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Abstract
The cigarette excise tax is viewed as an important policy tool to reduce smoking-related health problems and productivity losses. This is based on evidence that higher cigarette taxes reduce cigarette consumption and induce people to quit smoking, but there is also evidence that smokers adopt potentially health-reducing smoking behaviors to compensate for higher cigarette costs. In this paper, I exploit the substantial variation in cigarette taxes across and within U.S. states over time to examine the impact of cigarette taxes on health and wages. The analysis reveals that higher cigarette taxes cause a reduction in wages and a reduction in the number of healthy days in the past month. The negative impact on healthy days is more pronounced among individuals with low incomes and high daily intakes of nicotine and tar. These results indicate that cigarette taxes have unintended negative consequences, which may be driven in part by compensatory smoking behaviors. Alternative mechanisms related to weight gain and alcohol consumption are explored, but the analysis reveals that there is no empirical support for them.

Keywords
Cigarette taxes, health, smoking, wages

JEL Classification Codes
I12, I18, J31, J38, H71

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I. Introduction

The question of whether smokers suffer a wage penalty in the labor market is one that has received greater attention in recent years by economists and policymakers alike. Using a variety of methodologies, previous studies have found that smokers earn less than non-smokers (Levine *et al.* 1997; Lee 1999; Ours 2004; Auld 2005; Grafova and Stafford 2008; Anger and Kvansnica 2010). This literature has estimated that the "smoking wage penalty" is between 2% and 24%. It is commonly posited that smokers may earn less than non-smokers due to smoking-related health problems, which reduce worker productivity while on the job or that lead to higher rates of absenteeism.[1] For example, a recent study of U.S. employees indicates that current smokers have more lost working days and unproductive time at work compared with former smokers and non-smokers (Bunn *et al.* 2006). They estimate that the cost of health-related productivity losses among smokers is $4,430 per employee per year, which is much higher than the estimated loss of $2,623 among non-smokers.[2]

In response to evidence of a wage penalty on smoking in the labor market and smoking-related health problems that reduce worker productivity, the Congressional Budget Office has advocated an increase in the federal-level cigarette excise tax (Congressional Budget Office 2012). The cigarette excise tax is generally viewed as one of the most effective policy tools to reduce smoking and induce quitting (Chaloupka and Warner 2000). However, in light of recent evidence that smokers compensate for cigarette tax hikes in ways that could result in a reduction in health, it is unclear whether cigarette taxes improve the wage

[1] There are other explanations for the commonly observed wage gap between smokers and non-smokers. First, unobserved heterogeneity could be driving the relationship between smoking and wages. Individuals who choose to smoke may be relatively more myopic or have higher rates of time preference, given their decision to smoke for short-term benefits over the well-known long-term negative consequences of smoking. More discounting of the future, for example, may result in fewer investments in human capital, which may translate into lower wages. Second, employers may also choose to pay relatively lower wages to smokers due to higher expected costs of employer-sponsored health coverage. For example, Cowan and Schwab (2011) find that smokers with employer-sponsored health insurance receive lower wages than their non-smoking peers, while smokers without such insurance suffer no such wage penalty.

[2] In a review of the literature, Sloan *et al.* (2004) find that productivity losses attributable to smoking-related morbidity and mortality are estimated to be $36 billion and $95 billion per year on average, respectively.

outcomes of smokers. For example, there is evidence that smokers compensate for higher cigarette costs by extracting more nicotine per cigarette smoked (Adda and Cornaglia 2006). Also, current cigarette tax policy in the U.S. is to levy a tax per pack of 20 cigarettes, but not all cigarettes are created equally. There is evidence in the literature that smokers switch to longer cigarettes and cigarettes with greater concentrations of tar and nicotine to compensate for higher cigarette costs (Evans and Farrelly 1998; Farrelly *et al.* 2004). While there is clearly the potential for such smoking behaviors to reduce the health and productivity of smokers, there is surprisingly little evidence in the literature as to whether cigarette taxes have such perverse effects.

My first contribution to the literature is to provide the first estimates of the effect of cigarette taxes on wages. The main channel connecting cigarette taxes to wages is health, so a primary goal of the analysis is to study the extent to which changes in health underlie effects of cigarette taxes on wages.[3] I also contribute to the literature by providing estimates of the effect of cigarette taxes on a variety of health measures that might affect worker productivity, which have not been explored in the literature. For example, one important measure that I analyze is adult respiratory health, as measured by current asthma status.[4] Estimates of cigarette taxes on the probability of asthma are useful because some compensatory smoking behaviors observed in the literature such as increased puff duration and volume might have important effects on respiratory health. I also investigate the effects of cigarette taxes on other measures of health such as the number of unhealthy days in the past month, which may be viewed as capturing the impact of smoking on short-term productivity losses.

[3] There are few studies in the smoking literature that analyze effects of cigarette taxes on health measures that can help to understand the effects of cigarette taxes on worker productivity. An important exception is the literature examining the effect of cigarette taxes/prices on body mass index (BMI) and being overweight or obese (Chou *et al*. 2004; Gruber and Frakes 2006; Baum 2008; Courtemanche 2009). However, this literature has provided mixed evidence on whether increasing cigarette taxes/prices lowers BMI and reduces the probability of being overweight or obese.

[4] A recent review of the literature on cigarette smoking and asthma concluded that a majority of studies indicates that smoking significantly increases the risk of asthma incidence, and that among asthmatics smoking lowers the response to treatment and results in greater declines in lung functioning (McLeish and Zvolensky 2010).

This study uses within-state variation in cigarette taxes over time to identify the effect of cigarette taxes on health and wages. This identification strategy accounts for fixed unobserved state-level factors that may be associated with the level of cigarette taxation and health or wages. It relies on the exogeneity of *within*-state changes in cigarette taxes over time, which are arguably exogenous with respect to an individual's health or wages. Using data from the Current Population Survey's 1979-2012 Merged Outgoing Rotation Group (CPS-MORG) files merged with state-level information on cigarette excise taxes, I find that, on average, a $1 increase in cigarette taxes reduces wages by about 1.2%. I use smoking information from the 1992-2011 Tobacco Use Supplements to the Current Population Survey (CPS-TUS) to examine whether this finding is driven by the impact on smokers. I find that, relative to individuals who have a lower propensity to smoke, cigarette taxes have a larger negative impact on the wages of individuals who have a high propensity to smoke. In particular, I estimate that a $1 increase in cigarette taxes reduces the wages of individuals with a propensity to smoke by 1.6% relative to those who have no propensity to smoke.

Higher worker absenteeism due to smoking-related health problems is often cited as a reason for the lower relative wages of smokers. Unfortunately, the lack of health-related information in the CPS does not allow for a detailed study of the extent to which changes in health drive the negative estimated effects of cigarette taxes on wages. Nonetheless, the CPS contains information on a worker's pay status, which I use as a proxy for the generosity of the sick leave policy faced by workers. Workers paid on an hourly basis are less likely than salaried workers to have sick leave, so that a lost working day for hourly-paid workers often translates into a loss in compensation. I find that relative to non-hourly-paid workers, a $1 increase in cigarette taxes is estimated to reduce wages by about 4%. This suggests that changes in health might be important to understanding the negative estimated effects of cigarette taxes on wages.

I use data from the 1993-2012 Behavioral Risk Factor Surveillance System (BRFSS) to provide a more detailed analysis of the relationship between cigarette taxes and health. I find that, on average, cigarette taxes reduce the number of healthy days and increases the number of days that poor health limited usual activities in the past month. For a $1 increase in cigarette taxes, the estimated impacts range between 1.2% and 1.5%. I also find that cigarette taxes increase the probability of reporting asthma, but the estimated effect is not statistically significant at conventional levels. Using smoking information in the BRFSS, I find that the negative impact of cigarette taxes on health is concentrated among individuals who have a propensity to smoke. In particular, relative to those with no propensity to smoke, I find that a $1 increase in cigarette taxes increases the probability of asthma by 0.11% and increases the number of days in the past month that poor health limited usual activities by 0.369%.

Taken together with the results from the CPS, these results suggest that cigarette tax hikes may lead to detriments in health—which may have a negative impact on worker productivity—and ultimately translate into lower wages. These findings may seem surprising at first sight because it is well known that the demand for cigarettes falls when cigarette taxes increase—and that a reduction in cigarette consumption or quitting smoking has health benefits—which is expected to translate into higher productivity and wages. However, a recent study by Adda and Cornaglia (2006) shows that while smokers in the U.S. reduce the number of cigarettes that they smoke in response to a cigarette tax hike, there is also evidence that smokers extract a greater amount of nicotine per cigarette consumed. Smokers may "smoke more intensively" by increasing the depth of inhalation, reducing the amount of time between puffs, increasing the number of puffs per cigarette, increasing the duration of puffs, and blocking of filter vents (Scherer 1999).[5]

[5] One of these compensatory smoking behaviors, increased depth of inhalation, has been linked to lung cancer in the epidemiology literature (Thun, *et al.* 1997). I am not aware of any evidence that other health outcomes are also affected by such behaviors, but it seems plausible that there are other important health effects as well.

I explore whether there is empirical support for increasing smoking intensity as a potential mechanism for the negative cigarette tax effects on health and productivity. In the model of smoking intensity presented in Adda and Cornaglia (2006), agents who would like to increase nicotine consumption face a trade-off between buying more cigarettes and smoking each cigarette purchased more intensively. Agents derive utility from nicotine and disutility from intensity of smoking. The model predicts that smoking intensity is decreasing in income, and increasing in cigarette costs if an individual's level of nicotine demand is sufficiently high. These model predictions imply that in the face of a cigarette tax hike, detriments to health associated with higher smoking intensity, if any, may be more pronounced among those with low incomes and the highly addicted.

To test the former hypothesis, I use the BRFSS to examine whether the effect of cigarette taxes varies across the income distribution. I find that a cigarette tax hike increases the number of unhealthy days in the past month, but that these effects are decreasing with the level of income. For example, I estimate that while a $1 increase in cigarette taxes increases the number of days in the past month that poor health limited usual activities by 3% at the 25th percentile of the income distribution, the corresponding estimated effect at the 75th percentile is only one-tenth the size. Low-income individuals are less able to afford to maintain a given amount of cigarette consumption when faced with higher cigarette costs, which may induce them to smoke in ways that maximize nicotine intake per cigarette smoked and lead to reductions in health.

Due to the addictive nature of nicotine, the most addicted smokers may experience the greatest amount of disutility from the lower nicotine consumption associated with a reduction in the number of cigarettes smoked. If this is true, then reductions in health are expected to be more pronounced among smokers with a high daily intake of nicotine. This hypothesis cannot be tested using the BRFSS data set because it does not contain information on nicotine intake.

I examine this hypothesis by using the 1978-1980 Smoking Supplements and the 1987 Cancer Control Supplement to the National Health Interview Survey (SCC-NHIS), which contain information on the nicotine and tar level of the brand of cigarettes that smokers smoke most often. The SCC-NHIS also contains information on the number of restricted and bed days in the past two weeks, which are similar to the BRFSS measures of unhealthy days. There is very little within-state variation in cigarette taxes over 1978-1987 to exploit in estimation, so this part of the analysis uses within-region variation in cigarette taxes. Using the SCC-NHIS data, I find that cigarette taxes increase the number of restricted and bed days in the past two weeks, and that the estimated effects of cigarette taxes on these measures of health are larger among smokers who have above-mean daily intakes of nicotine and tar. This analysis reveals that a cigarette tax hike disproportionately reduces the short-run health of those who are highly addicted. This could be the result of increased smoking intensity or some other compensatory smoking behavior, but the lack of information on such behaviors does not allow me to directly shed light on this hypothesis.

There may be other channels through which cigarette taxes lead to reduced health and wages. First, if alcohol and tobacco are substitutes, increases in cigarette taxes may cause a substitution toward drinking. Second, to the extent that smoking reduces weight, cigarette taxes may lead to weight gain. I explore whether these are potentially important alternative mechanisms by examining whether cigarette taxes affect the extensive and intensive margins of alcohol consumption and BMI and the probability of being overweight or obese. However, I do not find evidence that cigarette taxes have important effects on alcohol consumption or body weight outcomes.

In sum, I find that higher cigarette taxes are not a panacea for improving the health and wage outcomes of smokers. While high cigarette costs cause some smokers to reduce the number of cigarettes that they smoke or to quit smoking, high cigarette costs may have perverse effects on other smokers. The evidence in this study indicates that higher cigarette taxes reduce health and wages. These findings may be partly driven by unintended consequences of the current cigarette tax policy in the U.S., which is to levy taxes per pack of 20 cigarettes. High cigarette costs may cause individuals to find ways of maximizing nicotine consumption per dollar spent on a pack of cigarettes, and such behaviors may have a negative impact on health. Suggestive evidence that reductions in health caused by higher cigarette taxes are concentrated among individuals with low incomes and the highly addicted is consistent with this hypothesis. To reduce the potential for unintended consequences of cigarette tax policy, a policy implication of this analysis is that a given pack of cigarettes ought to be taxed based on the nicotine and tar content in these cigarettes, and not simply on the size of the pack.

This paper is organized as follows. First, I will describe the data sets used in the analysis. Second, I will describe the empirical methods employed in this study and the results from the analysis. Third, I will explore potential mechanisms that may underlie the effects of cigarette taxes on health and wages. Finally, I will provide a discussion of the results and conclude.

II. Data

The analysis here of the effect on wages of cigarette taxes draws on data from the Current Population Survey (CPS). The CPS is a household survey that is conducted on a monthly basis by the Bureau of Labor Statistics to measure employment and labor force participation in the U.S. Every household that enters the sample is interviewed for 4 consecutive months, is rotated out and not interviewed for 8 months, and is finally interviewed for another 4 consecutive months before being permanently rotated out of the sample. The information needed to calculate hourly wages such as hours worked and earnings is collected from individuals who are in the 4^{th} and 8^{th} interview months (*i.e.* outgoing rotation groups). For this reason, in the first part of the analysis, I use data over the period 1979-2012 from the CPS Annual Earnings File, which is also known as the Merged Outgoing Rotation Groups (MORG-CPS) file. While these data contain a rich set of individual and labor market variables that are useful for a study on wages, they do not contain smoking information. Thus, for the second part of the analysis, which requires smoking information, I use the Tobacco Use Supplement to the CPS (TUS-CPS), which was administered in 1992, 1993, 1995, 1996, 1998, 1999, 2000, 2001, 2002, 2003, 2006, 2007, 2010, and 2011.

In the regression analysis, I restrict my sample to prime-age working individuals who are between 25 and 54, not self-employed, and earn a real hourly wage between \$1 and \$100. Hourly wages are calculated by dividing an individual's usual weekly earnings by the usual weekly hours worked. I obtain state-level cigarette tax information from the State Tobacco Activities Tracking and Evaluation (STATE) System, which is collected by the Centers for Disease Control and Prevention (CDC). I use the cigarette tax information from the STATE System and the history of tax changes reported in Orzechowski and Walker's 2012 Tax Burden on Tobacco to construct state-level cigarette tax data at the month/year level from January 1, 1979 to December 31, 2012. In this time period, there was much variation across states and within states, the latter of which will be used to identify the effects of cigarette taxes in this study. For example, there were about 275 state-level (nominal) changes in cigarette taxes over this period. Among states that increased the (nominal) cigarette tax compared to the previous year, the mean increase was \$0.25 and the median increase was \$0.12. Figure 1 shows a histogram of such cigarette tax increases. While states like Georgia and South Carolina made only 1 cigarette tax change over this period, other states like Hawaii and Washington made 12 such changes. The average nominal cigarette taxes across states was about \$0.49, with a between-state standard deviation (SD) of \$0.26, and a within-state standard deviation of $0.52.[6] Figure 2 plots mean real cigarette excise taxes (in $2012) across states over time. Real taxes have increased from an average of about $0.40 in 1979 to an average of about $1.50 in 2012, and these increases were most dramatic in the late 1990s and early 2000s.

The number of states that have imposed smoking bans in public places such as bars, restaurants, and workplaces has been on the rise in recent years, especially since the mid-1990s. In order to prevent confounding tax effects with those of smoking bans in public places, I control for the number of 100% smoke-free bans in a state throughout the analysis. This information was obtained from the Americans for Nonsmokers' Rights Foundation. The proportion of states with smoke-free bans was zero until 1995, which is the year in which Utah imposed a 100% smoke-free ban in restaurants. The proportion of states (including DC) with any 100% smoke-free ban grew from 2% in 1995 to 71% in 2012.

Because time-varying economic conditions may be correlated with a state's cigarette tax policy and wages, I also control for state-specific measures of economic activity such as the unemployment rate and GDP. State-level unemployment rates at the month/year level are obtained from the Bureau of Labor Statistics, and annual state-level GDP is obtained from the Bureau of Economic Analysis.[7] Summary statistics for the samples used in the CPS-MORG and CPS-TUS analysis can be found in Appendix Tables 1 and 2, respectively.

Analyses examining the relationship between cigarette taxes and measures of health draw from the Behavioral Risk Factor Surveillance System (BRFSS) and the National Health Interview Survey (NHIS). The BRFSS is a nationally representative health-related survey in the United States, established in 1984 by the CDC. It is one of the largest surveys tracking health conditions and health-related behaviors of adults aged 18 and over in the U.S. The

[6] Over the period in question, the average (real) cigarette tax across states was $0.64 with a between-state SD of $0.32, and a within-state SD of $0.50.
[7] Labor market earnings, wages, and state-level cigarette excise tax rates and GDP are inflated to $2012 using the consumer price index.

measures of health I analyze include self-reported current asthma status, whether general health status is fair or poor, the number of days in the past month that physical and mental health was “not good”, and the number of days in the past month that usual activities such as work, self-care, and recreation were limited as a result of poor health. Information on most of these health measures was collected from 1993 onward. However, information on current asthma status is not available prior to 1999, so I use information from the 1999-2012 BRFSS in the analysis involving asthma as a dependent variable.[8] Summary statistics for the 1993-2012 BRFSS data set can be found in Appendix Table 3.

The NHIS has been collecting health information on individuals in the U.S. since 1957, and it is a rich source of information on illness, disability, and health conditions. For a subset of my analysis, I am interested in information on the nicotine and tar content of cigarettes smoked, which is not collected in the BRFSS, but was collected in some waves of the NHIS. I use the 1978-1980 Smoking Supplements and 1987 Cancer Control Supplement to the National Health Interview Survey (SCC-NHIS), which are the only years in which such information was collected. The analysis that uses this information aims to understand the behaviors of smokers, so the SCC-NHIS sample is composed only of current smokers. I construct a measure of the daily intake of nicotine and tar consumption by taking the product of the number of cigarettes smoked per day and the nicotine and tar level of the brand of cigarettes smoked most often. The SCC-NHIS also contains measures of health that are similar to the “number of unhealthy days” measure I use in the BRFSS. In particular, the SCC-NHIS has information on the total number of restricted and bed days in the past 2 weeks. The NHIS also has information on general health status, which I use to construct an indicator for whether an individual reports being in fair or poor health. Summary statistics for

[8] Some states included questions about asthma prior to 1999, but the wording of these questions varied across states. The wording of questions about asthma has been consistent across states since 1999. Thus, when asthma is the dependent variable, I restrict my analysis to the 1999-2012 BRFSS.

the SCC-NHIS data used in the analysis can be found in Appendix Table 4. The SCC-NHIS public-use data files do not contain state of residence information for every respondent, so I use the finest level of geographic information available for each respondent when assigning cigarette taxes to each respondent. I am able to identify respondents from 18 states in the 1978-80 files, and 19 states in the 1987 file. However, there is very little variation in taxes left to exploit in estimation after state and year effects are controlled for. Thus, I include region and year effects, and region-specific time trends in regressions using SCC-NHIS data.

III. Methods and Results

a. *The Effect of Cigarette Taxes on Worker Productivity (CPS-MORG)*

To examine the impact of cigarette taxes on measures of worker productivity, a model of the following form is estimated,

$$Y_{ist} = \beta_0 + X'_{ist}\beta_1 + \beta_2 CIGTAX_{st} + \gamma_s + \gamma_t + \lambda(s,t) + \varepsilon_{ist}, \quad (1)$$

where the Y is either (log) earnings, (log) hourly wage, or (log) hours worked. The primary outcome of interest here is wages, but I provide results from models that use as dependent variables components of wages for comparison and to examine the extent to which earnings versus labor supply drives any effects on wages. These measures of worker productivity are observed for individual *i* residing in state *s* who is interviewed at time *t*; X is a vector of measured covariates that may affect smoking and wages, such as demographic information including age, sex, race/ethnicity, educational attainment, and marital status; γ_s is a state-of-residence fixed effect; γ_t is a time fixed effect, which includes month and year dummies; $\lambda(s, t)$ is state-specific information such as the number of 100% smoke-free bans in a state, the state-level unemployment rate and GDP, and state-specific time trends; and ε is an error term. The model in equation (1) controls for permanent factors that vary by state of residence, month, and year. The model also controls for unobserved state-specific time trends that could drive both cigarette taxation and labor market outcomes. Including time trends that vary by state in the regression of wages addresses the concern of reverse causality, *i.e.* the concern that a state's cigarette excise tax policy is influenced by labor market outcomes, and not the other way around. For example, a downward trend in wages might induce a state government to increase its cigarette excise tax, acting under the assumption that smoking has a negative impact on wages via the health channel. In the regression analysis below, I control for state-specific linear time trends, which will account for any slow-moving increasing or decreasing trends in measures of worker productivity in each state that might influence cigarette excise tax policy. Identification of β_2 relies on the assumption that variation in cigarette taxes *within* states over time is exogenous with respect to measures of worker productivity, net of the included covariates, state, time fixed effects, and state-specific linear time trends. Standard errors are clustered at the state-level to allow for arbitrary correlation among observations in the same state.

In Table 1, I present the results from the model shown in equation (1).[9] In columns 1 and 2, I find that increasing cigarette taxes by $1 reduces earnings and wages by about 1.2%. In column 3, I show that the estimated effect of cigarette taxes on (log) hours worked is negative, but very small in magnitude, and statistically insignificant. This finding suggests that the intensive margin of labor supply is unaffected by cigarettes taxes.[10]

The cigarette excise tax is often viewed as a policy tool to improve health, and if true, positive health effects of higher cigarette taxes are expected to boost worker productivity. The evidence in Table 1 indicates that the opposite may be true, which is

[9] Throughout the analysis, I show results from models that include a cigarette tax variable as the primary variable of interest because it is the relevant policy tool that can be manipulated to change the prices of cigarettes. Also, cigarette prices are likely to be endogenous in the models estimated here. Changes in prices within states are a function of changes in taxes within states, but prices may be affected by other factors that affect smoking and wages. For example, a tobacco company's selling price of cigarettes may depend on the average labor market earnings of local residents, which may change over time due to within-locality changes in demographics. In any case, in unreported regressions, I instrumented cigarette prices with cigarette taxes, and the results are very similar to those shown here.
[10] In an unreported regression, I also find that cigarette taxes do not affect the extensive margin of labor supply. The estimated effect of cigarette taxes on the probability of employment is very small in magnitude and statistically insignificant.

counterintuitive. However, recent evidence that smokers compensate for higher cigarette costs by switching to longer and more nicotine-dense cigarettes or by smoking more intensely may help to understand this counterintuitive finding (Evans and Farrelly 1998; Farrelly *et al.* 2004; Adda and Cornaglia 2006). For example, if such smoking behaviors are at work here, then changes in health may explain the negative impact of cigarette taxes on earnings and wages estimated here.

Unfortunately, the CPS has no measures of health that allows for a direct test of whether health is important to understanding the negative impact on earnings. However, worker absenteeism is often cited as a reason for why smokers earn less than non-smokers. If work-loss days are important to understanding the relatively lower wages of smokers, then information on a worker's pay status may help to provide suggestive evidence that cigarette taxes affect worker productivity through short-term illness or bad health. Hourly paid workers are less likely than salaried workers to have "paid sick days" as part of their contractual work agreement with employers. Salaried workers are often allotted a fixed number of "sick days", which allow a worker to miss work due to illness without suffering a loss in earnings. However, workers without such a provision in their employment contracts typically suffer a loss in compensation for every day that they miss work. I use a worker's pay status as a proxy for the generosity of sick leave, and examine whether the effect of cigarette taxes on measures of worker productivity vary by hourly pay status. If reductions in health underlie the negative impacts of cigarette taxes on earnings, wages, and hours of work, then these negative effects are expected to be more pronounced for hourly paid workers.

I examine this by adding a dummy variable for hourly pay status and its interaction with the cigarette tax to the model shown in equation (1). Interestingly, in Table 2, for non-hourly-paid workers, cigarette taxes have a positive impact on earnings, wages, and hours of work. In contrast, taken together with the main effect of the cigarette tax, the estimated impacts of cigarette taxes on these outcomes for hourly paid workers are all negative. Relative to non-hourly-paid workers, a $1 increase in cigarette taxes is estimated to reduce earnings and wages by about 4%, and reduce hours worked by about 0.7%. These are all larger in magnitude than the average estimated effects shown in Table 1. (Also, the magnitude of the estimated impact on earnings is larger than that on hours of work, suggesting that changes in earnings drive most of the changes in wages.) To the extent that "hourly pay status" proxies well for the generosity of sick leave, these results suggest that the negative impact on worker productivity may operate through changes in health. Before turning to the analysis of BRFSS data to examine the impact of cigarette taxes on various measures of health, I examine whether the estimated impacts on earnings, wages, and hours of work are driven by effects on smokers.

b. *The Effect of Cigarette Taxes on Worker Productivity by the Propensity to Smoke (CPS-TUS)*

The model in equation (1) implicitly assumes that a change in cigarette taxes will have an equal impact on those who are at risk of smoking and those who are not. However, cigarette taxes should have a larger effect on the labor market outcomes of smokers.[11] A cigarette tax policy change is expected to affect smokers, but may also affect smoking relapse among former smokers and initiation among non-smokers. Similar to the approach taken by Gruber and Mullainathan (2005), I use smoking information available in the 1992-2011 TUS-CPS files to construct a measure of smoking propensity, in an effort to form an appropriate control group. I choose to use a measure of the propensity to smoke because including current smoking status on the right-hand side might induce a sample selection bias. That is, a change in cigarette taxes may change the composition of smokers, which could bias the estimated effect of interest. For example, suppose that low-wage

[11] To the extent that increases in cigarette taxes reduce smoking prevalence and second-hand smoke exposure, higher cigarette taxes could conceivably have an impact on the wages of non-smokers via improved health.

workers are most likely to quit smoking when cigarette taxes increase because they are less able to afford to continue smoking. If this is true, then a cigarette tax increase would lead to a pool of higher wage workers, which would cause a bias toward finding higher wages in response to higher cigarette taxes.

I construct a measure of smoking propensity to estimate the impact of cigarette taxes on the labor market outcomes of those who are likely to be affected by a change in state-level cigarette taxes (*i.e.*, individuals with a high propensity to smoke), relative to those who are unlikely to be affected by such a change (*i.e.*, individuals with a low propensity to smoke). In practice, I regressed a dummy variable for being a current smoker on the demographic and state-specific information described above for each year in the TUS-CPS files that smoking information is available, and then obtained the predicted value of smoking ($PSMOKE_{ist}$). I use $PSMOKE_{ist}$ as a measure of the propensity to smoke, and expand the model in equation (1) to include this predicted value and its interaction with the cigarette tax:

$$Y_{ist} = \beta_0 + X'_{ist}\beta_1 + \beta_2 CIGTAX_{st} + \beta_3 PSMOKE_{ist} + \beta_4 PSMOKE_{ist} \times CIGTAX_{st} + \gamma_s + \gamma_t + \lambda(s,t) + \varepsilon_{ist}. \quad (2)$$

While the same control vector (X) is used in both the wage and smoking propensity regressions, the coefficient of interest (β_4) is well-identified by within-state changes in taxes over time because the smoking propensity regressions are estimated year-by-year, and the coefficients on the Xs are not allowed to be year-specific. The coefficient β_4 will reveal whether individuals with a high propensity to smoke earn lower ($\beta_4<0$) or higher wages ($\beta_4>0$) as a result of increased cigarette tax rates, relative to those with a lower propensity to smoke. The key identification assumption in this analysis is that factors omitted from the model in equation (2) equally affect those with and without a propensity to smoke.

In Table 3, I present estimates from variants of the model in equation (2). The results indicate that the negative effect of cigarette taxes on wages is concentrated among individuals who have a high propensity to smoke. Estimates of the interaction between smoking propensity and the cigarette tax are all negative, but statistical significance at the 10% level is obtained only in the wage model. To get a sense of the magnitude of this estimate, I use the difference in mean estimated smoking propensities between smokers and non-smokers as a measure of the propensity to smoke. In my sample, the mean estimated propensity to smoke for current smokers is 0.30 and the corresponding estimate is 0.22 for non-smokers. The estimates in column 2 imply that those with a propensity to smoke earn about 1.6% *lower* wages than do those without a propensity to smoke ((0.30-0.22) × -0.205 = -0.016) as a result of a $1 *increase* in cigarette taxes.

In summary, the evidence indicates that increasing cigarette taxes causes a reduction in wages, and that the reduction in wages is concentrated among individuals who have a propensity to smoke. The CPS-MORG analysis showed that the negative impact on wages is more pronounced among hourly paid workers who are less likely to have sick leave contracts and thus more likely to suffer a loss in earnings when ill. This finding implies that changes in health might be important to understanding the negative cigarette tax effects on wages estimated above. Next, I turn to an analysis of the relationship between cigarette taxes and health, to shed light on potential mechanisms underlying the negative relationship between cigarette taxes and wages.

c. *The Relationship between Cigarette Taxes and Health (BRFSS)*

I use smoking and health-related data from the BRFSS to explore whether the relationship between cigarette taxes and wages are operating through a health channel. All the subjects are aged 18 and over in this part of the analysis. The empirical approaches discussed above are used, in turn, but I now use as dependent variables various measures of health.[12]

[12] I present results of linear models throughout the analysis for ease of interpretation, but unreported results from probit/logit models for binary outcomes, and from poisson/negative binomial models for count outcomes produce results that are similar to those presented here.

First, I examine the relationship between cigarette taxes and health using a model similar to equation (1). In Table 4, I find that a \$1 increase in the cigarette tax increases the number of days individuals report that physical and mental was “not good” and the number of days that poor health limited usual activities by between 1.2% and 1.5%. These are all measures of short-term health and may be interpreted as broad measures of productivity, and they inform the analysis conducted above using CPS-MORG and CPS-TUS data. That is, for example, cigarette taxes may reduce productivity as measured by wages because of an increased number of lost working days due to reductions in health.

In Table 4, I do not find evidence suggesting that cigarette taxes affect the probability of currently reporting asthma or of reporting that general health is fair or poor. However, in column 1 of Table 5, when a model comparable to equation (2) is estimated, the interaction between the cigarette tax and smoking propensity is positive and statistically different from zero. In the face of higher cigarette taxes, individuals who have a high propensity to smoke are more likely than those with a lower propensity to smoke to report that they currently have asthma. In the BRFSS sample, the mean estimated propensity to smoke for current smokers is 0.27 and the corresponding mean for non-smokers is 0.18. Calculations like those discussed above imply that those with a propensity to smoke are about 0.01 percentage points more likely to report currently having asthma than those without a propensity to smoke ($(0.27-0.18) \times 0.001 = 0.00009$). In my sample, 8% of individuals currently have asthma, so my results indicate that a \$1 increase in cigarette taxes results in a 0.11% (0.00009/0.08) increase in the prevalence of asthma. This estimated effect is modest, but this finding is important in light of some compensatory smoking behaviors observed in the literature. For example, an increased depth of inhalation might negatively impact respiratory health, which could explain the small rise in the probability of currently reporting asthma among individuals with a propensity to smoke. The pattern for the other health measures is similar, but the only other statistically significant interaction is found in column 5 of Table 5. Relative to those with no propensity to smoke, the estimates indicate that a $1 increase in cigarette taxes increases the number of days that poor health limits usual activities by about 0.369% for those with a propensity to smoke.

The analysis of BRFSS data indicates that increasing cigarette taxes reduces health, as measured by the number of "unhealthy days" in the past month. The analysis of CPS and BRFSS data produces consistent, but counterintuitive, findings. I now explore whether there is empirical support for compensatory smoking behaviors as a mechanism that may be driving these counterintuitive findings. Evidence from the literature indicates that smokers compensate for higher cigarette costs by smoking in ways that could negatively impact health, *e.g.* by substituting toward more nicotine-dense cigarettes or extracting more nicotine per cigarette smoked. These are smoking behaviors that are undertaken to reduce the expense of obtaining a certain level of nicotine intake, and are most likely to be adopted by individuals who are least able to afford hikes in cigarette costs and by individuals who consume large amounts of nicotine. I now turn to an exploratory analysis that aims to examine whether there is empirical evidence to support this interpretation of the CPS and BRFSS results.

IV. *What is Driving the Relationship between Cigarette Taxes and Health?*

The analysis indicates that cigarette taxes have a perverse effect on health, as measured by the number of unhealthy days in the past month. Predictions from the smoking intensity model put forth by Adda and Cornaglia (2006) are useful as a guide to uncover empirical evidence that supports the notion that compensatory smoking behaviors underlie negative impacts of cigarette taxes on health and wages. In their model of smoking intensity, agents derive utility from nicotine and disutility from intensity of smoking. If an agent wants to increase his level of nicotine intake, he faces a trade-off between buying more cigarettes and smoking each cigarette purchased more intensively. Their model predicts that when nicotine demand is high enough, an increase in cigarette costs increases smoking intensity, and that smoking intensity is decreasing in an agent's income level. Using the BRFSS and SCC-NHIS, I conduct two sets of empirical exercises that are meant to draw out evidence of a potential importance for compensatory smoking behaviors to explain the negative impact of cigarette taxes on health and worker productivity.

a. *Does the Effect of Cigarette Taxes on Health Vary by Income?*

Low-income smokers are less able than high-income smokers to keep cigarette consumption fixed in the face of higher cigarette costs, and are thus more likely to smoke more intensively to maintain a given level of nicotine intake. If the latter is true, then any negative health effects of smoking more intensively as a result of a cigarette tax hike should be more pronounced among the low-income population. I examine this hypothesis in Table 6, and I find that cigarette taxes lead to reductions in health, and that this effect is decreasing in income. Together with the main effect of cigarette taxes, the estimates indicate that individuals at the 25th percentile of the family income distribution ($25,000) report 3% more days in which poor health limited usual activities when cigarette taxes go up by $1, while the corresponding estimate for individuals at the 75th percentile ($75,000) is much smaller at about 0.3%. Calculations like this one produce similar estimates of the relative impact of cigarette taxes on health as measured by the number of unhealthy days due to physical and mental health (columns 3 and 4 in Table 6). Health decreases caused by higher cigarette taxes are much larger for low-income individuals. The patterns are similar for the probability of reporting asthma and reporting that health is fair or poor, but the estimates of the main effects of the cigarette tax and its interaction with (log) family income are statistically insignificant.

b. *Does the Impact of Cigarette Taxes Vary by Nicotine and Tar Intake?*

Because of the addictive nature of nicotine, smokers who consume large amounts of nicotine are more likely than those who consume lower amounts of nicotine to compensate for higher cigarette costs by smoking more intensively or by adopting other compensatory smoking behaviors. Since the BRFSS does not contain such data, the analysis summarized in Table 8 draws from the SCC-NHIS. Instead of state and year effects and state-specific linear time trends, I include in regressions region and year effects and region-specific linear time trends. The identification of cigarette tax effects here relies on *within*-region variation in cigarette taxes because there are only a few years of suitable data for this analysis, and as a result there is very little state-level variation to exploit in estimation. I use a subset of health measures that is comparable to the set used in the BRFSS analysis: a dummy variable for whether general health is fair or poor, the number of restricted days in the past two weeks, and the number of bed days in the past two weeks.

The analysis here focuses only on current smokers because the goal is to determine if there is evidence that cigarette taxes have larger negative effects on smokers who have a relatively larger demand for nicotine. First, I estimate a model that is comparable to the one estimated in equation (1). Interestingly, in column 1 of Table 7 I find that smokers in high tax states are much less likely to report that their health is fair or poor. In contrast, in columns 2 and 3 of Table 7, I find that smokers in high tax states report many more restricted and bed days than smokers in low tax states. The evidence in columns 2 and 3 is consistent with the evidence presented using BRFSS data. To the extent that general health status is a measure of longer-term health, the findings in column 1 versus those in columns 2 and 3 are not necessarily at odds with each other. For example, it may be the case that cigarette taxes positively impact health in the long run, but compensatory smoking behaviors adopted in response to higher cigarette taxes have a negative impact on health in the short run.

To test whether there is evidence that the most addicted smokers are most likely to adopt compensatory smoking behaviors, I estimated models on subsamples of individuals with high and low nicotine and tar intake levels. The estimated impact of cigarette taxes on poor short-term health as measured by total restricted days or bed days is much larger among high-nicotine and high-tar smokers. For example, in column 3 of Panel A of Table 8, the estimates indicate that $1 increase in cigarette taxes increases restricted days in the past two weeks by about 22% among those who have above-mean daily nicotine intake; the corresponding estimate for those with below-mean daily nicotine intake is about 7%. It is important to note that this is a large tax increase over this period, and that these estimates are not statistically different from each other (p-value = 0.2070). The results when I split the sample by total daily tar intake instead of total daily nicotine intake are similar. However, the estimates in columns 3 and 4 of Panel B are almost statistically different from each other (p-value = 0.1143). The pattern for bed days is similar, with cigarette taxes having a larger detrimental health impact on high-nicotine and high-tar smokers, but none of the estimates are statistically significant. The estimated reduction in the probability of reporting fair or poor health is also larger for high-nicotine and high-tar smokers. None of the estimates are statistically significant, but they suggest that higher cigarette taxes have a disproportionately more beneficial long-run effect on smokers who take in the greatest amount of nicotine and tar.

c. *Are There Other Mechanisms at Work?*

In an unreported analysis, I explore two other potentially important mechanisms—drinking behavior and weight gain—that could drive the effects of cigarette taxes estimated here. For this analysis, I use the 1984-2012 waves of the BRFSS because information on alcohol consumption and measures of body weight is available for all waves of the BRFSS. First, to the extent that alcohol and tobacco are substitutes, a rise in cigarette taxes might increase the demand for alcohol. If this is true, then an increase in alcohol consumption in response to higher cigarette taxes could negatively impact health and productivity. I examined this possibility by estimating effects of cigarette taxes on measures of alcohol consumption using regression models that are similar to those used in this study.[13] However, in unreported regressions of models similar to those used here, I find no evidence that cigarette taxes increase alcohol consumption.[14] Second, higher cigarette taxes may increase weight gain, BMI, and the probability of being overweight or obese. In unreported regressions, I do not find evidence that cigarette taxes have effects on body weight outcomes.[15] In sum, I do not find evidence suggesting that cigarette tax effects on body weight or alcohol consumption are important to understanding the effects on health and wages estimated here.

V. Discussion and Conclusion

A recent report by the Congressional Budget Office calls for a federal-level increase in the cigarette excise tax of $0.50. Using this as a benchmark, my estimates indicate that a $0.50 cigarette tax hike will lead to a 0.5% reduction in wages and a 0.75% reduction in the number of healthy days in the past month. It is well known that increases in cigarette taxes reduce cigarette consumption and induce quitting behavior, but it is hard to reconcile these facts with the evidence of the negative impacts of cigarette taxes on measures of health and wages uncovered in this study.

[13] These regression models also controlled for beer taxes. Taxes on wine and spirits are highly correlated with beer taxes, so I used only beer taxes for this analysis. Beer tax data at the month/year level were drawn from the Brewer's Almanac.

[14] In particular, I can never reject the null that the estimated effects of cigarette taxes on drinking participation and drinking intensity as measured by the number of drinks had on drinking days are zero. This is true in models that control for state-specific time trends and also models that do not.

[15] In particular, in regression models that control for state and time effects, I find that a $1 increase in cigarette taxes reduce BMI by 0.10 units and reduce the probability of overweight or obesity by about 1 percentage point. These results are statistically significant, but in models that control for state-specific time trends, I cannot reject the null that the estimated effects of cigarette taxes are zero.

A possible explanation for these relationships is that increases in cigarette taxes may have had the unintended consequence of inducing smokers to adopt health-reducing compensatory smoking behaviors. I find evidence that lend credibility to this interpretation. For example, I find that the estimated effects of cigarette taxes on measures of poor health are more pronounced among low-income individuals and smokers with high daily intakes of nicotine and tar. Behaviors that aim to maximize nicotine intake per dollar spent on a pack of cigarettes are arguably most likely to be adopted by individuals who cannot afford the cost of maintaining a desired level of nicotine per day and by the highly addicted. If these smoking behaviors are driving the negative health and wage effects estimated here, an important policy implication is that a cigarette tax based on the ingredients in cigarettes smokers care about most—nicotine and tar—may be more effective than a tax that is levied independently of cigarette size, nicotine content, and tar content.

Without data on smoking behaviors, it is difficult to pin down compensatory smoking behaviors as the main mechanism driving these counterintuitive findings. However, these counterintuitive findings are consistent across different data sets and across time. I also do not find evidence for alternative explanations such as those related to cigarette taxes increasing alcohol consumption or weight gain. Nevertheless, an important avenue for future research is to use data on detailed smoking behaviors to provide precise estimates of the effect of cigarette taxes on health that operates through such behaviors.

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Table 1: The Effect of Cigarette Taxes on Earnings, Wages, and Labor Supply (CPS-MORG)

	(1)	(2)	(3)
Dep Var	Ln(Earnings)	Ln(Wage)	Ln(Hours)
Cigarette Tax	-0.012**	-0.012***	-0.000
	(0.004)	(0.004)	(0.001)
R-squared	0.281	0.298	0.083
Sample Size	3934897	3934897	3934897
State, Month, and Year FE	x	x	x
Control Variables	x	x	x
State Dummies × Year	x	x	x

Note: Other controls included but not shown: age group dummies (30-34, 35-39, 40-44, 45-49, 50-54), gender, race and ethnicity dummies (black, other race, hispanic), education dummies (HS graduate, some college, 2-year college graduate, 4-year college graduate or more), indicator for married, state unemployment rate and GDP, and dummies for the number of 100% smoke-free laws in the state. Standard errors are clustered at the state-level, and are in parentheses below OLS coefficients. All regressions used sample weights. *,**, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Table 2: The Effect of Cigarette Taxes on Earnings, Wages, and Labor Supply by Hourly Pay Status (CPS-MORG)

	(1)	(2)	(3)
Dep Var	Ln(Earnings)	Ln(Wage)	Ln(Hours)
Cigarette Tax	0.016***	0.010**	0.005**
	(0.005)	(0.004)	(0.002)
1 if Hourly Paid Worker	-0.248***	-0.141***	-0.107***
	(0.008)	(0.006)	(0.004)
Cigarette Tax × 1 if Hourly Paid Worker	-0.058***	-0.046***	-0.012***
	(0.009)	(0.007)	(0.004)
R-squared	0.319	0.319	0.113
Sample Size	3934897	3934897	3934897
State, Month, and Year FE	x	x	x
Control Variables	x	x	x
State Dummies × Year	x	x	x

Note: Other controls included but not shown: age group dummies (30-34, 35-39, 40-44, 45-49, 50-54), gender, race and ethnicity dummies (black, other race, hispanic), education dummies (HS graduate, some college, 2-year college graduate, 4-year college graduate or more), indicator for married, state unemployment rate and GDP, and dummies for the number of 100% smoke-free laws in the state. Standard errors are clustered at the state-level, and are in parentheses below OLS coefficients. All regressions used sample weights. *,**, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Table 3: The Effect of Cigarette Taxes on Earnings, Wages, and Labor Supply by Propensity to Smoke (CPS-TUS)

	(1)	(2)	(3)
Dep Var	Ln(Earnings)	Ln(Wage)	Ln(Hours)
Cigarette Tax	0.076	0.057	0.020
	(0.072)	(0.056)	(0.034)
P(Smoke)	-0.054	-0.036	-0.018
	(0.440)	(0.307)	(0.273)
Cigarette Tax × P(Smoke)	-0.228	-0.205*	-0.022
	(0.158)	(0.115)	(0.064)
R-squared	0.302	0.327	0.092
Sample Size	152646	152646	152646
State, Month, and Year FE	x	x	x
Control Variables	x	x	x
State Dummies × Year	x	x	x

Note: Other controls included but not shown: age group dummies (30-34, 35-39, 40-44, 45-49, 50-54), gender, race and ethnicity dummies (black, other race, hispanic), education dummies (HS graduate, some college, 2-year college graduate, 4-year college graduate or more), indicator for married, state unemployment rate and GDP, and dummies for the number of 100% smoke-free laws in the state. Standard errors are clustered at the state-level, and are in parentheses below OLS coefficients. All regressions used sample weights. *,**, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Table 4: The Effect of Cigarette Taxes on Various Measures of Health (BRFSS)

	(1)	(2)	(3)	(4)	(5)
Dep Var	1 if Currently Has Asthma	1 if General Health is Fair or Poor	Ln(# Days in Last 30 Physical Health Not Good+1)	Ln(# Days in Last 30 Mental Health Not Good+1)	Ln(# Days in Last 30 Poor Health Limited Usual Activities+1)
Cigarette Tax	0.001	-0.002	0.012**	0.016*	0.015***
	(0.001)	(0.001)	(0.006)	(0.009)	(0.005)
R-squared	0.014	0.137	0.059	0.064	0.048
Sample Size	3875975	4596699	4421685	4431255	4453433
State, Month, and Year FE	x	x	x	x	x
Control Variables	x	x	x	x	x
State Dummies × Year	x	x	x	x	x

Note: Other controls included but not shown: age group dummies (30-34, 35-39, 40-44, 45-49, 50-54), gender, race and ethnicity dummies (black, other race, hispanic), education dummies (HS graduate, some college, 2-year college graduate, 4-year college graduate or more), indicator for married, state unemployment rate and GDP, and dummies for the number of 100% smoke-free laws in the state. Standard errors are clustered at the state-level, and are in parentheses below OLS coefficients. All regressions used sample weights. *,**, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Table 5: The Effect of Cigarette Taxes on Various Measures of Health by Propensity to Smoke (1979-2012 BRFSS)

	(1)	(2)	(3)	(4)	(5)
Dep Var	1 if Currently Has Asthma	1 if General Health is Fair or Poor	Ln(# Days in Last 30 Physical Health Not Good+1)	Ln(# Days in Last 30 Mental Health Not Good+1)	Ln(# Days in Last 30 Poor Health Limited Usual Activities+1)
Cigarette Tax	-0.000	0.001	0.012**	0.018	0.008
	(0.001)	(0.002)	(0.006)	(0.012)	(0.005)
P(Smoke)	0.076***	0.086***	0.553***	1.181***	0.579***
	(0.014)	(0.029)	(0.068)	(0.093)	(0.054)
Cigarette Tax × P(Smoke)	0.001**	0.003	0.022	0.008	0.041*
	(0.005)	(0.013)	(0.025)	(0.037)	(0.024)
R-squared	0.014	0.141	0.064	0.067	0.054
Sample Size	3858758	3957547	3789034	3799099	3818141
State, Month, and Year FE	x	x	x	x	x
Control Variables	x	x	x	x	x
State Dummies × Year	x	x	x	x	x

Note: Other controls included but not shown: age group dummies (30-34, 35-39, 40-44, 45-49, 50-54), gender, race and ethnicity dummies (black, other race, hispanic), education dummies (HS graduate, some college, 2-year college graduate, 4-year college graduate or more), indicator for married, state unemployment rate and GDP, and dummies for the number of 100% smoke-free laws in the state. Standard errors are clustered at the state-level, and are in parentheses below OLS coefficients. All regressions used sample weights. *,**, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Table 6: Heterogeneity in the Effect of Cigarette Taxes on Various Measures of Health by Income (1979-2012 BRFSS)

	(1)	(2)	(3)	(4)	(5)
Dep Var	1 if Currently Has Asthma	1 if General Health is Fair or Poor	Ln(# Days in Last 30 Physical Health Not Good+1)	Ln(# Days in Last 30 Mental Health Not Good+1)	Ln(# Days in Last 30 Poor Health Limited Usual Activities+1)
Cigarette Tax	0.021	0.020	0.261***	0.271***	0.284***
	(0.015)	(0.028)	(0.079)	(0.082)	(0.091)
Log(Family Income)	-0.024***	-0.120***	-0.277***	-0.200***	-0.236***
	(0.004)	(0.005)	(0.020)	(0.015)	(0.015)
Cigarette Tax × Log(Family Income)	-0.002	-0.002	-0.023***	-0.024***	-0.025***
	(0.001)	(0.003)	(0.007)	(0.008)	(0.008)
R-squared	0.014	0.137	0.059	0.064	0.048
Sample Size	3875975	4596699	4421685	4431255	4453433
State, Month, and Year FE	x	x	x	x	x
Control Variables	x	x	x	x	x
State Dummies × Year	x	x	x	x	x

Note: Other controls included but not shown: age group dummies (30-34, 35-39, 40-44, 45-49, 50-54), gender, race and ethnicity dummies (black, other race, hispanic), education dummies (HS graduate, some college, 2-year college graduate, 4-year college graduate or more), indicator for married, state unemployment rate and GDP, and dummies for the number of 100% smoke-free laws in the state. Standard errors are clustered at the state-level, and are in parentheses below OLS coefficients. All regressions used sample weights. *,**, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Table 7: The Effect of Cigarette Taxes on Health Outcomes (1978-1980 and 1987 NHIS)

Sample Includes Only Current Smokers	(1)	(2)	(3)
Dep Var	1 if General Health is Fair or Poor	Ln(Total Restricted Days in Past 2 Weeks+1)	Ln(Bed Days in Past 2 Weeks+1)
Cigarette Tax	-0.099*	0.155**	0.114**
	(0.035)	(0.037)	(0.022)
R-squared	0.115	0.026	0.013
Sample Size	15392	15445	15445
Region and Year FE	x	x	x
Control Variables	x	x	x
Region Dummies × Year	x	x	x

Note: Other controls included but not shown: age group dummies (30-34, 35-39, 40-44, 45-49, 50-54), gender, race and ethnicity dummies (black, other race, hispanic), education dummies (HS graduate, some college, 2-year college graduate, 4-year college graduate or more), indicator for married, state unemployment rate and GDP, and dummies for the number of 100% smoke-free laws in the state. Standard errors are clustered at the state-level, and are in parentheses below OLS coefficients. All regressions used sample weights. *,**, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Table 8: The Effect of Cigarette Taxes on Health Outcomes by Nicotine and Tar Intake (1978-1980 and 1987 NHIS)

Sample Includes Only Current Smokers	(1)	(2)	(3)	(4)	(5)	(6)
Dep Var	1 if General Health is Fair or Poor		Ln(Total Restricted Days in Past 2 Weeks+1)		Ln(Bed Days in Past 2 Weeks+1)	
Panel A	Nicotine ≥ Mean	Nicotine < Mean	Nicotine ≥ Mean	Nicotine < Mean	Nicotine ≥ Mean	Nicotine < Mean
Cigarette Tax	-0.119	-0.065	0.218*	0.066	0.140	0.076
	(0.073)	(0.042)	(0.076)	(0.065)	(0.066)	(0.063)
R-squared	0.104	0.138	0.030	0.028	0.018	0.012
Sample Size	9291	6101	9313	6132	9313	6132
Panel B	Tar ≥ Mean	Tar < Mean	Tar ≥ Mean	Tar < Mean	Tar ≥ Mean	Tar < Mean
Cigarette Tax	-0.150	-0.043	0.279*	0.035	0.177	0.051
	(0.125)	(0.064)	(0.116)	(0.044)	(0.118)	(0.081)
R-squared	0.109	0.127	0.028	0.031	0.017	0.013
Sample Size	7818	7574	7837	7608	7837	7608
Region and Year FE	x	x	x	x	x	x
Control Variables	x	x	x	x	x	x
Region Dummies × Year	x	x	x	x	x	x

Note: Other controls included but not shown: age group dummies (30-34, 35-39, 40-44, 45-49, 50-54), gender, race and ethnicity dummies (black, other race, hispanic), education dummies (HS graduate, some college, 2-year college graduate, 4-year college graduate or more), indicator for married, state unemployment rate and GDP, and dummies for the number of 100% smoke-free laws in the state. Standard errors clustered at the state-level, and are in parentheses below OLS coefficients. All regressions used sample weights. *,**, and *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Appendix Table 1: Summary Statistics (1979-2012 MORG-CPS)

Outcome Variables	*Mean*	*S.D.*
Ln(Earnings)	6.549	0.675
Ln(Wage)	2.890	0.550
Ln(Hours)	3.659	0.301
Explanatory Variables		
Age	38.421	8.408
Male	0.529	0.499
Black	0.118	0.323
Other Race	0.052	0.221
Hispanic	0.108	0.310
1 if HGC is High School Degree	0.361	0.480
1 if HGC is Some College	0.145	0.353
1 if HGC is Two Year College Degree	0.105	0.307
1 if HGC is >= Four Year College Degree	0.303	0.460
1 if Married	0.665	0.472
Unemployment Rate	6.311	2.118
Real GDP (in $10,000)	51.707	46.984
Number of 100% Smoke-Free Bans	0.450	0.966
Real Cigarette Tax	0.717	0.638
Sample Size	3934897	

Note: These weighted summary statistics are for Table 1 regression samples. State-level cigarette taxes and GDP are in $2012. Individuals aged 25-54 are included here.

Appendix Table 2: Summary Statistics (1992-2011 TUS-CPS)

Outcome Variables	*Mean*	*S.D.*
Ln(Earnings)	6.514	0.677
Ln(Wage)	2.850	0.550
Ln(Hours)	3.664	0.306
Explanatory Variables		
Age	38.310	8.116
Male	0.517	0.500
Black	0.111	0.314
Other Race	0.042	0.201
Hispanic	0.091	0.287
1 if HGC is High School Degree	0.322	0.467
1 if HGC is Some College	0.189	0.392
1 if HGC is Two Year College Degree	0.099	0.298
1 if HGC is >= Four Year College Degree	0.303	0.460
1 if Married	0.665	0.472
Unemployment Rate	5.548	1.156
Real GDP (in $10,000)	47.061	38.825
Number of 100% Smoke-Free Bans	0.401	0.907
Real Cigarette Tax	0.741	0.579
Current Smoker	0.252	0.434
Sample Size	152646	

Note: These weighted summary statistics are for Table 2 regression samples. State-level cigarette taxes and GDP are in $2012. Individuals aged 25-54 are included here.

Appendix Table 3: Summary Statistics (1993-2012 BRFSS)

Outcome Variables	*Mean*	*S.D.*
1 if Currently Has Asthma	0.081	0.273
1 if General Health is Poor or Fair	0.150	0.357
# Days in Last 30 Physical Health Not Good	3.366	7.669
# Days in Last 30 Mental Health Not Good	3.338	7.392
# Days in Last 30 Poor Health Limited Usual Activities	2.033	6.136
Explanatory Variables		
Age	45.155	16.972
Male	0.495	0.500
Black	0.105	0.307
Other Race	0.085	0.279
Hispanic	0.118	0.323
1 if HGC is High School Degree	0.299	0.458
1 if HGC is Some College	0.276	0.447
1 if HGC is >= Four Year College Degree	0.306	0.461
Log(Family Income)	10.710	0.636
1 if Married	0.598	0.490
Unemployment Rate	6.081	2.105
Real GDP (in $10,000)	60.996	53.281
Number of 100% Smoke-Free Bans	0.752	1.149
Real Cigarette Tax	0.920	0.726
Current Smoker	0.215	0.411
Sample Size	4596699	

Note: These weighted summary statistics are for Table 3 regression samples. State-level cigarette taxes and GDP, and log of total family income are in $2012. Individuals aged 18 and older are included here.

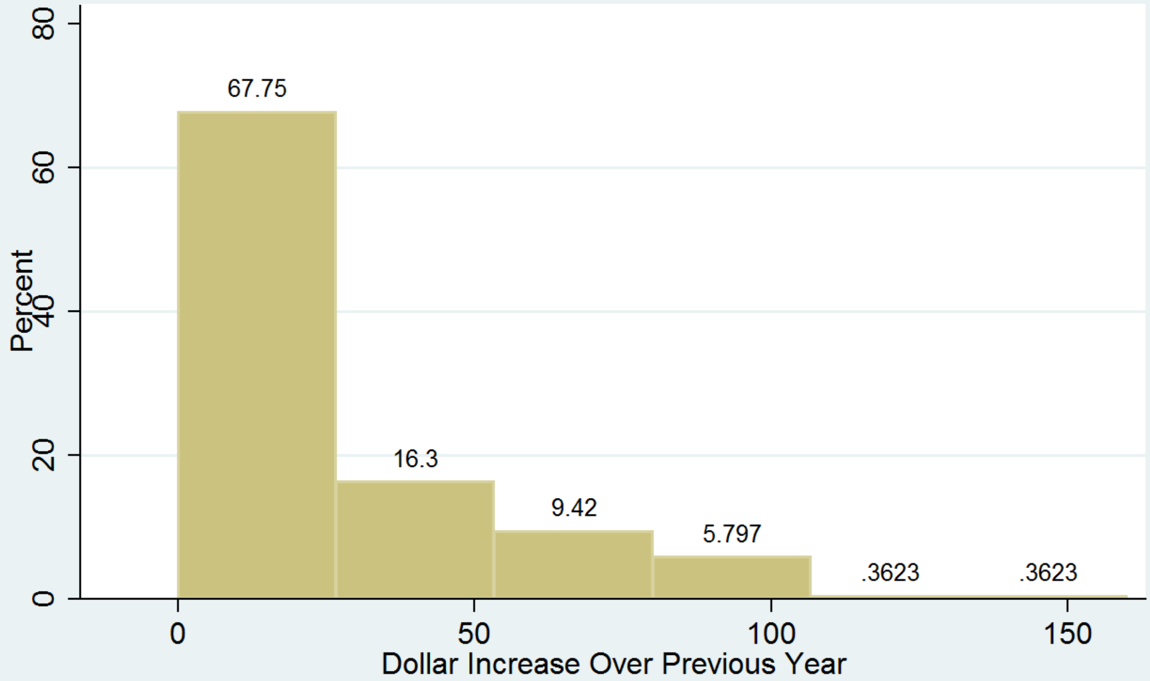
Appendix Table 4: Summary Statistics (1978-1980 and 1987 NHIS)

Outcome Variables	*Mean*	*S.D.*
1 if General Health is Poor or Fair	0.165	0.371
# Restricted Activity Days in Past Two Weeks	0.889	2.894
# Bed Days in Past Two Weeks	0.313	1.573
Explanatory Variables		
Age	39.598	15.335
Male	0.527	0.499
Black	0.109	0.312
Other Race	0.013	0.112
Hispanic	0.049	0.215
1 if HGC is High School Degree	0.368	0.482
1 if HGC is Some College	0.172	0.377
1 if HGC is >= Four Year College Degree	0.111	0.314
Log(Family Income)	10.600	0.714
1 if Married	0.649	0.477
Unemployment Rate	6.261	1.103
Real GDP (in $10,000)	7.464	11.010
Real Cigarette Tax	0.404	0.099
Total Daily Nictotine Intake (in mg)	21.799	15.440
Total Daily Tar Intake (in mg)	303.717	218.143
Sample Size	15445	

Note: These weighted summary statistics are for Table regression samples. State-level cigarette taxes and GDP are in $2012. Individuals aged 18 and older are included here.

Figure 1

The Magnitude of (Nominal) Cigarette Tax Increases (1979-2012)



Note: This histogram plots information for states that increased cigarette taxes compared to the previous year

Figure 2

Average (Real) Cigarette Taxes Over Time