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Smoking initiation among youth: The role of cigarette excise taxes and prices by race/ethnicity and gender

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Abstract

Existing evidence for the role of cigarette excise taxes and prices as significant determinants of youth smoking initiation is mixed. A few studies have considered the possibility that the impact of cigarette taxes and prices might differ by gender or race/ethnicity. In this paper, we address the role of cigarette taxes and prices on youth smoking initiation using the National Longitudinal Survey of Youth 1997 cohort and discrete-time survival methods. We present results overall and by gender, race/ethnicity, and gender by race/ethnicity. We examine initiation over the age range during which youth are most at risk of initiation and over a period in which substantial changes have occurred in tax and price. The result for cigarette excise taxes is small and mixed across alternative specifications, with the effect strongest for black youth. Cigarette prices are more consistently a significant determinant of youth smoking initiation, especially for black youth.

Keywords

state cigarette excise taxes; state cigarette prices; youth smoking initiation

1. Introduction

Adolescent smoking is of particular interest from both a research and a policy perspective because smoking initiation and early smoking habits are known to have important implications for lifetime smoking. More than 90% of adult smokers started smoking as teens or younger. Few people in their 20s or older choose to start smoking (USDHHS, 1994; Glynn et al., 1993; IOM, 1994). The earlier in life a youth tries a cigarette, the more likely he or she is to become a regular smoker or daily smoker, translating into a greater incidence of negative health effects (IOM, 1994; Lewit et al., 1981). Less than half (46%) of youth who initiate smoking in the 11th grade become regular adult smokers, whereas 67% of youth who initiate smoking in the 6th grade become regular smokers (IOM, 1994). Gruber and Zinman (2001) find that there is an important intertemporal correlation in the decision to smoke. They estimate that between 25% and 50% of the increase in youth smoking seen in the 1990s will persist into adulthood, which will result in an estimated long-run cost to the United States of at least 1.6 million life-years lost.

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Throughout most of the 1990s, youth smoking rates increased despite attempts to reduce them. Nationally, from 1988 to 1996, the incidence of first use of cigarettes increased by 30% and the incidence of daily use increased by 50% among youth aged 12 to 17. From the late 1990s to approximately 2004, youth smoking rates declined, although recent evidence suggests that this decline has slowed or stopped (Johnston et al., 2005). Despite the declines, a significant number of adolescents continue to experiment with cigarette smoking, and significant numbers of youth continue to smoke on a regular basis. According to the 2007 Monitoring the Future (MTF) survey, 7.2% of 10th grade students and 12.3% of 12th grade students were daily smokers. Also, 2.7% of 10th grade students and 5.7% of 12th grade students smoked half a pack or more of cigarettes per day (Johnston et al., 2008).

Smoking rates differ by gender and race/ethnicity. Youth Risk Behavior Survey (YRBS) data from 2009 show gender differences for smoking initiation: male students (11.8%) were significantly more likely than female students (9.4%) to have smoked a whole cigarette before age 13. This gender difference held for each racial/ethnic group as well. Similarly, Hispanic and white students were more likely than black students to have smoked a whole cigarette before age 13 (12.6%, 10.3%, and 9.1%, respectively) (CDC, 2010). In terms of any current cigarette use (past 30 days), male students (19.8%) were more likely to report use than female students (19.1%), although the difference was not statistically significant. This difference was true for each racial/ethnic group as well, although the difference was only significant for black students. The prevalence of any current use was higher among white students (22.5%) than Hispanics (18.0%) and blacks (9.5%). Hispanic students (51.0%) had higher rates of ever having tried a cigarette compared with white (46.1%) and black (43.5%) students. White students (9.5%) had higher rates of frequent smoking than Hispanic (4.2%) and black (2.1%) students. Males (8%) had higher frequent smoking rates than females (6.4%), although this difference is not significant. Within the racial/ethnic subgroups, Hispanic and black males smoked frequently at higher rates than females, but this was not true for white students (CDC, 2010). In terms of quitting, females (54.2%) were more likely than males (48.0%) to report ever having tried to quit. White students (49.9%) were more likely than Hispanic (53.3%) and black (45.2%) students to report ever having tried to quit (CDC, 2010).

From 1991 through 1997, the prevalence of current cigarette smoking increased 80% among black high school students, 34% among Hispanic high school students, and 28% among white high school students. For blacks and Hispanics (blacks especially), this reverses the trend over the period from 1978 through 1995. From 1997 through 2007, the prevalence of current cigarette smoking declined among all high school students, with the greatest decline among female Hispanic students (54.8%) and the lowest among white male students (39.9%). While current cigarette consumption prevalence for black male students declined by 47.2% between 1997 and 2007, this rate declined by only 8.6% from 2001 through 2007. In addition, the smoking prevalence rate among black male students actually increased by 18.4% in 2003 and 6.4% in 2007 (versus the previous report 2 years prior). The fact that the decline in current cigarette consumption rates among black male students slowed, and actually reversed in two reporting years, is a disturbing recent development that warrants attention (CDC, 2008b).

A number of studies have found that cigarette excise taxes and prices have an effect on the prevalence and intensity of smoking among youth (Carpenter and Cook, 2008; Taurus et al., 2005). A number of studies have considered that price responsiveness might vary by characteristics of the youth. For example, Gruber and Zinman (2001) found that older teens are sensitive to price whereas younger teens are not. Emery et al. (2001) found that price was not an important factor in predicting the probability that a respondent was an experimental smoker but was a significant predictor of established smoking. Liang and

Chaloupka (2002) found that higher cigarette prices have an increasing effect as an adolescent's level of cigarette consumption increases. These studies are consistent with evidence that adolescents experimenting with smoking do not always buy their own cigarettes but rather obtain them from social sources such as friends (e.g., Emery et al., 1999). If youth are not purchasing their own cigarettes when experimenting with smoking (initiating), then cigarette price may not be a salient factor.

However, not all studies have shown that cigarette taxes or prices affect adolescents who smoke more often or more intensely. Harris and Chan (1999) found that cigarette price varies inversely with age and that among 15- to 17-year-olds the effect of price on smoking some days (i.e., for experimenters) was significantly higher than the effect on smoking every day.

In recent years, researchers have begun to assess the effect of taxes and prices on smoking initiation with mixed results. Douglas and Hariharan (1994) and Douglas (1998) used survival methods to investigate smoking initiation and found no significant price effect. Forster and Jones (2001) and Nicolas (2002) also used survival methods and found a significant effect of tax and price on smoking initiation; however, the magnitude of these effects is relatively small. A recent series of studies by DeCicca et al. (2002, 2008, 2009), using data from the National Education Longitudinal Survey(s) (NELS), has called into the question evidence for the impact of tax and price on youth smoking. DeCicca et al. used a number of different methods and introduced a measure of state antismoking sentiment as a control for factors likely to affect taxes and youth smoking initiation. DeCicca et al.'s empirical methods included a discrete-time hazard model to focus on smoking initiation, and they found no significant impact of the cigarette excise tax on smoking initiation. In the 2002 study, they controlled for state unobserved heterogeneity using state fixed effects, which eliminated any effect of state excise tax on smoking initiation. In later studies (2008 (2009), they included a measure of state antismoking sentiment to better control for state factors associated with smoking sentiment in each state. In these later studies, DeCicca et al. appear to have defined initiation as going from a nonsmoker in 1992 to a smoker in 2000 using the 2000 tax rate in each state as the policy variable of interest. Once again, they did not find evidence that the tax had an effect on youth smoking.

The impact of price and tobacco control policies also appears to differ by gender and race/ethnicity (see Chaloupka and Pacula, 1999). Chaloupka and Pacula find that significant differences in price responsiveness and sensitivity to tobacco control policies exist by both gender and race/ethnicity. They found that men are much more price responsive than women—the participation elasticity for men being nearly twice as large as that for women—and the smoking rates of young black men are more responsive to price than young white men. Gruber and Zinman (2001) also found that among older teens, blacks were more responsive to price/tax than whites. DeCicca et al. (2000) used data from NELS to examine racial/ethnic differences in the onset of smoking and found some support that higher cigarette prices will reduce smoking among Hispanic and black youth but not among white youth. Cawley et al. (2004) used the NLSY97 to examine the factors, including cigarette prices, on smoking initiation among youth and in particular focused on gender differences. They found that males were more price sensitive than females.

2. Methods

2.1 Data

The primary data set for this analysis is the National Longitudinal Survey of Youth 1997 cohort (NLSY97). NLSY97 is a nationally representative cross-sectional sample of 8,984 adolescents aged 12 to 17 at baseline (NLSY, 2003). NLSY97 is designed to track a youth's

transition from school (adolescence) to the labor market (adulthood) through annual surveys starting in 1997. Survey respondents were between 22 and 26 years old in the ninth wave of the survey, the last round of data used in this analysis. The survey sample includes multiple respondents from the same household in cases where multiple youth per household met age restrictions at baseline. Data from rounds 1 through 9 (1997–2006) of the NLSY97 were used in the analyses.

2.2 Measures

2.2.1 Defining event indicator for initiation to smoking from never smoking—

The outcome of interest is an event indicator that indicates whether initiation has taken place. Initiation is defined as a transition from being a never smoker to an ever smoker. At the baseline survey, all respondents were asked, “Have you ever smoked a cigarette?” and, if yes, “How old were you when you smoked your first cigarette?” Responses to these questions were used to determine that initiation had taken place and the age at which initiation had taken place for those who initiated at or before baseline. Once a respondent had valid responses to these questions, we used the question “Have you smoked a cigarette since the last interview…?” in subsequent waves for those who initiate post baseline. For these respondents, the age of initiation was based on their age at the time of the survey wave in which they first reported smoking. An exception to this algorithm for coding the event indicator occurred for those respondents with missing data on the smoking status questions in some waves of the survey. For these respondents, we coded the event as occurring at the midpoint of the period of missing data if the respondent entered the period of missing data as never smoking but reported smoking in the first period after the missing data. For instance, if a respondent was a never smoker in wave 2, had missing data for waves 3 through 7, and reported smoking in wave 8, we coded the event as occurring in wave 5. However, if this respondent did not report smoking in wave 8, we coded waves 3 through 7 as not having initiated smoking. The year of smoking initiation was set at the midpoint of the period of missing data for 819 cases.

2.2.2 State and federal cigarette excise taxes—Measures of cigarette taxes are available from Orzechowski and Walker’s *The Tax Burden on Tobacco* (2006). We added the federal cigarette excise tax rate to the state tax rates to create total state-level cigarette taxes. All tax rates were adjusted for inflation and represent 2006 dollars. The tax data were linked to the NLSY data by year and state of residence. Local tax rates for New York City and Cook County, Illinois, were included in several alternate model specifications.

2.2.3 Cigarette prices—Measures of cigarette pack prices are available from Orzechowski and Walker’s *The Tax Burden on Tobacco* (2006). These prices represent the average price per pack of cigarettes weighted by pack sales for each state. Weighted cigarette prices are also adjusted for inflation and represent 2006 dollars.

2.2.4 Sociodemographic and other control variables—All of the models included age indicators, the number of residents in the household, the educational level achieved by the resident parents at baseline, whether living with both biological parents at baseline, an indicator for the Master Settlement Agreement (MSA), perceived smoking prevalence at baseline, and region indicators. In the overall model, gender and race/ethnicity (indicators for black, Hispanic, and other races) variables were included. These variables were used to create subpopulations for stratified analyses and included in stratified model specifications as appropriate (include gender when stratifying by race/ethnicity and race/ethnicity when stratifying by gender).

The models also controlled for baseline smoking prevalence by state using the Behavioral Risk Factor Surveillance System (BRFSS), a state-based telephone survey of over 350,000 adults in all 50 states (CDC, 2009). We used the adult smoking prevalence in the state as a proxy for smoking sentiment in the state (i.e., states with the highest adult smoking prevalence would also have the lowest antismoking sentiment). Alternate model specifications used a measure of state antismoking sentiment (SASS) instead of smoking prevalence at baseline. SASS was developed by DeCicca and colleagues (2008) to account for potential state-level confounders between youth smoking, cigarette taxes and price, and state-level attitudes toward smoking. SASS is derived from several indicators taken from the Tobacco Use Supplements of the Current Population Survey and NELS. A detailed description of the derivation and validation of the SASS measure is available elsewhere (DeCicca et al., 2008). We found our measure(s) of adult smoking prevalence in the state to be highly correlated with DeCicca et al.'s SASS measure (correlation coefficient = −.88).

In some of our models, we included a state-level measure of tobacco control investments that is based on federal and state government sources (CDC, 2001, 2002) and supplemented by data from state programs (Farrelly et al., 2003; CDC, 2008a). Funding from nongovernment and federal sources reflects appropriations, whereas funding from state sources is generally a mixture of appropriations and expenditures. These data are available from 1985 through 2006. We used yearly cumulative tobacco control funding adjusted to 2006 dollars using the Consumer Price Index and discounted at 25% in our analyses. Although tobacco control funding is an important policy variable, we focused on cigarette taxes and prices. Thus, we include this measure in some models as a time-varying covariate.

2.3 Empirical Model and Statistical Analysis

Our empirical model can be motivated by considering a latent variable model of smoking, such as the one presented in DeCicca et al. (2009). This model suggests a discrete-time empirical model with the relevant tax/price variable being the tax/price contemporaneous to the initiation event.

To estimate a discrete-time model of smoking initiation, we created a person-period data set based on the age at which each youth initiated smoking. Youth remained in the analytic sample as long as they remained at risk for initiating smoking. Once an individual experienced the "event" (i.e., ever use of cigarettes), that person was dropped from subsequent time periods, allowing us to calculate the probability that an individual will initiate smoking given that he or she has not smoked in a previous time period.

We present results for state cigarette excise taxes and prices (estimated separately). DeCicca et al. (2008) and Gruber and Zinman (2001) argued that state excise taxes are a better measure of the cost of cigarettes than the state price of cigarettes. In contrast, Chou et al. (2006) argued the opposite. Given this debate, we feel it is worth reporting both tax and price results.

The discrete-time empirical model also allows us several options for controlling for state factors that might influence smoking initiation and state excise taxes (and cigarette prices). Using this empirical model, we can include both time invariant and time-varying state factors. For example, we estimate alternative specifications that include the adult smoking prevalence in 1997, the adult smoking prevalence as a time-varying covariate, DeCicca et al.'s SASS measure (entered as the average value for the years for which we have the measure), and state fixed effects. We also have data on state tobacco control funding, which we enter as a time-varying covariate.

The main results we present in this paper are estimated using the following model specification:

> hazard of smoking initiation = f(age dummies, tax or price, region dummies, state smoking prevalence in 1997, number of residents in the household, educational level achieved by the resident parents at baseline, whether living with both biological parents at baseline, an indicator for the Master Settlement Agreement, perceived smoking prevalence at baseline)

The hazard was modeled using the logit command in Stata with robust standard errors and clustered by state.

In addition to the above model specification, we estimated a number of alternative specifications: using adult smoking prevalence averaged over the years for which each state has data in the BRFSS to replace the BRFSS adult smoking prevalence at baseline measure; using SASS instead of the BRFSS adult smoking prevalence—an average SASS measure (1991–2005) and SASS at baseline (1997–1998) were modeled separately; including state fixed effects as a proxy for SASS; and using baseline weights. We do not present results from these alternative specifications in the main body of the paper but do discuss the extent to which our findings are robust to these alternative specifications. In addition, these results are presented in an on-line appendix of supplemental materials.

3. Results

3.1 Descriptive Statistics

Descriptive statistics of our sample are presented in Table 1. Youth in the NLSY97 cohort were between the ages of 12 and 17 at baseline with a mean age of 14.5. Youth who had experimented with smoking were, on average, also 14.5 years old, indicating that the majority of youth who experimented with cigarettes did so at or before baseline. Overall, almost three-quarters (70%) of youth had experimented with smoking at some time during the study period (1986–2006).

Our sample has slightly fewer women (49%) than men (51%) and is predominantly white (49%). Forty-eight percent of respondents live in a household in which one or both parents have some education after high school, and 13% live in a household in which neither parent graduated from high school. The average household size among respondents is 4.5 people, and slightly more than half of respondents (51%) live with both biological parents. The prevalence of adult smoking was 23% at baseline, ranging from 18% in California to 30% in Montana.

Descriptive statistics of our sample are also presented by gender, by race/ethnicity, and by gender by race/ethnicity. For adolescents in the NLSY97 cohort, the percentage of respondents who initiated smoking differed by gender and race/ethnicity, as well as within the “by race/ethnicity by gender” specification. Parent’s education, whether the adolescent was living with both parents, and mean household size differed by race/ethnicity. Average cigarette excise tax rate and real average weighted price of cigarettes varied slightly for Hispanics versus non-Hispanics. The prevalence of adult smoking remained relatively constant among all gender and race/ethnicity specifications.

The average cigarette excise tax rate and per pack price increased across survey waves (Figure 1). Average cigarette excise taxes and prices doubled between 1985 and 2006, ranging from $1.82 to $4.05 and $0.59 and $1.26, respectively.

3.2 Hazard Plot

Figure 2 presents the proportion of youth who initiated smoking at each age given that they had not previously tried smoking, separated by gender and race/ethnicity. The top half displays the hazard rates of smoking initiation at any age for males, and the bottom half displays the hazard rates for females. The rate of first cigarette use remained relatively low for white and black males until around age 9 when the hazard of smoking initiation began to rise sharply. For Hispanic males, this same increase began around age 10. The hazard of smoking initiation peaked at age 14 for white and black males and remained relatively stable with a second similar peak at age 18. After the second peak, the hazard began a sharp decline. The hazard for Hispanic males peaked first at age 15 and peaked again at age 18 before following the decline with white and black males. By age 25, the rate of first time cigarette use for all males was similar to the rate of initiation for 9- and 10-year-olds. This hazard plot shows that our sample covers the age range of greatest smoking hazard for males.

The bottom half of Figure 2 presents the proportion of females who initiated smoking at each age given that they had not previously tried smoking. The hazards for white, Hispanic, and black females followed relatively similar patterns to their respective male counterparts. The hazard of smoking initiation began its initial increase around age 9 and 10 and rose sharply until peaking around age 18, after which it slowly declined. The decline continued until the last reported age of 27 when hazard rates reached levels similar to the rate of first time cigarette use at age 9 and 10. The sample also covers the age range of greatest smoking initiation hazard for females. The female hazard rates exhibited a second peak, but it was lower than the original peak, differing from the second peak present in the male hazards. The highest hazard rates were similar for black and Hispanic males and females. However, for white females, the peak hazard rate at age 15 was higher than the hazard rate at age 15 for white males.

3.3 Discrete Time Results

Results from our base model specifications are reported in Table 2. We estimated the effects of tax and price separately while controlling for adult smoking prevalence in each state in 1997 (without the measure of state tobacco control funding) as well as a model including state tobacco control funding. Increases in cigarette excise tax rates and prices are associated with significant decreases in the likelihood of youth smoking initiation across various model specifications. Cigarette price and excise tax rate were statistically significant (odds ratio [OR] = 0.88 for both) at the 1% and 10% level, respectively, when including state tobacco control funding. Although not a focus of this paper, we did not find cumulative state tobacco control funding to be significantly associated with youth smoking initiation. We estimated that a 10% increase in cigarette taxes is associated with a 0.9% decrease in the hazard of initiating smoking at each age. The elasticity of cigarette prices is larger with a 10% increase in price yielding a 3.1% decrease in the hazard of initiating smoking at each age.

We re-estimated the baseline model including gender and race/ethnicity covariates (results shown in Table 2). An increase in taxes or prices had a larger and more significant effect for female and black youth than for other gender and race/ethnicity specifications. We estimated that a 10% increase in prices is associated with a 4.8% decrease in the hazard of a female initiating smoking and associated with a 5.0% decrease in the hazard of a black youth initiating smoking. These results suggest that females are more tax and price sensitive than males, and black youth are more tax and price sensitive than either whites or Hispanics.

Table 3 presents the results of the model re-estimated using gender and race/ethnicity cross specifications. The gender-by-race/ethnicity elasticity was strongest for black females. We

estimated that a 10% increase in prices is associated with a 5.7% decrease in the hazard of initiating smoking for this group. While the results for white males suggest that an increase in taxes or prices is associated with an increase in the smoking initiation hazard rate, these results are not statistically significant. An increase in taxes only significantly decreased the hazard for black males and females, but an increase in price was associated with a significant decrease in the smoking initiation hazard for all gender and race/ethnicity interactions with the exception of white males and Hispanic females.

4. Discussion and Conclusions

In this paper, we examined the effect of cigarette excise taxes and prices on youth smoking initiation. We examined these relationships overall and by gender, race/ethnicity, and gender-by-race/ethnicity.

Although we found a significant effect of both tax and price on youth smoking initiation overall, the effect was relatively small. Our stratified models suggested that the overall result was largely driven by higher price responsiveness among minorities, especially among black youth. Tax is typically not significant for white youth. Price is significant for white youth in some model specifications including a model with state fixed effects. For black youth, the results are statistically significant for both tax and price, and there is evidence of meaningful tax/price responsiveness. These results are robust to the different model specifications. For Hispanics, results are mixed for tax—significant in some specifications but not others. Price, however, is significant in most specifications. The results are stronger for Hispanics when baseline weights are included.

The results by race/ethnicity are consistent with the results of DeCicca et al. (2000). They concluded that “the results for Hispanics and African-Americans provide some support that higher taxes will reduce smoking in these populations, because the imprecisely estimates effects are suggestive of a potentially high degree of price-responsiveness” (2000, p. 335). They also find that higher cigarette prices do not deter smoking onset for whites when controlling for state fixed effects.

When we stratify by gender, we do not find a significant effect of tax on males. Price is sometimes significant for males although not consistently across different model specifications. For females, we find tax and price significant, although the tax results are not always significant.

Our results do not agree with those of Cawley et al. regarding gender differences in the effect of tax/price on smoking initiation. In particular, we find that females are more sensitive to tax and price, although we find males to be sensitive to price.

There are several possible reasons for the differences between Cawley et al.’s results and our results. First, they do not use the age of initiation information to look back prior to baseline (i.e., they restrict the initial risk pool to those who were nonsmokers at baseline). This leaves a sample of relatively late initiators, particularly for whites in the sample (i.e., leaves out early initiators). We use the age of initiation to look back prior to baseline and essentially expand the age range for initiation to 5 to 24. Furthermore, we restrict our risk pool to never smokers and focus on first initiation. Second, they only had available the first four waves of the NLSY97, which creates a number of possible differences between their estimates and ours. Their data did not cover some later tax increases that our data capture, and their estimates would have missed the relatively late initiation that occurs for blacks.

No prior studies have examined the impact of tax or price on youth smoking initiation stratified by gender-by-race/ethnicity. We find no evidence that white males are influenced

by tax or price. Our results suggest that white females are responsive to price but not tax. Black males and females are responsive to both tax and price with these results remaining significant across most model specifications. Hispanic males also appear responsive to price consistently, whereas the result for Hispanic females is somewhat mixed, depending on the particular model specification.

Our overall results are consistent with evidence published by Taurus et al. (2005) also using the NLSY97. This study did not explicitly investigate the impact of cigarette excise taxes on smoking initiation but rather estimated a participation (prevalence) elasticity for both tax and price of −0.06 and −0.31, respectively. Our overall estimates are also in the range estimated by Carpenter and Cook (2008) for a participation elasticity (they estimated a participation elasticity for price of −0.23 to −0.56). Carpenter and Cook's results suggest that a $1 increase in the tax per pack would reduce smoking participation by 3 to 6 percentage points or approximately 10% to 20%. Participation or prevalence elasticities are not the same as what we estimate using discrete-time methods. Our models estimate incidence rather than prevalence (prevalence mixes incidence and duration).

DeCicca et al. (2009) point out that the price elasticity of participation is a weighted average of initiation and cessation (a point related to the distinction between incidence and prevalence [Singer and Willet, 1991]) and that this elasticity will vary over the life-course because initiation and cessation rates vary over the life-course. In early adolescence, initiation is more important than cessation; as individuals age, initiation becomes less important, while cessation becomes more important. Thus, it is not surprising that we find similar initiation elasticities to the participation elasticities found by Taurus et al. (2005) and Carpenter and Cook (2008).

Our study has several limitations. One possible limitation is related to our use of the recall of age of initiation for those who initiated smoking prior to baseline. Although this is a potential limitation, we suggest the potential for recall bias is less in a youth sample than an adult sample. In addition, we estimated a model specification conditional on being a never smoker at baseline, thus avoiding the use of the recall data. These results were virtually identical to the results reported (available upon request), although this sample would be relatively late initiators compared to the full sample.

A second potential limitation is that our model specification does not adequately account for unobserved state factors which are related to taxes and smoking initiation. We estimated several alternative model specifications to address this limitation including a specification using state fixed effects. The real weighted price of cigarettes remained protective and significant in all of these alternate model specifications. The cigarette excise tax rate was protective (similar magnitude to our base model specification) but became marginally significant or statistically insignificant in these alternate model specifications. These results are presented in tables A.1 in the on-line appendix.

A third potential limitation is related to the discrete-time methodology. We report results that impose a proportional odds assumption (i.e., that tax and price have the same impact on the hazard at each age). It is possible to relax this assumption by including interaction terms between the tax/price and each age indicator. This model specification, although possible, is complicated, especially in the context of a logistic regression model, and thus we chose not to report results from such a model. However, we found that a model including the interaction terms did not improve the fit of the model. We also estimated a model using age groupings (5–11, 12–17, and 18+) rather than single year age dummies (to reduce the number of interaction terms) and found that the proportional odds assumption is violated—

suggesting that older youth are more sensitive to tax or price (see table A.2 in the on-line appendix).

A fourth potential limitation is that our unweighted sample, which we used in estimating our results, is not very representative of the US population (see table A.3 in on-line appendix). To partially address this limitation we re-estimated our model using baseline weights (see table A.4 in on-line appendix). Using this model specification, our results remained qualitatively similar.

In the current tobacco control environment, a number of states have increased or are considering making large increases to their cigarette excise taxes. In addition, the federal excise tax has also recently increased considerably. The mean increase across states (due to the increase in the federal excise tax to $1) is 82% with a standard deviation of 0.42. The increase ranges from a low in New York (35%) to a high in South Carolina (217%). Although we found no effect of tax or price on white males and only some evidence for an effect of price on white females, our results do suggest the potential for an impact on blacks and Hispanics. As Gruber and Zinman (2001) have noted, even relatively small changes in smoking rates among youth cohorts can have substantial long-run public health consequences. Thus, our results suggest that policy makers should continue to consider excise taxes, in addition to other policies to increase the cost of cigarettes, as a way to prevent youth smoking initiation and lessen the long-term health consequences of smoking.

Despite considerable research into the effect of tax/price on youth smoking, clear evidence is lacking regarding the magnitude of such an effect. A body of research suggests an elasticity on the order of −0.7, whereas other work suggests no effect. To some extent, the mixed evidence could result from a difference in the measure of youth smoking (e.g., some work focuses on initiation explicitly, whereas other work focuses on prevalence or intensity of smoking). In addition, although some work has been done examining racial/ethnic differences in the effect of taxes on youth smoking, the evidence remains limited. Mixed evidence on the magnitude of the effect of tax/price on youth smoking is an important policy question. The importance of providing further evidence on this topic is highlighted by efforts to simulate the impact of tax/price increases on smoking rates, morbidity, and mortality. For example, Levy et al. (2000) used a simulation model to simulate the impact of a tax increase on smoking rates and smoking attributable mortality. They used a consensus estimate of −.6 for youth below age 20; the elasticity declined with age in their model (−0.5 for young adults aged 20 to 25 and −0.4 for adults). In the discussion, they note that their results (the impact of the tax on outcomes) are driven largely by the effect on youth, which in turn is a consequence of the larger tax elasticity used for this age group. We feel our paper addresses several shortcomings in the existing literature. Of particular importance is that a substantial portion of our cohort is exposed to potentially large tax increases during the ages at which smoking initiation occurs (although we acknowledge that, for some of our sample, initiation had already occurred or was most likely to have occurred prior to the recent larger tax changes). Recent studies casting doubt on the impact of taxes have mostly used data ending before these recent large tax changes. Also, our data and methods allow us to examine initiation over the entire range at which most initiation typically occurs. Again, the recent studies have not done this; those that have attempted to focus on initiation have not included younger and older youth. The omission of older youth is especially important when examining racial/ethnic differences because black youth tend to initiate somewhat later than other youth.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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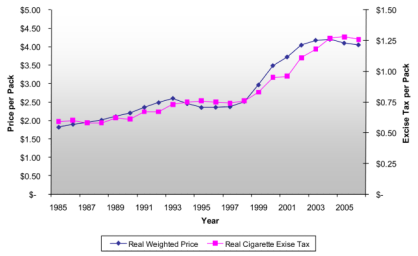

Figure 1.
Real weighted cigarette price and excise tax rate by year

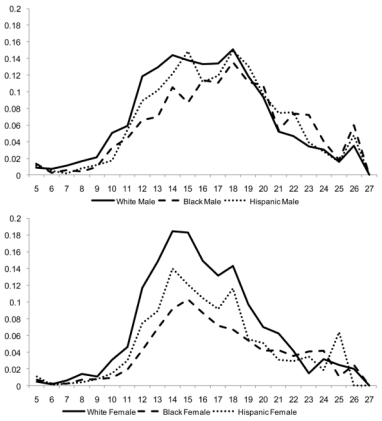

Figure 2.
Estimated hazard of initiating smoking by age of initiation

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Table 1

Descriptive statistics of sample

Measure		Male	Female	White	Black	Hispanic	Male by White	Male by Black	Male by Hispanic	Female by White	Female by Black	Female by Hispanic
Sample	8984	4599	4384	4414	2333	1900	2287	1169	976	2127	1164	924
Initiated smoking	70%	3381	2936	3305	1465	1324	1718	820	730	1587	645	594
Gender												
Male	51%	4599	na	2287	1169	976	2287	1169	975	na	na	na
Female	49%	na	4384	2127	1164	924	na	na	na	2127	1163	924
Race/Ethnicity												
White	49%	2287	2127	4414	na	na	2287	na	na	2127	na	na
Black	26%	1169	1164	na	2333	na	na	1169	na	0	1163	0
Hispanic	21%	976	924	na	na	1900	na	na	975	na	na	924
Other	4%	159	157	na	na	na	na	na	na	na	na	na
Missing	0%	8	12	na	na	na	na	na	na	na	na	na
Education												
Less than high school	13%	665	521	265	327	550	137	193	305	128	134	245
High school graduate	30%	1394	1343	1286	938	452	661	461	245	625	477	207
College	37%	1699	1593	1985	704	462	1027	364	238	958	340	224
Professional degree	11%	499	450	730	90	72	392	43	34	338	47	38
Unknown education	4%	177	194	90	130	120	47	60	57	43	70	63
Living with both parents	51%	2435	2167	2657	687	1049	1417	350	554	1240	337	495
Mean Age												
At baseline (1997)	14.48 (1.47)	14.45 (1.45)	14.51 (1.48)	14.45 (1.47)	14.56 (1.46)	14.48 (1.46)	14.42 (1.46)	14.46 (1.40)	14.53 (1.47)	14.49 (1.47)	14.67 (1.53)	14.40 (1.43)
At initiation	14.51 (3.43)	14.48 (3.59)	14.54 (3.23)	14.07 (3.29)	15.20 (3.64)	14.79 (3.36)	13.99 (3.51)	15.14 (3.74)	14.81 (3.44)	14.16 (3.04)	15.29 (3.51)	14.75 (3.25)
Mean Household Size	4.5 (1.54)	4.54 (1.50)	4.48 (1.50)	4.29 (1.23)	4.60 (1.73)	5.00 (1.69)	4.29 (1.16)	4.62 (1.76)	5.02 (1.73)	4.29 (1.31)	4.53 (1.70)	4.91 (1.64)
Average Cigarette Excise Tax Rate (1997)	$0.74 (0.24)	$0.75 (0.24)	$0.73 (.24)	$0.76 (.27)	$0.66 (.24)	$0.80 (.15)	$0.77 (.26)	$0.67 (.25)	$0.80 (.15)	$0.75 (.27)	$0.65 (.23)	$0.79 (.14)
Real Average Weighted Price per Pack (1997)	$2.37 (0.32)	$2.38 (0.32)	$2.36 (0.32)	$2.38 (0.35)	$2.26 (0.30)	$2.47 (0.20)	$2.39 (0.35)	$2.28 (0.32)	$2.47 (0.20)	$2.37 (0.36)	$2.25 (0.29)	$2.47 (0.19)
Adult Smoking Prevalence (BRFSS, 1997)	23% (.03)	23% (.03)	23% (.03)	24% (.03)	24% (.02)	21% (.03)	24% (.03)	24% (.02)	21% (.03)	24% (.03)	24% (.02)	21% (.03)

BRFSS = Behavioral Risk Factor Surveillance System

Table 2

Estimated tax and price effects

Odds Ratio Standard Error (p-value) [Elasticity]	**Overall**	**Male**	**Female**	**White**	**Black**	**Hispanic**
Real Cigarette Excise Tax Rate	0.88*	0.93	0.81**	0.99	0.74**	0.86
	0.06	0.08	0.06	0.08	0.05	0.13
	(0.06)	(.41)	(.001)	(0.852)	(0.000)	(0.326)
	[−0.09]	[−0.05]	[−0.15]	[−0.01]	[−0.21]	[−0.125]
Real Weighted Price per Pack	0.88**	0.92**	0.83**	0.94	0.82**	0.85**
	0.03	0.04	0.04	0.05	0.04	0.07
	(0.001)	(.05)	(.000)	(0.244)	(0.000)	(0.033)
	[−0.31]	[−0.22]	[−0.48]	[−0.145]	[−0.50]	[−0.44]

Note: Referent group includes female, white, less than high school education, living with single parent, age 5. Also controls for cumulative state tobacco control program funding, baseline adult smoking prevalence, gender, race/ethnicity, household size, and parental education attainment at baseline and includes age indicators and a dummy variable to indicate pre- and post-Master Settlement Agreement (1998).

*Significant at 10%.

**Significant at 5%.

Table 3

Sensitivity analyses

Odds Ratio Standard Error (p-value) [Elasticity]	White Male	White Female	Black Male	Black Female	Hispanic Male	Hispanic Female
Real Cigarette Excise Tax Rate	1.11 0.13 (0.36) [0.08]	0.85 0.09 (0.11) [−.12]	0.71** 0.07 (0.001) [−.24]	0.80* 0.11 (0.08) [−.16]	0.97 0.16 (0.86) [−.02]	0.75 0.18 (0.21) [−0.25]
Real Weighted Price per Pack	1.02 0.06 (0.76) [0.04]	0.85** 0.07 (0.04) [−0.39]	0.83** 0.07 (0.02) [−0.45]	0.80** 0.06 (0.002) [−0.57]	0.86* 0.08 (0.08) [−0.41]	0.84 0.09 (0.11) [−0.47]

Notes: All models controlled for gender, race/ethnicity, household size, parental education, living in two parent household, BRFSS/SASS, and age fixed effects. Referent category: Female, white, less than high school education, living with single parent, age 5.

BRFSS = Behavioral Risk Factor Surveillance System; CI = confidence interval; MSA = Master Settlement Agreement; SASS = state antismoking sentiment