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A Policy Research Partnership to Reduce Youth Substance Use

New Evidence on Youth Smoking Behavior Based on Experimental Price Increases

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Abstract

The high prevalence of smoking among American teenagers remains an important public policy challenge into the 21st century. This study applies a unique approach to analyzing the impact of cigarette prices on youth smoking cessation by evaluating reactions among high school students to several alternative hypothetical price increases. It concludes that many young smokers believe that they would quit smoking or decrease their smoking intensity in response to a cigarette price increase. The estimated price elasticity of cessation is reported to be between 0.889 and 0.818. In addition, the study predicts the strength of behavioral responses to price increases of various magnitudes. The results indicate that youths expect to change their smoking behavior even when the price change is relatively small. However, the behavioral change is most dramatic among the group exposed to the largest price increases suggesting a sustained impact of higher price on cigarette consumption. Large cigarette tax increases would result in both substantially higher quitting rates and a considerable drop in smoking intensity.

JEL Classification: I18

Introduction

Despite the recent declines in smoking among high school students detected by the Monitoring the Future (MTF) surveys, the 30-day prevalence rate in 2002 remains high – 10.7% for 8th graders, 17.7% for 10th graders and 26.7% for 12th graders. Cigarette smoking among adolescents is of particular concern to public policymakers. There are over 2,000 American kids who become addicted to tobacco each day, one-third of whom will die prematurely from smoking-related diseases (CDC, 1996). Cigarette smoking is the leading cause of preventable death and disease in the US (USDHHS, 1989). Smoking accounts for the majority of lung cancer cases and it is an important risk factor for cardiovascular disease (USDHHS, 1988). In addition, a recent panel of experts concluded that smoking is even more deleterious than previously thought, for both smokers and those exposed to environmental tobacco smoke (ETS), causing cancer in many more organs of the body than previously believed (IARC, 2002). Further, many youths underestimate the risk of addiction and the health consequences of smoking (USDHHS, 1994; Kessler, 1995; Johnston et al., 2001).

Even though some states have implemented comprehensive tobacco strategies consistent with the guidelines recommended by the Centers for Disease Control (CDC), the majority of them are lagging behind. The current budget crises are causing some states to reconsider their spending on tobacco control. Given these circumstances it is even more important to identify the most effective measures to reduce youth smoking.

It is essential to gain a better understanding of how economic factors, such as price, affect youth smoking behavior. This knowledge will facilitate the design of optimal tobacco control strategies. The Healthy People 2010 initiative set a goal to reduce the prevalence of adolescent cigarette smoking in America to 16% by 2010. While preventing youth and young adults from

initiating smoking is an extremely important approach to tobacco control, according to the 1990 Surgeon General's report, smoking cessation represents the single most important step that smokers can take to enhance the quality and length of their lives.

Studies of youth smoking behavior suggest that many teen smokers are motivated to quit smoking. It has been estimated that 74% of occasional teen smokers and 65% of daily teen smokers have a desire to quit, although there is evidence that the success rate among those who do attempt to quit is low (Stone and Kristeller, 1992; Lamkin, Davis and Kamen, 1998). An important conclusion of several studies of adolescent smoking is that it is essential to intervene to keep occasional smokers from becoming daily smokers. Yet, many adolescents are unfamiliar with the tools or methods that support quit attempts (Balch, 1998). In addition, the majority of formal smoking cessation programs are aimed exclusively at adults. Given the cost effectiveness of smoking cessation interventions for adults, and the large number of addicted teenagers, research on cessation programs tailored to youth should be a high priority (Cromwell, et al, 1997; Warner, 1997)

The survey data used in this paper provide a unique opportunity to gain insight into whether and to what extent cigarette prices motivate smoking cessation among high school students by examining the strength of the reaction to proposed price increases of various magnitudes. The data are also suitable for an analysis of the compensatory behavior triggered by cigarette price changes. Improved knowledge in this area can be directly translated into public policies aimed at curbing youth smoking such as the availability of youth cessation services, and regulations directed at compensatory behavior. The study further addresses questions related to the design of optimal tax policies. Public policymakers often debate whether to enact a series of

incremental tax increases or to jump directly to the target tax level. We analyze the implication of this policy decision for youth smoking behavior.

This analysis introduces a new technique of estimating youth price responsiveness by analyzing the expected reaction to a future cigarette price increase among current smokers while employing two alternative price measures and several analytical methods. The results based on model simulations are used to predict the effect of future tax increases on youth smoking behavior.

The paper is organized into six sections. After this introduction, it reviews the literature on youth cigarette demand, on youth smoking cessation, and on factors associated with smoking intentions and actual smoking behavior among young people. Next, the description of the data is followed by the explanation of the empirical models employed in this analysis. The subsequent section summarizes the results. The paper concludes with a discussion of the findings and their implications for tax policy design.

Literature Review

The demand for tobacco has been estimated using different types of data, estimation techniques, and measures of cigarette consumption and prices. The impact of price on consumption is measured by the price elasticity of demand, where the elasticity is defined as the percentage change in the quantity consumed resulting from a one-percent increase in price. While the estimates of price sensitivity vary from study to study, the current consensus for the overall price elasticity ranges from –0.3 to –0.5 for adult smokers (USDHHS, 2000; Gruber, 2000). Numerous studies of youth cigarette demand have also identified price as one of the major

determinants of adolescents' smoking (Chaloupka and Warner, 2000). The estimates of these price elasticities vary substantially from study to study, with the majority of estimates ranging from –0.9 to –1.5, three times larger than for adults (USDHHS, 2000).

The existing economic studies of the price elasticity of youth cigarette demand have used various price measures, including state taxes and state average prices published by the Tobacco Institute. Ross and Chaloupka (2003) analyzed how the choice of a particular price measure in the cigarette demand equation affects the results. Apart from commonly used state level prices and taxes, they evaluated the performance of more local specific cigarette prices such as average prices in the Metropolitan Statistical Areas and local cigarette prices as perceived by adolescents. They noted that adolescents usually buy cigarettes in places with higher average sales prices than an average point-of-sale and smoke more expensive premium brands. The study found that elasticities based on youth reported prices ranged between –1.00 and -1.71. These estimates were higher compared to elasticities based on other conventionally used price measures, which ranged from –0.67 to –0.99. The authors concluded that youth might be even more price responsive than previously thought. However, they did not specifically address the issue of youth smoking cessation.

The economic literature on youth smoking trajectories is quite limited, and provides mixed evidence that cigarette prices affect adolescents' decisions to quit smoking. Cross-sectional data are not always suitable for this type of analysis. They have to rely on retrospective information, which can suffer from imperfect recall by respondents. Another challenge is to match correctly the cigarette price with a respondent who may have changed his/her state of residence. Thus, it is usually assumed that a person is living in his/her current location during their entire lifetime.

The more suitable longitudinal data for evaluating quitting behavior are rare. Tauras and Chaloupka (2001) estimated smoking cessation equations for young adults participating in the Monitoring the Future Surveys. Their semi-parametric Cox duration model used micro-level panel data to examine the impact of cigarette prices and clean indoor air laws on any young adult smoking cessation behavior. They found that higher cigarette prices increase smoking cessation among both young male (price elasticity of cessation ranged from 1.07 to 1.17) and young female (price elasticity of cessation ranged from 1.17 to 1.21). Restrictions on smoking in private workplaces had a positive impact on the probability of cessation among employed young adult females. However, the study could not distinguish between long-term and short-term cessation and did not analyze smoking re-initiation of smoking.

In his following study, Tauras (1999) addressed some of the weaknesses of Tauras and Chaloupka (2001). He used both parametric and semi-parametric duration models to estimate multiple cessation attempts including relapse and multiple failures among young adults. This allowed him to estimate long-run elasticity of youth smoking cessation using the Monitoring the Future Surveys panel data for high school seniors. Tauras concluded that an increase in cigarette prices would raise the probability of initial smoking cessation as well as subsequent cessation for those who failed after a prior cessation attempt. He estimated the average price elasticity of cessation of 0.343. This estimate reflects the long-term price effect that is much smaller than the combination of short-run and long-run estimates of Tauras and Chaloupka (2001). Tauras (1999) also found that stronger restrictions on smoking in private workplaces and public places (excluding restaurants) had a positive effect on smoking cessation among youth adults.

Powell, Tauras and Ross (2003) studied the importance of peer effects on smoking behavior applying a two-stage generalized least squares estimator. Their cigarette demand

equation controlled for both a direct effect of cigarette prices (taxes) and tobacco control policies, and an indirect price effect operating via the peer pressure. They found that peer effects have a significant impact on youth smoking behavior and that there is a strong potential for social multiplier effects with respect to any exogenous change in cigarette taxes or tobacco control policies. This means that a peer influence would have a positive multiplying effect for cigarette price increases—in addition to reducing a given youth's smoking directly, smoking would be reduced indirectly as peers reduce their smoking.

Chaloupka (2003) has summarized the effect of various contextual factors and explains conceptually the difference between the direct and indirect effects of price and other public policy measures on youth smoking behavior. Each of the contextual factors (economic and policy factors, media influence, community factors, peer influence and familiar factors) works in combination with the others, but the majority of economic studies do not separate these mechanisms. While these linkages are also moderated by genetic factors, environmental, or contextual factors play an important role in translating economic incentives into behavioral change. Thus, higher prices may affect smoking directly by reducing consumer's utility per unit of currency, but also indirectly by reducing peer pressure or limiting social sources of cigarettes when other members of the family or a peer group quit smoking after a price increase.

To our knowledge, only one survey done by the Roper Organizations Inc, on behalf of the Tobacco Institute in 1978, studied a hypothetical reaction to higher prices among current adult smokers. A series of questions tried to determine whether or not smokers would continue to smoke after tax increases of 5 cents, 50 cents, and $ 1. In response, 93% of all smokers indicated that they would continue smoking after a 5 cent per pack tax increase, while 62% and 41% said the same after tax increases of 50 cents and $ 1, respectively. Whether or not a smoker would

give up smoking was correlated with how heavily they smoked, with the light and moderate smokers more likely to indicate that they would quit than those smoking a pack or more per day. In addition, smokers were asked if they would smoke more if cigarette taxes were eliminated. Relatively few (10%) indicated that they would increase their cigarette consumption, while most (80%) said they would continue to consume the same amount. However, this study analyzed only adult smokers whose reaction may differ from response among youth.

The econometric evidence on the impact of price on cigarette smoking and other tobacco use is based on the relatively small changes in price that occur cross-sectionally and over time. Little is known, however, about the impact of relatively large price increases on cigarette demand, particularly among youths (Gilleskie and Strumpf, 2000). The data used in this study provide a unique opportunity to examine the impact of large nominal increases in cigarette prices that have never been observed at this magnitude in real life, thus offering valuable insights into the mechanism by which cigarette price increases affect youth smoking behavior. It is expected that the level of cigarette prices and the magnitude of the price shock a consumer is exposed to will affect the extent of price responsiveness. The results will have direct implications for predicting reactions to tax-related public policies. This will also enhance our theoretical knowledge of the shape of a cigarette demand curve having practical implications for the optimal design of tax increases.

Further, little is known about the impact of price changes on the compensating behavior among smokers in terms of brand switching, opting for alternative sources of cigarettes, choosing different packaging, and switching to alternative tobacco sources. Among those individuals who intend to continue smoking, we report on their intentions by differential price increases to switch brands, offer cigarettes to friends, buy singles, packs or cartons, and

substitute cigarettes with smokeless tobacco. We examine how those individuals who intend to continue smoking even after a cigarette price increase plan to deal with the new economic environment. It is important to understand to what extent the compensatory behavior among smokers may alter the intended impact of public health policies so that they can be designed with maximum effectiveness.

Hence, overall, this study advances the knowledge of the mechanism by which price increases affect smoking and compensatory behaviors among current smokers providing further insights into the economic determinants of youth smoking behavior.

Data

The data on cigarette smoking among high school students were collected for the project "The Study of Smoking and Tobacco Use Among Young People" funded by the Robert Wood Johnson Foundation. Audits & Surveys Worldwide (ASW) conducted the school-based survey between March and June of 1996. All 17,287 completed questionnaires were self-administered and participants were assured of the anonymity and confidentiality of their responses.

The original sample of 200 U.S. high schools of all types (public, private, and parochial) was drawn in four parts. The first part represented a core sample of 100 U.S. high schools. The second part was a supplementary sample of 40 schools from areas heavily populated by the African-American population. The third part, also a supplementary sample, consisted of 40 schools from areas heavily populated by the Hispanic population. The last part was drawn from a supplementary sample of 20 schools from high poverty areas.

The core school sample was selected in three stages. In the first stage, a sample of counties was randomly chosen, with probability proportional to population. In the second stage, a sample of schools was drawn from the selected counties, with probability proportional to the number of students enrolled in grades 9 through 12. Then, one class per grade was randomly selected allowing each school to be represented by four classes. All students enrolled in the selected classes constituted the sample of respondents.

Twenty-seven percent of the originally selected 200 high schools refused to cooperate or did not respond to the request to conduct the survey. Similar schools based on the original school's demographic profile replaced these schools. In the end, the total number of participating institutions exceeded the originally intended 200 high schools by two due to later agreement with schools for which a substitute had already been recruited. Because the survey oversampled schools in African-American, Hispanic, and high poverty communities, different sampling weights were employed to account for this fact.

The survey collected information on all respondents' current smoking behavior and expected smoking behavior after a hypothetical change in cigarette prices. Both smokers and non-smokers were randomly exposed to four different price changes – an increase by $0.50, by $1.00, by $2.00 and by $4.00. Respondents who smoked in the last 30 days indicated how many cigarettes on average they currently smoke in a week and how many cigarettes on average they intend to consume per week after a price increase. Those who reported a positive amount of average weekly consumption at the time of the survey are defined as current smokers. Another dichotomous indicator was assigned the value of one for a person who intended to consume on average any positive amount per week after a price change (future smoker), and zero for the rest of the sample. The intention to quit smoking is captured by a dummy variable assuming a value

of 1 for those who currently consume cigarettes weekly, but will consume 0 cigarettes per week after a future price increase. Those who will continue to consume cigarettes on a weekly basis in the future are assigned the value of zero. This definition of a future quitter is used in the regression analyses.

The information about the number of cigarettes consumed per week currently and after a price change was used to create two continuous variables describing current and future smoking intensity, respectively. Individuals who did not provide information regarding their smoking status or their smoking intensity were excluded from the analysis. In addition, those individuals who reported increased cigarette consumption after a price change (85 cases, 0.5 % of the sample) were also eliminated.

The survey captures expected compensatory behavior by presenting current smokers with alternatives on how to deal with a change in cigarette prices. Students indicated whether or not they would switch to a cheaper brand, buy fewer cigarettes than they currently do, be less likely to offer cigarettes to friends, buy single cigarettes instead of packs, buy packs instead of cartons, buy cartons instead of packs, switch to chewing tobacco or snuff. This information allows us to assess how the future continuing smokers modify their smoking-related behavior based on the new economic incentives.

Two cigarette price measures were created and assigned to each respondent based on the location of his/her residence in order to measure youth responsiveness to price increases. The first price measure was obtained from the survey. Both smoking and non-smoking students self-reported on how much a pack of cigarettes costs in the area where they live. This rare measure of cigarette price, individually perceived price, has several advantages over the standard price measures, but also several disadvantages. Its primary advantage is that it is teen-specific. Young

smokers generally differ from adult smokers in brand choices, preferred packaging, purchasing places, and sources of cigarettes. Given these factors, it can be expected that teens are buying their cigarettes at higher average sales prices than an average adult smoker (used, for example, for estimating the second price measure - state average price collected by the Tobacco Institute). Comparing the mean of perceived prices with the mean of state average price confirms this expectation. The second advantage of perceived prices is that they are local-specific, reflecting the existence of local cigarette taxes and price promotions that are not captured by state average price. The main disadvantage of perceived prices is their potential endogeneity[1]. Those who smoke have incentives to search for lower cigarette prices, causing a potential downward bias in the perceived price. On the other hand, smokers may have better information than non-smokers as far as true cigarette prices in the area. The problem of endogeneity is partly alleviated by creating an average perceived price across students in a high school excluding the individual's own perception. In order to retain observations on students who did not provide their perception of cigarette price, a school average perceived price (based on the rest of the students who answered the question) is assigned to them. Most variation in the average perceived price is attributable to price differences between different school locations.

Apart from the average perceived price, the state average price was merged to the survey based on respondents' state of residence. Information on state average prices was obtained from the Tobacco Institute (TI). It is a weighted average of single pack, carton, and vending machine cigarette prices in a state, including state excise taxes. Prices of both branded and generic cigarettes are used to compute the average. The state average price is a comprehensive measure of cigarette price that accounts for various brands and various types of sale. However, it

[1] A statistical test for the endogeneity of the perceived price variable cannot be performed because the second equation of the system with the perceived price as the dependent variable cannot be identified.

represents an average price for an average smoker, including adults, and this price may not accurately reflect prices that high school students face. In addition, the state average price is not local-specific - it neither includes local cigarette taxes nor local price promotions. To assess future quitting intentions, we created two continuous measures of future cigarette prices by adding the proposed price increase to either the average perceived price, or to the state average price. We also assess the impact of the price increase by creating a series of dummy variables that reflect the random price change of $0.50, $1.00, $2.00, and $4.00.

There are two additional price related variables matched to the survey. They control for smuggling between states. If the possibility of smuggling is not accounted for, it can lead to an underestimation of the price elasticity of the cigarette demand equation. The first "smuggling" variable is defined as the difference between State Average Price in each youth's state of residence and State Average Price in the lowest-price state within 25 miles of the youth's county of residence. If the respondent lives in a county that is more than 25 miles from the state border, or the state across the border has higher cigarette prices, the value of this variable is zero. The second "smuggling" variable is defined similarly to the first one but it represents the difference in State Excise Taxes between states for those respondents who live in a county within 25 miles of the neighboring state. The difference between average state prices controls for smuggling in models using State Average Price; the difference between state taxes is used in models employing Average Perceived Price.

Two measures describing tobacco control policies were merged with the survey data based on each respondent's location code. The first measure is a youth specific index of the clean indoor air laws created by a Roswell Park Cancer Institute research team led by Gary Giovino

under the ImpacTeen initiative funded by the Robert Wood Johnson Foundation[2]. The index covers restrictions on smoking in private worksites, restaurants, arenas/gymnasiums, shopping malls, government worksites, day care centers, health facilities, public transit facilities, grocery/retail stores, and hotels. Each restriction takes on a value of between 0 and 3 depending on the strength of protection. For example, if smoking is prohibited, the restriction rating is 3; if smoking is restricted with separate ventilation, the restriction rating is 2; if smoking is restricted with no separate ventilation the restriction rating is 1; and if smoking is not restricted, then the restriction rating is 0. The index is derived by adding up the restriction ratings for each of the ten restrictions, giving a weight of two for the private worksite, restaurant, arena/gymnasium, and shopping malls restrictions and a weight of one for the remainder of the restrictions. Furthermore, if states preempt smaller governmental units from passing more restrictive clean indoor air laws, the index is decreased by five points.

The second measure represents a youth access index based on the measure developed by Alciati, et al. (1998) for the National Cancer Institute, as modified by Gruber and Zinman (2000). The index captures the extensiveness and comprehensiveness of state policies aimed at reducing youth access to tobacco products. Twelve separate restrictions comprise the youth access index variable including minimum age of purchase, packaging, clerk intervention, photo identification, vending machine availability, free distribution of samples, graduated penalties, random inspections, statewide enforcement, advertising, licensing, and restrictions on minors. Each of these restrictions takes on a value of between either 0-4 or 0-5 depending on the strength of the regulation. Summing up the ratings for each of the twelve restrictions and subtracting two points in the various components of the index if states preempt stronger local actions derives the youth access index.

[2] Data at ImpacTeen web page http://www.impacteen.org/tobaccodata.htm

Methods

Several methods are applied to assess the price responsiveness of intentions to quit smoking among high school students. First, we estimate an equation for the probability of future quitting among current smokers as a function of future cigarette prices and a set of control variables representing socio-economic characteristics of the survey participants. Second, we assess the importance of future price increases using a series of dummy variables controlling for current price and socio-economic characteristics for both smoking cessation among current smokers, and future smoking intensity among those who will continue to smoke even after the price change. The probability of future quitting is estimated using a probit model. Ordinary Least Squares (OLS) regression is employed to assess the determinants of the reduction of weekly cigarette consumption. The set of control variables in both the probit and the OLS regressions are identical and include: current price, socio-demographic characteristics (e.g. age, gender, race, parental education, completeness of the family, rural/urban status), personal disposable income, living arrangement, opportunity to buy cheaper cigarettes outside the state, youth specific exposure to clean indoor air laws and youth access restrictions.

Empirical Model

The empirical model of youth smoking behavior in this paper applies a unique approach to examining the impact of price responsiveness among high school students by evaluating their reaction to hypothetical price increases. There are two different measures of prices tested in the model: average perceived price and average state price. It is assumed that the values of the independent variables of interest other than price will not be different from the current situation when the respondents evaluate their hypothetical reaction in the future. Our fist empirical model

of youth smoking cessation uses a probit model to estimate the impact of future cigarette prices on the probability of future quitting conditional on being a current smoker:

$$Q_{i,t+1} = ß_0 + ß_1 X_i + ß_2 T_i + ß_3 P_{i,t+1} + e_{i,t+1} \quad (1)$$

where $Q_{i,t+1}$ represents the probability of future smoking cessation for individual *i* at time *t+1*, X_i is a vector of personal and family socio-demographic characteristics that are assumed to stay constant between period *t* and period *t+1*, T_i is a set of dummy variables for tobacco control policies other than price (also assumed to be constant over time), and $P_{i,t+1}$ represents future cigarette prices at time *t+1*. This model is used for calculating the price elasticity of quitting intentions.

In our second empirical model, the change in price is expressed by three dummy variables representing a $1, $2, and $4 increase in cigarette price, respectively, omitting the $0.5 price change. We use again a probit model to estimate the probability of future quitting conditional on being a current smoker:

$$Q_{i,t+1} = ß_0 + ß_1 X_i + ß_2 T_i + ß_3 P_{i,t} + ß_4 D_{1,t+1} + ß_5 D_{2,t+1} + ß_6 D_{3,t+1} + e_{i,t+1} \quad (2)$$

where $P_{i,t}$ represents cigarette prices at time *t*, $D_{1,t+1}$ is a dummy variable for $1.00 price increase, $D_{2,t+1}$ is a dummy variable for a $2.00 price increase, and $D_{3,t+1}$ is a dummy variable for a $4.00 price increase. The reference category for the dummy variable estimates is the $0.50 price change. The remaining variables are defined as above.

The reduction in smoking intensity (in absolute value) is estimated by the following OLS specification conditional on smoking both at time *t* and time *t+1*:

$$| C_{i,t} - C_{i,t+1} | = ß_0 + ß_1 X_{i,t} + ß_2 T_{i,t} + ß_3 P_{i,t} + ß_4 D_{1,t+1} + ß_5 D_{2,t+1} + ß_6 D_{3,t+1} + ?_{i,t+1} \quad (3)$$

where $C_{i,t}$ and $C_{i,t+1}$ represent the number of cigarettes consumed weekly at time *t* and *t+1*, respectively, and the remaining variables are defined as above.

In our sensitivity analyses, we estimate an alternative model, similar to the model specification given by equations (2) and (3), but controlling for percentage versus nominal price increases with the set of three dummy variables.

We also provide a descriptive analysis to examine the extent to which future continuing smokers plan to change their behavior in terms of brand choices, smoking intensity, sources of cigarettes, preferred packaging, and substitution to alternative tobacco products. We analyze these compensatory behaviors for the whole sample, the sample stratified by future price changes, and according to current smoking intensity. The results from these analyses will inform us on differential reactions to price increases of various magnitudes and expected compensatory behavior among smoking adolescents.

Results

Table 1 provides descriptive statistics on smoking participation, and Table 2 describes smoking intensity before and after a price increase. The average price increase based on the mean of price increases respondents are exposed to is $1.889. At the time of the survey the

respondents faced the state average price $ 1.890, and reported the average perceived price $ 2.378.

Table 1 – Smoking Participation: Before and After a Price Increase

Variable / Group	Full Sample		Current Smokers	
	Before Price Increase	After Price Increase	Before Price Increase	After Price Increase
Whole sample	0. 221 (0.415) N= 16304	0.199 (0.399) N= 16304	1.000 (0.000) N= 3610	0.897 (0.304) N= 3610
$ 0.50 increase N=3948	0.223 (0.416) N= 4093	0.209 (0.406) N= 4093	1.000 (0.000) N= 911	0.937 (0.242) N= 911
$ 1.00 increase N=3845	0.220 (0.415) N= 3982	0.203 (0.403) N= 3982	1.000 (0.000) N= 878	0.923 (0.267) N= 878
$ 2.00 increase N=3903	0.219 (0.414) N= 4074	0.198 (0.398) N= 4074	1.000 (0.000) N= 893	0.901 (0.298) N= 893
$ 4.00 increase N=4057	0.223 (0.417) N= 4155	0.185 (0.389) N= 4155	1.000 (0.000) N= 928	0.830 (0.376) N= 928

Notes: The numbers in parentheses are standard deviations. All differences are statistically significant at 1% level.

We analyzed smoking participation by looking at the smoking prevalence both among the entire sample and among the sample limited to current smokers. The 1st row shows the results for respondents exposed to a mixture of price increases, results in the 2nd through 4th rows provide results for the sample stratified according to the magnitude of the price increase that the respondents are exposed to. The 2nd and 3rd columns of Table 1 demonstrate to what extent the overall smoking rate decreases after a price increase. The 4th and 5th columns of the same table compare the current and future smoking prevalence among those who currently smoke. Hence, the smoking prevalence in the 4th column is equal 100%. It is important to note that the current

smoking prevalence reflects smoking on a weekly basis and thus excludes those who experiment with cigarettes during the last 30 days and who are included in the most commonly used definition of smoking prevalence. This explains the relatively low smoking prevalence of 22.1%.

The overall smoking prevalence after an average price increase of $1.889 can be expected to decrease the prevalence of smoking from 22.1% to 19.9%. As economic theory predicts, the largest drop in smoking prevalence would occur among the group exposed to largest price increase ($4.00). There, the prevalence declines from 22.3% to 18.5%, or by 17%. The right hand part of the table indicates the expected quitting rate among the current smokers. Overall, 10.3% of current smokers expect to stop smoking based on the average price increase. The statistics in Table 1 demonstrate that many students expect to quit smoking as a result of higher cigarette prices, and that this intention is positively related to the magnitude of price increase. The positive effect of higher cigarette prices on smoking cessation continues as the difference between the current and future prices increases.

Table 2 informs on changes in smoking intensity after a price increase. Current and future smoking intensity among current smokers expressed by the number of cigarettes consumed on average per week is presented in the 2nd and 3rd columns, the 4th and 5th columns shows an average weekly cigarette consumption among those who plan to continue to smoke even after a price increase.

Table 2 – Smoking Intensity: Before and After a Price Increase

Variable / Group	Weekly Consumption Among Current Smokers		Weekly Consumption Among Continuous Smokers	
	Before Price Increase	After Price Increase	Before Price Increase	After Price Increase
Whole sample	34.52 (47.79) N= 3610	25.03 (39.92) N= 3610	37.07 (48.43) N= 3239	27.89 (41.19) N= 3239
$ 0.50 increase N=3948	35.77 (52.75) N= 911	29.36 (42.50) N= 911	36.72 (51.37) N= 854	31.32 (43.20) N= 854
$ 1.00 increase N=3845	33.80 (44.21) N= 878	27.97 (42.78) N= 878	35.79 (45.00) N= 810	30.32 (43.73) N= 810
$ 2.00 increase N=3903	35.76 (47.39) N= 893	23.78 (37.72) N= 893	38.55 (48.53) N= 805	26.38 (38.86) N= 805
$ 4.00 increase N=4057	32.79 (46.31) N= 928	19.19 (35.62) N= 928	37.27 (48.50) N= 770	23.12 (37.93) N= 770

Notes: The numbers in parentheses are standard deviations. All differences are statistically significant at 1% level.

It is evident that price increases will also affect average weekly cigarette consumption. On average, smokers expect to reduce their smoking intensity by 9 cigarettes per week, or by 27.5% and 24.8% for current and continuous smokers, respectively. The largest reduction is recorded among those who are exposed to $2 and $4 price increases. Smokers in these groups expect to lower their weekly consumption by 12 and 14 cigarettes, respectively. The decrease is only slightly larger among continuous smokers. It is interesting to note that the group exposed to a $4 price increase has a greater relative reaction in terms of quitting than in terms of reducing smoking intensity compared to the group exposed to a $2 price increase. This suggests that larger price increases result in greater quit rates as opposed to just lower levels of smoking intensity. Also, the reduction in smoking intensity is much larger for a price increase equal to or exceeding

$2 compared to a price increase equal to or lower than $1. The second empirical model confirms this observation.

Our first empirical model where future quitting intentions were regressed on the future price and the other independent variables described in the Methods section, provides estimates of price elasticities of cessation. The estimated price elasticity of cessation are 0.889 and 0.818 for models that employ the average perceived price and the average state price, respectively[3].

Turning to the second empirical model, Table 3 summarizes our results based on the analysis of the future quitting behavior among current smokers and the future smoking intensity among continuing future smokers while controlling for the current price, the set of dummy variables representing the future price increases, and the other covariates mentioned in the previous section.

The first column in Table 3 lists the price measures that are being examined in the model. The second column describes the type of behavior that is being affected by the price increase. Marginal effects of the price and the dummy variables representing the certain price increases are recorded from the third throughout the sixth columns.

[3] The price elasticities of continued future smoking based on the similar model are -0.102 and -0.094, respectively.

Table 3: Youth cigarette demand response to a hypothetical nominal price increase (marginal effects)

Price measure	Behavior	Price	$ 1 price increase	$ 2 price increase	$ 4 price increase
Average Perceived Price	Smoking cessation	-0.034 (0.019)	0.025 (0.017)	0.049 [a] (0.025)	0.103 [b] (0.024)
	Smoking intensity	-0.821 (2.819)	-0.943 (0.978)	-8.143 [b] (1.827)	-11.549 [b] (1.799)
State Average Price	Smoking cessation	0.002 (0.024)	0.025 (0.017)	0.049 [a] (0.025)	0.104 [b] (0.024)
	Smoking intensity	-2.714 (3.490)	-1.015 (1.003)	-8.178 [b] (1.828)	-11.545 [b] (1.806)

Notes: Coefficients are marginal effects. Numbers in parenthesis are standard errors. The reference category for the price dummy variables is the $0.50 price increase.
a - significant at 5% level, two tailed test
b - significant at 1% level, two tailed test

The marginal effects of all of the price increase variables on the future intention to quit smoking among current smokers are positive suggesting that higher prices will lead to cessation among current smokers. The price increases also have a negative effect on smoking intensity among those who will not give up smoking after a price increase. The positive effect of the $ 2 price increase is statistically significant at the 5% level with respect to smoking cessation, and its negative effect on smoking intensity is statistically significant at the 1% level. The positive effect of the $ 4 price increase on smoking participation is significant at the 1% level, and its negative effect on smoking intensity is significant also at that level. This means that a price increase of the magnitude of $2 or $4 will significantly increase the probability of cessation and lower the smoking intensity as compared to the effect of a $0.5 price increase. Within the range of our hypothetical price increases, we do not find evidence of a threshold beyond which students would stop responding to a price increase. As revealed by the marginal effects for the incremental price increases presented in Table 3, the differential impacts appear to be almost

linear in their effect on youth smoking cessation. That is, the results support the hypothesis that the intended reaction to a price change in terms of smoking cessation is almost linear in price. The results presented in Table 3 are robust with respect to the both price measures.

Table 4 presents the intended probabilities of smoking cessation and reduction in smoking intensities among current smokers obtained by simulating the results from our empirical model. The 3rd column represents the expected smoking cessation and reduction in smoking intensity when current smokers are exposed to the random combination of the four different price increases. The 4th through 7th columns show predictions of intended smoking behavior if the entire sample were exposed to the price increase indicated in the column's heading.

Table 4: Predicted youth cigarette demand – Model 1 simulation

Price measure	Behavior	Mix of price increases	$ 0.5 price increase	$ 1 price increase	$ 2 price increase	$ 4 price increase
Average Perceived Price	Smoking cessation (%)	10.33 (7.58)	6.29 (4.66)	8.32 (5.66)	10.53 (6.63)	15.90 (8.59)
	Reduction in # of cigs per week	10.31 (7.82)	5.28 (6.21)	6.22 (6.21)	13.42 (6.21)	16.83 (6.21)
State Average Price	Smoking cessation (%)	10.37 (7.56)	6.31 (4.64)	8.37 (5.64)	10.54 (6.59)	16.00 (8.56)
	Reduction in # of cigs per week	10.29 (7.84)	5.24 (6.24)	6.25 (6.24)	13.41 (6.24)	16.78 (6.24)

Notes: Numbers in parenthesis are standard deviations.

On average, over 10% of current smokers intend to quit smoking when the sample is exposed to the mix of price increases. The average expected reduction in smoking intensity exceeds 10 cigarettes per week. The probability of smoking cessation and the reduction in

smoking intensity is increasing with the level of price increase. For example, if the whole sample is exposed to an increase of a pack of cigarettes that equals $4, the expected quit rate among current smokers would reach almost 16%, and those who would continue to smoke would reduce their weekly cigarette consumption by 45%, or by almost 17 cigarettes.

Results based on an alternative specification where we define the hypothetical future price increases as percentage price increases from the current price confirm the results from our benchmark empirical model. In this specification our three dummy variables represent a 30 – 50% price increase, a 50 – 100% price increase, and a 100% and higher price increase, with a reference category of less than 30% price change. As revealed by Table A1 in the appendix, the marginal effects from this model confirm that higher price increases have a positive effect on the future intention to quit smoking and a negative effect on smoking intensity.

The results when the entire sample is exposed to various price increases are similar to our benchmark empirical model simulation: about 10% of current smokers intend to quit smoking, and those who expect to be smoking expect to reduce their smoking intensity by about 10 cigarettes a week (Table A2). The largest increase in the probability to quit smoking and the largest drop in smoking intensity is expected when the whole sample is exposed to a price increases exceeding 100% of current cigarette price. In that case, the expected quit rate among current smokers would reach between 13% and15%, and those who would continue to smoke would reduce their weekly cigarette consumption by 15 to 16 cigarettes. Note that the simulations presented in Table A2 confirm the near linear relationship between the alternative price increases and resulting cessation rates. That is, the percentage increase in the cessation rate that results from the increasing percentage change in the price categories is found to be almost constant.

Table 5 describes how future smokers plan to deal with the new economic environment if they are exposed to higher cigarette prices. The second column analyzes the mean reaction of the whole sample, the 3rd and 4th column distinguishes between those who plan to smoke less than 10 cigarettes per week (light smokers), and those who intend to smoke at least 10 cigarettes per week (heavy smokers).

Table 5: Compensatory Behavior Among Future Smokers After Price Increase

Behavior	All Future Smokers	Light Future Smokers	Heavy Future Smokers
Switch to cheaper brand	0.286 (0.45)	0.251** (0.43)	0.324** (0.47)
Buy fewer cigarettes	0.451 (0.50)	0.430* (0.50)	0.474* (0.50)
Offer less to friends	0.600 (0.49)	0.486** (0.50)	0.723** (0.45)
Buy singles instead packs	0.145 (0.35)	0.203** (0.40)	0.081** (0.27)
Buy packs instead cartons	0.369 (0.48)	0.338** (0.47)	0.404** (0.49)
Buy cartons instead packs	0.255 (0.44)	0.128** (0.33)	0.390** (0.49)
Supplement cigs with smokeless tobacco	0.065 (0.25)	0.068 (0.25)	0.062 (0.24)

Notes: Numbers in parenthesis are standard deviations. All results for All Future Smokers are significantly different from zero. The split between a light and a heavy smoker is based on a median number of cigarettes consumed per week by future smokers. Light Smoker is defined as a person consuming 10 or less cigarettes per week; Heavy Smoker is defined as a person consuming 11 or more cigarettes per week.
* difference between Light and Heavy Smoker significant at 5% level
** difference between Light and Heavy Smoker significant at 1% level

Table 5 reveals that the strongest reaction to a new price situation is reflected in a lower willingness to share cigarettes with friends as 60% of future smokers intend to offer fewer cigarettes to their friends. The willingness to share a cigarette with a friend declines with smoking intensity. This behavior reflects the mechanism of an indirect effect of a price increase on youth smoking behavior that limits social sources of cigarettes. Several studies show that social sources are the most common sources of tobacco for adolescents, with friends and family being the most frequent source (DiFranza and Coleman, 2001; Jones et al., 2002, Ma GX, et al., 2003).

About 45% of the continuing smokers expect to buy fewer cigarettes and this reaction is more frequently cited among heavier smokers compared to lighter smokers. The analysis further shows that almost 21% of future smokers who do not expect to change their smoking intensity after a price increase also expect to buy fewer cigarettes. These smokers plan to look for alternative cigarette sources, although getting them from their peers may become harder as evidenced in the previous paragraph.

Thirty seven percent of continuing smokers plan to buy cigarettes by packs instead of cartons, and about 26% plan to switch from packs to cartons of cigarettes. Both of these tendencies are higher among heavier smokers. Lighter smokers will be more induced to buy single cigarettes compared to heavier smokers, but heavier smokers plan to switch to cheaper cigarette brands more than lighter smokers. About 6% of those who plan to continue to smoke contemplate supplementing cigarettes with smokeless tobacco. Further, 7% of current smokers who intend to quit smoking after a price increase report their intention to switch to smokeless tobacco. This behavioral response would increase the smokeless tobacco use prevalence among high school students from the current rate of 5.5% to 6.9% (a 25% increase in the rate).

Table 6 describes compensatory behavior among groups of students exposed to different price increases to determine whether the size of a price increase influences this decision. The table shows that the tendencies to switch to cheaper cigarette brands increases with the level of future price increases. The same applies to fewer cigarette purchases, lower willingness to share cigarettes with friends, switching from pack to single cigarettes, and to a higher rate of supplementation with smokeless tobacco among future cigarette users. The results suggest that the intention to engage in compensatory behavior increases with the level of the price increase.

Table 6: Compensatory Behavior Among Future Smokers After Price Increase

Behavior	All Future Smokers	Smokers exposed to $ 0.5 price increase	Smokers exposed to $ 1 price increase	Smokers exposed to $ 2 price increase	Smokers exposed to $ 4 price increase
Switch to cheaper brand	0.286 (0.45)	0.188** (0.39)	0.243* (0.43)	0.336** (0.47)	0.388** (0.49)
Buy fewer cigarettes	0.451 (0.50)	0.306** (0.46)	0.416* (0.49)	0.518** (0.50)	0.579** (0.49)
Offer less to friends	0.600 (0.49)	0.535** (0.50)	0.590 (0.49)	0.632 (0.48)	0.649* (0.48)
Buy singles instead packs	0.145 (0.35)	0.092** (0.29)	0.112* (0.32)	0.165 (0.37)	0.217** (0.41)
Buy packs instead cartons	0.369 (0.48)	0.346 (0.48)	0.343 (0.47)	0.393 (0.49)	0.399 (0.49)
Buy cartons instead packs	0.255 (0.44)	0.227 (0.42)	0.264 (0.44)	0.278 (0.45)	0.250 (0.43)
Supplement cigs with smokeless tobacco	0.065 (0.25)	0.048* (0.21)	0.057 (0.23)	0.073 (0.26)	0.084* (0.28)

Notes: Numbers in parenthesis are standard deviations. All results for All Future Smokers are significantly different from zero.
* difference between the average for the whole sample and the group exposed to a certain price incentive significant at 5% level
** difference between the average for the whole sample and the group exposed to a certain price incentive significant at 1% level

Discussion

This study examines the expected behavioral response to higher cigarette prices among current high school smokers. The results demonstrate that many high school smokers will quit smoking while others will lower their smoking intensity as a response to higher cigarette prices. This response is confirmed using different methods and three different cigarette demand model specifications. We establish that the magnitude of the reaction differs with the size of the future price increase, and that the largest absolute response can be expected among students that are exposed to the largest price increases. Empirical evidence on expected reaction to cigarette price increases has profound implications for effective design of tobacco tax policy. Our results, robust to different price measures, demonstrate that the largest public health improvements could be achieved with the largest increase in cigarette prices and that the relative impact of greater price increases is almost linear in its effect on consumption.

Our estimated price elasticity of cessation is smaller than those based on cross-sectional data (Tauras and Chaloupka, 2001). This however is to be expected because our results may capture only the direct effect of price on smoking cessation. The price elasticity results based on cross-sectional data typically reflect the combined direct and the indirect price effects due to the failure to control for confounding factors such as peer effects, parental effects, effects of other contextual influences such as community norms, and the effect of price on cigarette availability. In this respect our estimates represent a lower bound of the price effect on smoking cessation given that the current period observations are isolated from the future period contextual factors.

The analysis of the future compensatory behavior among smokers demonstrates that the extent of this behavior increases with the price increase. Most future smokers plan to cut back on sharing cigarettes for free with their friends, which will affect the availability of cigarettes from

social sources. Thus, a cigarette tax increase may further indirectly increase prices by reducing the number of cigarette distributional channels. This particularly may affect those smokers who plan to buy fewer cigarettes, but smoke the same amount as before a price change. There is also evidence that a small group of current cigarette smokers plan to switch to or compensate with smokeless tobacco products. Public policymakers should take this possible substitution into account when considering changes in cigarette and tobacco taxes. This suggests that policymakers may want to consider coordinating increases in cigarette and smokeless tobacco taxes.

When interpreting our results, it is important to bear in mind the following points. First, the reaction to future price increases is measured by the expected reaction as reported by students themselves, and the nature of our cross-sectional dataset does not allow for a comparison of the expected and actual reaction to a price change. However, even if forming expectations about an unknown future biased the expected reaction to a price change, this bias is systematic across all individuals, particularly when the effect of individual characteristics is controlled for in the regressional analysis. The reported future response informs on the overall expected tendency of a reaction to a price change. The comparison of the relative expected reaction to a price change is not likely to be affected by any individual bias. It means that our conclusion of higher price responsiveness to larger price increases is valid if relative expectations are on average formed accurately.

Second, the necessary assumption of no change of the independent variables except for price in the future can also obscure the true reaction. This is particularly problematic regarding the assumption of no age change. If the probability of smoking cessation among high school

students decreases with age, the assumption of constant age generates optimistic estimates in terms of expected future reactions to a price change.

With these caveats in mind, the analyses in this paper provide important insights into forming expectations about responses to cigarette price changes of various magnitudes and about intended compensatory behavior among youth who cannot be induced to give up smoking by higher cigarette prices. The findings on the relative responsiveness to price changes of various magnitudes is important for formulating effective public health policy based on cigarette tax increases.

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Appendix

Table A1: Youth cigarette demand response to a hypothetical relative price change (marginal effects) – Model 2

Price measure	Behavior	Price	30-50% change in price increase	50-100% change in price increase	100+% change in price increase
Average Perceived Price	Smoking cessation	-0.024 (0.020)	0.014 (0.017)	0.054[a] (0.023)	0.090[b] (0.023)
	Smoking intensity	-2.159 (2.852)	-1.056 (0.925)	-7.380[b] (1.849)	-11.074[b] (1.758)
State Average Price	Smoking cessation	0.026 (0.032)	-0.028 (0.019)	0.035 (0.026)	0.064[b] (0.022)
	Smoking intensity	-7.039 (3.817)	-3.138 (1.834)	-5.484[b] (1.950)	-11.109[b] (1.396)

Notes: Coefficients are marginal effects. Numbers in parenthesis are standard errors. Reference category for Model B is price increase equal or less than 30% of current price.
a - significant at 5% level, two tailed test
b - significant at 1% level, two tailed test

Table A2: Predicted youth cigarette demand – Model 2 simulation

Price measure	Behavior	Mix of % price increases	Price increase less than 30%	30-50% price increase	50-100% price increase	Price increase over 100%
Average Perceived Price	Smoking cessation (%)	10.31 (7.44)	6.43 (4.63)	7.57 (5.19)	11.23 (6.78)	14.96 (8.15)
	Reduction in # of cigs	10.30 (7.688)	5.32 (6.20)	6.37 (6.20)	12.70 (6.20)	16.39 (6.175)
State Average Price	Smoking cessation (%)	10.43 (7.38)	6.80 (4.96)	4.59 (3.74)	9.93 (6.42)	13.49 (7.81)
	Reduction in # of cigs	10.36 (7.58)	3.75 (6.34)	6.89 (6.34)	9.23 (6.34)	14.86 (6.34)

Notes: Numbers in parenthesis are standard deviations.

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