoking inside of restaurants. X represents a set of covariates. There will be 6 indicators for education level, 6 indicators for marital status, 5 indicators for general health, 8 indicators for employment status, 8 indicators for income level including an indicator if an individual was unsure about their income, 2 indicators for gender, and 8 indicators for race. Each indicator variable represents different responses from the BRFSS questionnaire. σ represents state-level

fixed effects, λ represents the month fixed effects, ν represents year fixed effects, and ϵ is an error term. Also, in addition to the full sample, I also performed an identical test on five different age groups. The age groupings are as follows: group 1 consists of ages between 18-24, group 2 includes ages 25-34, group 3 includes ages 35-44, group 4 includes ages 45-54 and group 5 includes ages 55-59. I also limited my sample of older adults to the age of 59 because according to Taylor et al[31] individuals who stop smoking when they are middle-aged still have large beneficial health effects that result from quitting smoking. Whereas older individual's reported associated health effects were not as substantial thus individuals older than 59 were left out of the sample.

To explain further, the fixed effect variable for state is included to account for different population characteristics that may affect the smoking participation rate differently. For example, if a state has developed strong anti-smoking laws such as public smoking restrictions or any anti-smoking programs such as educating people about the health dangers of smoking. Also, some states produce tobacco and producing tobacco may still be a substantial part of their economy. On average, states that produce tobacco have lower taxes. So logically we can assume, states with a high anti-smoking sentiment may pass higher taxes. The excise tax variable may be correlated with these unobservable state-level effects. So, by controlling for time-invariant characteristics in each state I hope to sufficiently solve the endogeneity problem in the data. I will estimate the relationships using the model mentioned above with and without the matrix of covariates (X) as a robustness check. Then I will estimate the models again including the covariates. Lastly, I will estimate the model including the set of covariates as well as including indicator variables that equal one if the state has enacted a ban on smoking in workplaces and

[31] Taylor, D.H., Hasselblad, V., Henley, J., Thurn, M.J., Sloan, F.A., 2002. Benefits of smoking cessation for longevity. American Journal of Public Health 92, 990–996.

restaurants. I will also run the same models using a logit regression to check if marginal effects and elasticities are similar regardless of model choice.

In order to ensure that there is enough variation in the exogenous variable of interest, which is the excise tax in this case, I regress the tax variable on the set of state year and month fixed effects then I compute the variance inflation factor which is the reciprocal of one minus the R^2 from the aforementioned regression. According to the literature, if the variance inflation factor exceeds 10 then there is not sufficient independent variation to perform this analysis using a fixed effects model[32]. After running the aforementioned regression with my sample, it resulted in a small enough R^2 to conclude that there is enough variation in the excise taxes. The variance inflation factor was calculated as approximately 8.7.

6. Results

In all alternative specifications of the model that was estimated there was usually a small statistically insignificant negative relationship between excise taxes and smoking participation and a small statistically significant positive relationship between the probability of a former smoker and tax increases. This means that excise taxes may no longer be an effective policy when attempting to decrease the smoking participation amongst adults. However, my estimates suggest that tax increases still play a role in the decision to quit. Based on my results it seems that excise taxes alone cannot explain why the smoking participation rate is steadily decreasing. One possible explanation for this is that excise taxes may not influence an individual's decision to start smoking as much as

[32] O'Brien, R. M. (2007). A Caution Regarding Rules of Thumb for Variance Inflation Factors. *Quality & Quantity, 41*(5), 673-690. doi:10.1007/s11135-006-9018-6

taxes influence an individual's decision to quit. However, I cannot empirically test for this. The smoking participation rate is influenced in part by individuals transitioning from current smoker to former smoker status so I cannot fully distinguish between decisions to start and decisions to quit. All standard errors reported for coefficients are robust standard errors clustered around the state variable allowing for independence. The important findings from our estimations will be reported below.

6.1 Main Estimation Results

Table 4

Main estimation results

	(1)	(2)	(3)
Smoker on all days			
Real cigarette tax	-0109208	-.0110827	-.010517
	(.0089012)	(.010729)	(.0107358)
Marginal effect	[-.0025077]	[-.0022513]	[-.0021364]
Elasticity	{-.0211885}	{-.0232349}	{-.0220489}
	(.0172766)	(.0225175)	(.0225)
N	1,288,984	1,288,984	1,288,984
Smoker on at least some days			
Real cigarette tax	.0019622	.004149	.0044147
	(.0090259)	(.0421339)	(.0421339)
Marginal effect	[.000558]	[.0010514]	[.0011188]
Elasticity	{.0033516}	{.0075616}	{.0080459}
	(.0190519)	(.0191066)	(.0193179)
N	1,288,984	1,288,984	1,288,984
Former Smoker			
Real cigarette tax	-.0166272**	.0174876**	.0178852**
	(.0084309)	(.0090507)	(.0088836)
Marginal effect	[.0043921]**	[.0045314]**	[.0046344]**
Elasticity	{.0290564}	{.0309679}	{.0316719}

	(.0147266)	(.0160175)	(.0157213)
N	1,288,984	1,288,984	1,288,984

Notes: All models are weighted by sample weights provided by the BRFSS. The models were also run without including weights and although results were not reported the results were nearly identical to the results to the tests that included weights. I also ran these tests utilizing a logit model (Estimates reported in table A1 in the appendix) the logit marginal effects are very similar to the probit marginal effects reported here which suggests results are not dependent on model choice. Model (1) is the model that includes fixed effects without covariates and public bans, model (2) includes covariates only, and model (3) includes covariates and the indicator variables I constructed for smoking bans. Standard errors (in parentheses) are calculated using the delta method allowing for non-independence at the state level (clustering). Numbers in the square brackets are the marginal effects. Elasticities are reported in curly brackets and the standard errors for elasticities are calculated using the delta method. *0.05< p-value $\leq$ 0.10, ** 0.01< p-value $\leq$ 0.05, *** p-value $\leq$ 0.01

Table 4 presents estimates for the three different model specifications utilized. The values reported are the estimated effects of real cigarette tax on participation and cessation. The coefficients corresponding to the tax variable is the first number reported in each test, while the values reported in parentheses are the calculated standard errors which are adjusted for non-independence at the state level. The numbers in the square brackets are the probit marginal effects, the values reported after that in the curly brackets are the estimated elasticities calculated in STATA, and then the standard error of the estimated elasticities are the final number reported in each test, also in parentheses. I performed nine regressions in total to obtain the main estimates. This table presents the estimates of β_1 with three different specifications represented by the columns in the table. Column (1) treats tax as an exogenous variable and includes no covariates except for fixed effects. The specification in column (2) includes individual-level covariates in the form of indicator variables. The specification for column (3) includes two additional indicator variables that equal one if the state where the interviewee resides has enacted a restriction on smoking in a public workplace or restaurant respectively. The real cigarette tax sections display the results from each regression concerning the independent variable of interest, real excise tax in this case. All percentage decreases or increases mentioned henceforth

are relative to the current smoking population and not the population as a whole. For example, if a 2% decrease is reported it is relative to the percentage of people that smoke and not the whole population.

The estimates resulting from the tests where the dependent variable was equal to one if the individual was an everyday smoker indicate that recent large increases of excise taxes do not have a large effect over time as the resulting coefficients on tax and the probit marginal effect are both slightly negative and statistically insignificant. All three model specifications yield similar results and model specification (2) and (3) yield almost identical results. I find consistent evidence that excise taxes do not play a large role in everyday smoking participation. For everyday smokers, my preferred model specification (column (3)) predicts that the probit marginal effects are negative, close to zero and statistically insignificant. If excise taxes increase by $1 then smoking participation among the population that smokes every day will decrease by roughly 0.22364 percentage points which is quite small. Also, given the lack of statistical significance, it is difficult to distinguish the effect from zero. I have also calculated an implied smoking participation price elasticity of -0.022 which was calculated using STATA. However, there is no need to use an arbitrary unit of tax increases to explain the effect as price elasticities are prevalent in the literature. For simplicity's sake, I will explain the relationships with the marginal effects. The price elasticity of -0.022 seems relatively small when comparing the result to the existing literature which suggests that excise taxes have become less effective in deterring smoking over time. This result should be interpreted as a short run effect caused by a tax increase as a measure for addictiveness was not included in the model. Also, given the relatively short time period of the data being used, there is no way to model the long-term effect of a tax increase. These findings advance the literature because I am not aware of any studies that have estimated the effects of tax increases and adult smoking using increases that that have been enacted this recently in the United

States and for the most part, these are large tax increases that followed previous increases.

In the next row of estimations, I relax the definition of a current smoker to include people who smoke on some days as well as everyday smokers. As expected, the estimates show that there is less of an effect on smoking participation when defining a current smoker in this manner. The marginal effect in the preferred model specification for this test is 0.0011188 which is near zero, slightly positive and statistically insignificant. Therefore, smoking participation, in this case, may have a small effect of 0.11188 percentage points if excise taxes increase by $1. However, this result is difficult to distinguish from zero. This test also yielded an implied price elasticity of 0.0080459. This result is somewhat counter-intuitive since the marginal effect of smoking participation is positive however it is very close to zero and insignificant. This estimate implies that for casual smokers, they are not affected negatively by tax increases at the state level at all. The result is fairly consistent with other literature in the sense that multiple studies that have tested relationships with this relaxed definition of current smoker status to include people that smoke on some days the marginal effect of smoking participation is always lower (less negative). There are not many studies that perform this analysis however Decicca and Mcleod[33] and Callison and Kaestner[34] both found that including someday smokers in the analysis reduced the effect taxes had on smoking participation.

In the third test, still using the full sample from the BRFSS, I use my previously defined model specifications to estimate the effect that taxes have on smoking cessation. For these tests, the dependent variable equaled 1 if the individual identified as a former

[33] Decicca, Philip, and Logan Mcleod. "Cigarette Taxes and Older Adult Smoking: Evidence from Recent Large Tax Increases." *SSRN Electronic Journal*, 2007. doi:10.2139/ssrn.992521.
[34] Callison, Kevin, and Robert Kaestner. "Do Higher Tobacco Taxes Reduce Adult Smoking? New Evidence of the Effect of Recent Cigarette Tax Increases on Adult Smoking." 2012. Accessed July 10, 2018. doi:10.3386/w18326.

smoker. These estimates show that there is a small statistically significant positive association between excise taxes and the probability of being a former smoker. Ultimately, the goal of the tax policy is to reduce the smoking population and my estimates show that taxes still play a positive role in the decision to quit. The estimates show that in the preferred specification (model 3) the marginal effect of taxes on adult smoking is 0.0046344 with an implied participation elasticity of .0316719. If the excise tax increases by $1 this estimate implies that the probability of being a former smoker will increase by 0.46344 percentage points. This result is interesting because it shows that there is still an association between excise taxes and the number of former smokers. However, the association between smoking participation and excise taxes is smaller and not significant. This could be because taxes do less to affect the decision to start smoking while still influencing the decision to quit as evidenced by the differences in the participation estimates and cessation estimates. However, there may be other factors possible for the difference in participation effects and cessation effects. There may be other factors that are considered when the decision to start smoking, such as, health concerns or social concerns. There is no consensus in the literature for this result as the association between excise taxes and the probability of being a former smoker is seldom tested. However, I think it does provide more nuance to my estimates of smoking participation as it shows that taxes still have a significant effect (although still relatively small) on the probability of becoming a former smoker.

To summarize these results, my estimates for the three different model specifications show that my model is robust because it achieved similar results in all three specifications. These results add to the literature because it tests more recent tax increases and my results corroborate other studies that have found small participation

elasticities in their research such as Callison and Kaestner[35] and Farrelly et. al.[36]. Although, my estimates show insignificant participation relationships, cessation activities are still positively associated with taxes according to my findings. This is interesting since Taylor et al.[37] indicates that quitting smoking will result in substantial health benefits and with increased health awareness taxes still play a significant role in cessation activities. Taxes, then, still may be a useful policy tool to get adults to quit smoking. However, the estimated participation elasticities are smaller than the cessation elasticities. One possibility for this could be that taxes have less of an influence on the decision not to start smoking than they do on the decision to quit. I cannot separate these two possibilities since the participation rate is influenced by individuals transitioning to former smoker status. However, it may help explain the differences in elasticities between smoking participation behaviours and cessation behaviours. Overall, my estimated elasticities are lower then what was reported in previous research. This suggests that even though there is a significant positive effect on cessation activities, taxes may be less influential than they once were in tobacco control policy. The next section I will break down the sample by age groups and use the same model specifications to test smoking participation and former smoker probability among several different age groups.

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[35] Callison, Kevin, and Robert Kaestner. "Do Higher Tobacco Taxes Reduce Adult Smoking? New Evidence of the Effect of Recent Cigarette Tax Increases on Adult Smoking." 2012. Accessed July 10, 2018. doi:10.3386/w18326.

[36] Farrelly, Matthew C., Jeremy W. Bray, Terry Pechacek, and Trevor Woollery. "Response by Adults to Increases in Cigarette Prices by Sociodemographic Characteristics." *Southern Economic Journal* 68, no. 1 (2001): 156. Accessed July 10, 2001. doi:10.2307/1061518

[37] Taylor, D.H., Hasselblad, V., Henley, J., Thurn, M.J., Sloan, F.A., 2002. Benefits of smoking cessation for longevity. American Journal of Public Health 92, 990–996.

6.2 Estimates for different age groups.

Evidence from previous studies suggests that responsiveness to taxes and prices are different for younger and older adults. To test for this hypothesis, I split my sample into five different age groups: 18-24, 25-34, 35-44, 45-54, and 55-59. I test each age group using the preferred specification of my model. That is a probit fixed effects model including individual-level covariates and controls for public smoking bans. The estimates for each age group are reported in table 5

Table 5

Estimates for different age groups

	(3)
Smoker on all days	
Real cigarette tax age 18-24	-.0162413
	(.0231847)
Marginal effect	[-.0032189]
Elasticity	{-.0341928}
	(.0488364)
N	68,843
Real cigarette tax age 25-34	0076882
	(.0196025)
Marginal effect	[.0015733]
Elasticity	{.015733}
	(.0400795)
N	193,377
Real cigarette tax age 35-44	-.020257
	(.0125339)
Marginal effect	[-.0038618]
Elasticity	{-.0444336}
	(.0275435)
N	302,587
Real cigarette tax age 45-54	-.012115
	(.0142214)

Marginal effect	[-.0025987]
Elasticity	{-.0249946}
	(.0293763)
N	418,492
Real cigarette tax age 55-59	.0017015
	(.0161491)
Marginal effect	[.0003337]
Elasticity	{.003657}
	(.0347053)
N	234,213
Smoker on at least some days	
Real cigarette tax age 18-24	.0023188
	(.0151825)
Marginal effect	[.006073]
Elasticity	{.0040644}
	(.0266137)
N	68,843
Real cigarette tax age 25-34	.0284273
	(.0217774)
Marginal effect	[.007428]
Elasticity	{.0488017}
	(.037279)
N	193,377
Real cigarette tax age 35-44	-.0049201
	(.0113978)
Marginal effect	[-.001699]
Elasticity	{-.0094383}
	(.0218714)
N	302,587
Real cigarette tax age 45-54	-.0082995
	(.016085)
Marginal effect	[-.0021064]
Elasticity	{-.0153555}
	(.0297791)
N	418,492
Real cigarette tax age 55-59	.0222512**
	(.010363)
Marginal effect	[.0052625]**
Elasticity	{.0430597}
	(.0200282)
N	234,213

Former Smoker	
Real cigarette tax age 18-24	-.0269082
	(.0316741)
Marginal effect	[-.0035575]
Elasticity	{-.0636829}
	(.0750675)
N	68,843
Real cigarette tax age 25-34	.0387167*
	(.0227729)
Marginal effect	[.0092553]*
Elasticity	{.0705764}
	(.0414825)
N	193,377
Real cigarette tax age 35-44	.029375**
	(.0134211)
Marginal effect	[.0075942]**
Elasticity	{.0524832}
	(.0239682)
N	302,587
Real cigarette tax age 45-54	.0260755**
	(.0106514)
Marginal effect	[.0081063]**
Elasticity	(.0409112}
	(.0166893)
N	418,492
Real cigarette tax age 55-59	-.0276159**
	(.0127208)
Marginal effect	[-.0095661]**
Elasticity	{-.038535}
	(.0178141)
N	234,213

Notes: All models are weighted by sample weights provided by the BRFSS. Column (3) represents my preferred model specification including individual-level covariates and variables on smoking bans in the workplace and restaurants. The first number reported in each test is the coefficient of the tax variable, all the numbers in parentheses are standard errors for the coefficient and elasticity respectively, the number in square brackets are the probit marginal effects for all test, and the number in the curly bracket is the participation elasticity for all tests. Standard errors (in parentheses) are calculated using the delta method allowing for non-independence at the state level (clustering). *0.05< p-value $\leq$ 0.10, ** 0.01< p-value $\leq$ 0.05, *** p-value $\leq$ 0.01

On tests where the dependent variable equals one if an individual is an everyday smoker, the breakdown of the sample into five different age groups all show that relationships between excise taxes and smoking participation are almost non-existent. The marginal effects for each age group are close to zero, statistically insignificant and are a small positive or negative number. For age group 18-24 there is an implied participation elasticity of -0.0341928, the age group 25-34 has an implied participation elasticity of 0.015733, the age group 35-44 has an implied elasticity of -0.044336, the age group 45-54 has an implied elasticity of -0.0249946 and finally, the age group 55-59 has an implied price elasticity of 0.03657. These results follow the estimate of the full sample in the sense that marginal effects are mostly negative and insignificant and difficult to distinguish from zero. From my analysis, there is no evidence that smoking participation varies a great deal in different age groups when defining a current smoker as an everyday smoker.

When including someday smokers in my analysis, testing the association between smoking participation and excise taxes using my preferred model specification[38]. My estimates for these tests mostly resulted in small positive close to zero and statistically significant marginal effects that is difficult to distinguish from zero. The age group 18-24 has an implied participation elasticity of 0.004064. the age group 24-34 has an implied elasticity of 0.0488017, the age group 35-44 has an implied elasticity of -0.0094383, the age group 45-54 has an implied elasticity of -0.0153555, and the age group 55-59 has an implied elasticity of 0.0430597. One interesting result is the estimate for the age group 55-59 also shows a small positive statistically significant relationship between taxes and smoking participation. For the 55-59 age group, my estimate yielded a positive statistically significant marginal effect. If excise taxes are increased by $1 then smoking participation

[38] My preferred model specification includes a set of covariates and indicators concerning smoking bans in workplaces and restaurants.

among those aged 55-59 increases by 0.55625 percentage points. Although I cannot test for this, this significant result may be the result of older individuals reducing the amount they smoke but not quitting altogether because of their level of addictiveness.

When testing the association between former smokers in each age group using my preferred model specification, I obtain the following estimates. The 18-24 group has an implied elasticity of -0.0636829 while the marginal effect is -0.0035575 and not significant. The 25-34 group has an implied elasticity of 0.0705764, the marginal effect is 0.0092553 and is statistically significant at a 10 percent level of significance. The 35-44 age group has an implied elasticity of 0.0524832, a marginal effect of 0.0075942 and is statistically significant. The 45-54 age group has an implied elasticity of 0.0409112, a marginal effect of 0.0081063 and is statistically significant. The 55-59 age group has an implied elasticity of -0.038535 and a marginal effect of -0.0095661 and is statistically significant. Given the negative smoking cessation effect for adults aged 55-59 and the positive relationship between smoking participation and taxes for that same age group when allowing someday smokers into the analysis, this may suggest that older adults transition to smoking fewer cigarettes rather than quitting altogether. This may be due to the addictiveness factor of cigarettes and how older smokers may be more addicted given that they have been smoking for longer than younger adults.

Overall, in terms of smoking participation, my estimates in table 5 provide no evidence for the hypothesis that younger persons are more price sensitive than older persons because most estimates were close to zero and statistically insignificant. However, concerning former smokers, my estimates suggest that individuals in the 25-34, 35-44, and 45-54 categories are more likely to quit smoking as a result of excise taxes than adults aged 55-59. This evidence suggests that smoking cessation for adults aged 24-55 are still being influenced by tax increases whereas for the age group 18-24 smoking cessation estimates do not seem to be influenced strongly by excise tax increases. While

smoking cessation estimates for adults aged 55-59 illustrate a negative influence from taxes. This could also potentially be explained by the aforementioned addictiveness factor. So, it makes sense that the oldest age group in my analysis would be less likely to quit smoking in response to tax increases than the other age groups.

6.3 Robustness Checks

In this section, I will be building upon my preferred model as well as testing the sensitivity of the model. First, I perform an anti-test of sorts where I take my preferred model including individual-level covariates and smoking policy controls and perform an identical test used to obtain the main estimates except the dependent variable is now defined as individuals who have never smoked. Results for this test should show that there is no association between excise taxes and people that have never smoked since estimates should be driven by individuals in the everyday, someday and former smoker status. Next, I perform my main test excluding observations from 2007 from my dataset because the largest tax increases took place in 2008, 2009, and 2010 and the marginal effect of the year 2007 was the lowest. Lastly, I include a proxy of anti-smoking sentiment instead of state fixed effects in an attempt to model the heterogeneity that leads to the inclusion of state fixed effects. Since I cannot construct an empirical measure of anti-smoking sentiment with the data I have I include indirect proxies that may represent anti-smoking sentiment suggested by other researchers. Wasserman et al.[39] suggests that policy restricting smoking in public places may serve as a proxy for the anti-smoking sentiment and Decicca et al.[40] suggests that living in a state that produces tobacco could

[39] Wasserman, J, Manning, WG, Newhouse, JP and Winkler, JD (1991). "The effects of excise taxes and regulations on cigarette smoking." Journal of Health Economics 10: 43-64

[40] DeCicca, P, Kenkel DS, and Mathios, AD (2002). Putting out the fires: Will higher taxes reduce the onset of youth smoking? Journal of Political Economy 110 (1): 144-169.

be a useful indicator for anti-smoking sentiment as citizens may have a more positive attitude toward tobacco since the tobacco industry plays a part in the state's economy.

Table 6

Sensitivity checks

	(1)	(2)	(3)	(4)
Smoker on all days				
Real cigarette tax		-.0100259	-.0235973	--.0228047
Marginal effect		(.0123918)	(.0147782)	(.0147782)
Elasticity		[-.004031]	[-.0048062]	[-.004649]
		{-.0434768}	{-.0494446}	{-.0477797}
		(.0269549)	(.0309972)	(.0365714)
N		1,288,984	1,288,984	1,288,984
Smoker on at least some days				
Real cigarette tax		.0012528	-.0111419	-.0085549
Marginal effect		(.0129522)	(.01373)	(.0160272)
Elasticity		[.0004417]	[-.0028309]	[-.0021751]
		{.0010063}	{-.0202881}	{-.0155759}
		(.0073816)	(.025005)	(.0291625)
N		1,288,984	1,288,984	1,288,984
Former Smoker				
Real cigarette tax		0251673**	.0338519***	.0243934***
Marginal effect		(.0088645)	(.0059545)	(.0067648)
Elasticity		[.0065302]**	[.0087787]***	[.0063264]***
		{.0458591}	{.0599156}	{.0431703}
		(.0161379)	(.01053)	(.0119155)
N		1,288,984	1,288,984	1,288,984
Never Smoked				
Real cigarette tax	-.0000435			
Marginal effect	(.0091888)			
Elasticity	[-.000109]			
	{-.0000822}			
	(.0244821)			
N	1,288,984			

Notes: All models are weighted by sample weights provided by the BRFSS. The models were also run without including weights and although results were not reported the results were nearly identical to the results to the tests that included weights. I used my preferred model (model (3) from my main estimates) for all of the robustness checks Column (1) tests the relationship between people who never smoked and excise taxes with the probability of having never smoked as the dependent variable, column (2) represents estimates when the year 2007 is excluded from the data set, and column (3) includes a proxy for anti-smoking sentiment. In this case, I include a variable that equals one of the individual lives in a state that produces tobacco and if the tobacco industry is important to the state's economy states that produced tobacco in 2006-2010 were North Carolina, Kentucky, Tennessee, Virginia, South Carolina, Georgia, Pennsylvania, Ohio, Connecticut, Missouri, and Massachusetts. Column (4) includes an alternative proxy for anti-smoking sentiment

which includes controls for smoking bans in workplaces, restaurants, bars, gambling establishments, and hotels. Standard errors (in parentheses) are calculated using the delta method allowing for non-independence at the state level (clustering). Numbers in the square brackets are the marginal effects. Elasticities are reported in curly brackets and the standard errors for elasticities (parentheses) are calculated using the delta method. *0.05< p-value ≤ 0.10, ** 0.01< p-value ≤ 0.05, *** p-value ≤ 0.01

As expected, since people who never smoked should not be affected by cigarette taxes, the association between excise taxes and the probability of never smoking using my preferred model specification is statistically insignificant and has a marginal effect that is very close to zero.

Estimates from the test where I omitted observations from 2007 are very similar to the main estimates of my preferred model. When testing the responsiveness of everyday smokers there is a small negative statistically insignificant effect on smoking participation. When including someday smokers into the current smoker definition my model yielded a statistically insignificant positive marginal effect extremely close to zero. Also similar to my main estimates, the model shows a small positive relationship that is statistically significant between the increase of excise taxes and the probability of being a former smoker. Suggesting an increase of .65302 percentage points for every increase on excise taxes of $1 which is a slightly larger effect than the main estimate.

In robustness check (3) and (4) I included different proxies for anti-smoking sentiment in lieu of state fixed effects. My main findings continue to hold in the sense that there is a small negative and statistically insignificant association between excise taxes and smoking participation. However, the estimates from the models that include anti-smoking sentiment are somewhat larger than my preferred estimates. when testing with former smoker status as the dependent variable, both models yielded a positive and statistically significant relationship between excise taxes and the probability of being a former smoker with implied elasticities of 0.0599156 and 0.0431703, respectively, which are a slightly larger than the elasticities reported in my preferred estimates.

7. Discussion

The degree to which excise taxes affect adults' smoking participation and consumption is still debated in the literature. For adults, Chaloupka and Warner[41] suggest that elasticities in previous studies range from -0.3 to -0.5, although, more recent studies such as the meta-analysis from Gallet and list[42] suggests a median participation elasticity of -0.32 among adult smokers.

This paper examined the issue of adult smoking habits and extended the literature in the following ways. First, by utilizing recent large tax increases and by testing the analysis on former smoker status and not just on smoking participation. This paper examined the price sensitivity between adult-aged individuals in the United States and how behavior differed as a result of state excise tax increases. Interestingly, cigarette excise taxes seem to no longer be a significant factor in explaining adults' relationship with smoking participation. This result is somewhat surprising since excise taxes have continued to increase dramatically over the time period used in my sample (2006-2010). Taxes have continued to rise by large amounts in 2011-2017 but not at the same rate of the first decade in the twenty-first century. Based on my results, it seems that state-level excise taxes are a relatively unimportant factor when in adult's participation decisions. My results did, however, indicate that cigarette excise taxes play an important role in cessation activities as evidenced by the positive statistically significant relationship between state excise taxes and adults' smoking cessation activities with statistically significant elasticities generated. This an interesting result because the original hypothesis seemed to indicate that increasing state excise taxes may no longer be an effective policy.

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[41] Wasserman, Jeffrey, Willard G. Manning, Joseph P. Newhouse, and John D. Winkler. "The Effects of Excise Taxes and Regulations on Cigarette Smoking." *Journal of Health Economics* 10, no. 1 (1991): 43-64. Accessed July 10, 2018. doi:10.1016/0167-6296(91)90016-g.

[42] Gallet, Craig A., and John A. List. "Cigarette Demand: A Meta-analysis of Elasticities." *Health Economics* 12, no. 10 (2003): 821-35. doi:10.1002/hec.765.

Arguably, was everyone that may have quit smoking because of tax increases would have done so by this point in time, however, this is not the case. My model shows that cessation activities are still influenced by state excise taxes. This means that excise taxes still affect cessation activities however, my results cannot conclude that excise taxes still play a factor in smoking participation. There are several studies that illustrate the lack of consensus among the literature. Callison and Keastner[43] as well as Evans and Farrelly[44] both find that participation elasticities are small and, in some cases, not statistically significant. Farrelly et al[44]. finds that older adults are not price sensitive to excise taxes although found that younger adults were significantly sensitive to excise taxes. Whereas Callison and Kaestner[43] finds insignificant elasticities for smoking participation rates and cigarette consumption. Alternatively, Decicca and Mcleod[45] concludes that older adults are still price sensitive to excise taxes as they estimate relatively large elasticities for older adults in contrast to Evans and Farrelly's findings. Also, Taraus (2006)[46] estimates that adults are sensitive to excise taxes and prices with reported participation elasticities of -0.15. One interesting result is that the estimations I found infer that people with excellent health were more price sensitive to taxes than people with poor health. So, health could be playing more of a role in the decision to smoke and the decision to quit than taxes do.

Additionally, my estimates find that there is no difference in price responsiveness between age groups as every age group displayed a small and statistically insignificant effect on smoking participation regardless of the definition of a current smoker used.

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[43]Callison, Kevin, and Robert Kaestner. "Do Higher Tobacco Taxes Reduce Adult Smoking? New Evidence of the Effect of Recent Cigarette Tax Increases on Adult Smoking." 2012. Accessed July 10, 2018. doi:10.3386/w18326.

[44] Farrelly, Matthew C., Jeremy W. Bray, Terry Pechacek, and Trevor Woollery. "Response by Adults to Increases in Cigarette Prices by Sociodemographic Characteristics." *Southern Economic Journal* 68, no. 1 (2001): 156. Accessed July 10, 2001. doi:10.2307/1061518

[45] Decicca, Philip, and Logan Mcleod. "Cigarette Taxes and Older Adult Smoking: Evidence from Recent Large Tax Increases." *SSRN Electronic Journal*, 2007.

[46] Tauras, John A. "Smoke-Free Air Laws, Cigarette Prices, And Adult Cigarette Demand." *Economic Inquiry* 44, no. 2 (2006): 333-42. doi:10.1093/ei/cbj028.

However, there seems to be some differences between age groups when testing the effect that excise tax has on cessation activity. While the estimates for the 18-24 age group show a small negative and statistically insignificant result. estimates concerning adults aged 24-34, 35-44, 45-54 all report statistically significant positive relationships between the increase of excise taxes and the probability of being a former smoker with reported elasticities of 0.0705764, 0.0524832, and 0.0409112 respectively. However, the reported elasticity for adults aged 55-59 is -0.038535 and statistically significant. This result suggests that cessation activities for adults aged 24-54 in response to taxes are fairly significant while adults aged 55-59 tend not quit smoking as a response to taxes. Based on these estimates it seems that young adults and older adults are not as likely to shift to former smoking status as people aged 24-54. One possible reason for this is that cigarettes are an addictive good and assuming older adults have been smoking longer than middle-aged adults means that they are less likely to quit smoking because of excise taxes because of the addictiveness factor. Also, older adults may not face the same health benefits associated with quitting smoking as middle-aged or younger adults will. Also, for adults aged 18-24 cessation activity seems to be largely unaffected by cigarette taxes. One possibility for this is that the sample size for this age group is smaller than the others which will cause larger confidence intervals. Also, the individuals of this subsample that define themselves as an everyday smoker or some day smoker in the age 18-24 age group is much smaller than the other age groups which could contribute to a statistically insignificant result.

Finally, my sensitivity analysis suggests that my findings that smoking participation may have a very small statistically insignificant negative relationship with excise taxes and cessation activity has a small significant positive relationship with excise tax increases are quite robust as my main findings continue to hold for every alternative model specification I tested. In table six, two of the alternative specifications provided slightly larger marginal

effects than my main estimates. Both of these alternative specifications are column 3 and 4 from table six where I include the anti-smoking proxies instead of the state fixed effects. My findings seem to be fairly robust to reasonable specification changes.

8. Limitations

it is very difficult to develop causal relationships when studying the effect that tax increases have on price sensitivity because of the nature of the data. I attempted to remove endogeneity to the best of my ability while following similar techniques presented in the literature such as incorporating fixed effects and demographic control variables. However, there still may be unobservable variables that may affect smoking participation.

The BRFSS does not have any information about smoking intensity (i.e. the number of cigarettes smoked per day). So, I was limited in my analysis in the sense that I could only test the effect of state-level excise tax increases on smoking participation and not on cigarette demand.

This was strictly a short run analysis with an empirical study spanning 5 years and there is no long-run component to this study. So, there was no way to analyze whether the tax increase is effective in the long-run, rather, I only measured short run reactionary changes.

There is no measure of the addictiveness of cigarettes in this paper. Addictiveness is only assumed to explain why the price smoking activities of different age groups might be different based on common knowledge and what has been accepted in the previous literature.

9. Conclusion

To summarize, my analysis of the association of adult smoking participation, cessation and excise taxes suggests that smoking participation is largely unaffected by state-level excise taxes. My estimates suggest that at best there may be a small negative effect among everyday smokers which is difficult to distinguish from zero. It would take a very large increase to make a noticeable difference in smoking participation. Similarly, when including someday smokers into the definition of a current smoker it is difficult to distinguish the effect from zero. Although, when testing the effect of taxes on the probability of a former smoker my estimates suggest that excise taxes do play a role in individuals cessation activities as my estimates show a statistically significant relationship between excise taxes and the smoking cessation. This suggests that excise taxes still play a role in an individual's decision to quit smoking.

Previous analysis on youth smoking suggests that anti-smoking sentiment may be a bigger factor in reducing smoking participation than excise taxes. For example, Decicca et al[47] found that for youth smoking anti-smoking sentiment made a bigger impact on youth smoking then excise taxes using an empirical measure for anti-smoking sentiment they created themselves. An interesting future research idea would be to perform a similar analysis for adults and for different age groups. I could not perform this analysis because the BRFSS did not ask the questions necessary to develop an empirical anti-smoking sentiment variable similar to the one developed in Decicca et al[48] Since my estimates show that excise taxes have little to no effect on smoking participation among adults even

[47] Decicca, Philip, Donald Kenkel, and Alan Mathios. "Putting Out the Fires: Will Higher Taxes Reduce the Onset of Youth Smoking?" *Journal of Political Economy* 110, no. 1 (2002): 144-69. Accessed July 10, 2018. doi:10.1086/324386.

[48] Decicca, Philip, Donald Kenkel, and Alan Mathios. "Putting Out the Fires: Will Higher Taxes Reduce the Onset of Youth Smoking?" *Journal of Political Economy* 110, no. 1 (2002): 144-69. Accessed July 10, 2018. doi:10.1086/324386.

though smoking participation is falling. There is evidence that suggests there are real social consequences to smoking. Dillard et al[49] finds evidence that nonsmokers held more of a negative attitude and were less willing to engage in different close relationships with a smoker. It would be interesting to see if anti-smoking sentiment/negative social consequences of smoking would play more of a factor in the decision to smoke or not than taxes and prices do.

[49] Dillard, A. J., Magnan, R. E., Köblitz, A. R., & Mccaul, K. D. (2013). Perceptions of smokers influence nonsmoker attitudes and preferences for interactions. *Journal of Applied Social Psychology, 43*(4), 823-833. doi:10.1111/jasp.12008

Appendix

Table A1

Main estimates when using a logit regression

	(1)	(2)	(3)
Smoker on all days			
Real cigarette tax	-.01402208	-.0148452	-.0136147
	(.01133681)	(.0124271)	(.0125419)
Marginal effect	[-.00241179]	[-.0023614]	[-.0021364]
Elasticity	{-.0211867}	{-.0232349}	{-.022907}
	(.0176948)	(.0225175}	(.02145)
N	1,288,984	1,288,984	1,288,984
Smoker at least on some days			
Real cigarette tax	.0022325	.0050003	.0055015
	(.0199395)	(.0189577)	(.0192268)
Marginal effect	[.0003653]	[.0007245]	[.0007971]
Elasticity	{.0021701}	{.0048606}	{.0053477}
	(.0193815)	(.0184265)	(.0186879)
N	1,288,984	1,288,984	1,288,984
Former Smoker			
Real cigarette tax	-.0286541**	.0313266**	.0320611**
	(.0147559)	(.015574)	(.0153071)
Marginal effect	[.0043037]**	[.0046235]**	[.0047319]**
Elasticity	{.0290098}	{.0306223}	{.0313402}
	(.0144173)	(.0152156)	(.0149547)
N	1,288,984	1,288,984	1,288,984

Notes: All models are weighted by sample weights provided by the BRFSS. All models utilized a logit regression. Model (1) is the model that includes fixed effects without covariates and public bans, model (2) includes covariates only, and model (3) includes covariates and the indicator variables I constructed for smoking bans. Standard errors (in parentheses) are calculated using the delta method allowing for non-independence at the state level (clustering). Numbers in the square brackets are the marginal effects. Elasticities are reported in curly brackets and the standard errors for elasticities are calculated using the delta method. *0.05< p value $\leq$ 0.10, ** 0.01< p value $\leq$ 0.05, *** p value $\leq$ 0.01

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