PUTTING OUT THE FIRES: WILL HIGHER TAXES REDUCE YOUTH SMOKING?

Philip DeCicca

Donald Kenkel

Alan Mathios

Department of Policy Analysis & Management
Cornell University
Ithaca, NY 14853
ppd1@cornell.edu
dsk10@cornell.edu
adm5@cornell.edu

We thank Frank Chaloupka, Thomas Dee, William Evans, Michael Grossman, Jeffrey Harris, Pauline Ippolito, Joe Mulholland, Rosalie Pacula, and participants at sessions at the 1998 annual meetings of the American Economics Association and the Western Economic Association for helpful comments. Financial support from the Bronfenbrenner Life Course Center, Cornell University, and the National Cancer Institute, grant number R01-CA77005-01, is gratefully acknowledged.

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ABSTRACT

This paper re-examines the empirical support for predictions that proposed cigarette tax or price increases will substantially reduce youth smoking. Part of the support for these predictions comes from evidence that higher taxes reduce aggregate tobacco sales and adult smoking rates. But taxes may have much different impacts on youth starting behavior than on adult quitting behavior. We use a panel microdata set, the National Education Longitudinal Survey of 1988 (NELS:88), that spans a period when many states increased taxes on cigarettes. We are able to study the impact of taxes and prices on smoking behavior during exactly the period in adolescence when most smokers start their habits. Cross-sectional models of 12th grade smoking based on the NELS:88 data yield estimated price elasticities ranging from -0.29 to -0.98, similar to previous studies. But when we exploit the longitudinal nature of the data our results suggest that cigarette taxes or prices are not important determinants of smoking initiation. We find weak or nonexistent tax and price effects in models of the onset of smoking between 8th and 12th grade, models of the onset into heavy smoking between 8th and 12th grade, and discrete time hazard models that include state fixed effects. Our estimates create doubt about the strength of the response of youth smoking to higher taxes or prices, and suggest that alternative policy approaches to preventing youth smoking deserve serious attention. We also provide a new perspective on the relationship between smoking and schooling. We find that students with better tests scores are less likely to smoke, and that eventual dropouts are already more likely to smoke in 8th grade. Possible explanations for these patterns include individual heterogeneity in: the rate of time preference; tastes for deviancy; parental investment in smoking prevention as an aspect of child quality; and optimal lifetime plans for health and education human capital investment.

1. INTRODUCTION

Since the 1964 Surgeon General's Report on the health consequences of smoking, the prevalence of smoking among adults has decreased from 40 percent to about 25 percent (USDHHS 1990). Since the early 1990s, however, the prevalence of youth smoking has been increasing (see Figure 1). In September 1997 President Clinton called for national tobacco legislation that would include a comprehensive plan to reduce youth smoking by 30 percent in five years and 60 percent in ten years (American Public Health Association [APHA], 1997). Clinton's plan included policies to increase the price of cigarettes by as much as $1.50 per pack. The APHA (1996) and the National Cancer Policy Board of the Institute of Medicine [IOM] (1994, 1998) also endorsed tax or price increases at least this large. Although national tobacco legislation was not passed in 1998, state attorneys general negotiated a settlement with the tobacco industry that increased wholesale cigarette prices by $0.45 per pack. Clinton's most recent budget proposes to increase the federal cigarette excise tax by another $0.55 per pack.

Reliance on higher prices as a way to discourage youth smoking has widespread support among researchers as well. Warner (1997) concludes that "Among people who have studied various policy measures to influence tobacco consumption, there would be nearly universal agreement that price is the single most important policy lever we can pull to influence youth smoking." Chaloupka (1997) predicts that a $1.50 price increase would reduce the number of young smokers by 50 percent, even without other new anti-smoking initiatives.[1] Using the standard welfare economics criteria of efficiency and equity, Warner *et al.* (1995) also conclude that "protection of children constitutes the strongest argument favoring increased taxation of cigarettes."

This paper re-examines the empirical support for predictions that cigarette tax or price increases will substantially reduce youth smoking. Part of the support for these predictions comes from evidence that higher taxes reduce aggregate tobacco sales and adult smoking rates, coupled with the argument that taxes will have a disproportionate impact on youth smoking (USDHHS 1994a, IOM 1998). But the tax responsiveness of adult and youth smoking depend on two distinct types of behavior. As shown in Table 1, very few people start smoking once they are over

[1] With the current price of a pack of cigarettes at about $2.00, $1.50 is a 75% price increase. Using an estimated smoking participation elasticity of -0.675 from Chaloupka and Grossman (1996), extrapolation implies a 51% decrease in the number of youth smokers. For other price-elasticity estimates see the review by the USDHHS (1994a),the Congressional Budget Office (1998) and Table 2 below.

the age of 22.[2] Higher taxes reduce adult smoking and aggregate sales by encouraging current smokers to quit or cut down. However, because almost no youth quit smoking (also shown in Table 1), higher taxes reduce youth smoking mainly by preventing them from starting. Taxes may have much different impacts on youth starting behavior than on adult quitting behavior. This paper explicitly focuses on the impact of taxes and prices on the onset of smoking among youth.

We use a panel microdata set, the National Education Longitudinal Survey of 1988 (NELS:88), that spans a period when many states increased taxes on cigarettes, to develop new price-elasticity estimates. Our study exploits the fact that NELS:88 provides data on cigarette smoking by 8th graders, with follow-up surveys two and four years later. We are able to study the impact of taxes and prices on smoking behavior during exactly the period in adolescence when most smokers start their habits. In contrast, almost all previous studies rely on cross-sectional data, often collected from high school seniors or young adults several years after they started smoking. Section 2 reviews previous studies in more detail.

Section 3 discusses our data and empirical approach. Our strategy is first to estimate benchmark cross-sectional models based on the NELS:88 data that can be directly compared to previous studies. The results are presented in section 4. Next, we improve upon the benchmark models by exploiting the panel nature of the NELS:88 data to estimate the onset of smoking using a variety of empirical models. These results are presented in section 5. Section 6 concludes.

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[2]The patterns shown in Table 1 are typical. For example, data from the 1991 National Household Survey on Drug Abuse (NHSDA) show that of adults who had ever smoked daily, 89 percent has first tried a cigarette before the age of 18 and 71.2 percent had begun smoking daily by the age of 18 (USDHSS 1994a, p. 67).

2. BACKGROUND

Trends in Youth Smoking

Nelson *et al.* (1995) discuss trends in cigarette smoking among youth over the period 1971 through 1991. They conclude that overall youth smoking prevalence dropped rapidly from 1974 to 1980, by as much as 2 percentage points annually. The rate of decline seems to have slowed after 1980, with evidence of only minimal overall declines in adolescent smoking from 1985 to 1991. Figure 1 illustrates the change in smoking rates for the years 1991 through 1996 for 8th , 10th and 12th graders. These data are taken from the Monitoring the Future (MTF) Study and illustrate an alarming trend in smoking rates among those in their high school years. From 1992 to 1997 daily smoking among 12th graders increased from 17.2 percent to 24.6 percent. Trends for 8th and 10th grade smoking are similar, but the most recent data show a small decline in smoking among 8th graders (from 10.4 percent in 1996 to 9.0 percent in 1997).

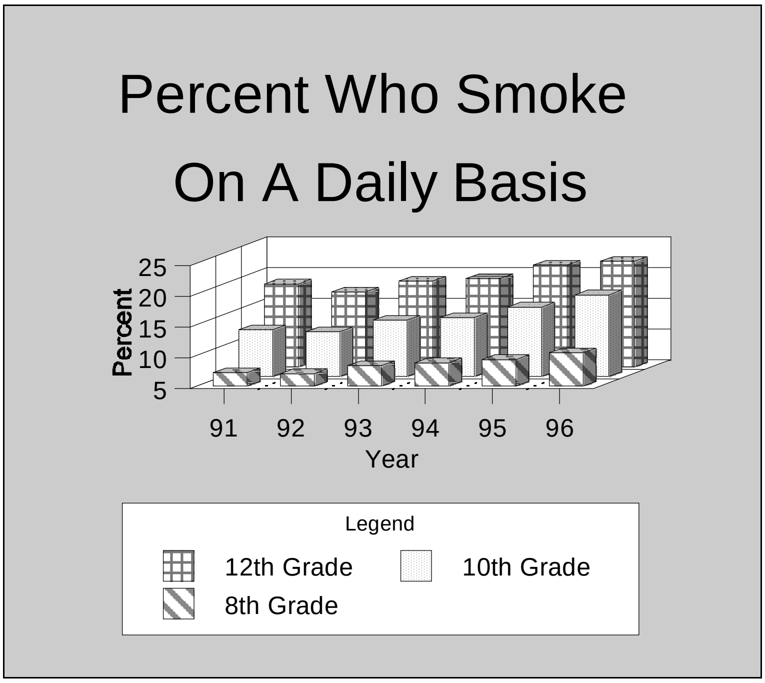

Figure 1

The reasons behind the recent trend towards more youth smoking are not yet well understood. Johnston (1995) speculates that there may be culture-wide forces at work, including industry advertising and promotion and the portrayal of smoking by the entertainment industry. Grossman and Chaloupka (1997) suggest instead that the trend can be attributed to the fact that around 1993 the real price of cigarettes actually fell. Based on an existing estimate of the price-responsiveness of youth smoking, this price decrease can explain the observed increase in teen smoking from 1992 to 1993, but can not explain the continuing upward trend from 1994 to 1997.[3] While more research is needed to sort out these alternative explanations, the trends clearly show the continued need for research into the effectiveness of youth smoking prevention policies. In addition to the general anti-smoking campaign, public health efforts to prevent youth smoking include school-based programs, restrictions on youth access to cigarettes, and increases in cigarette taxes (USDHHS 1994a, Chapter 6). Litigation against tobacco companies has created a new policy tool; for example the failed national settlement included targets for youth smoking and penalty schedules if the targets were missed.

Effects of Cigarette Prices and Taxes on Youth Smoking

Empirical studies provide compelling evidence that consumer decisions about cigarette consumption obey the economic "law of demand:" when prices of cigarettes go up, the amount consumed falls. Cigarette demand functions have been estimated using different types of data and measures of consumption: time series data on national aggregate consumption; pooled time series of state cross-sections; and micro-level data on consumption from surveys of individuals. As reviewed by Manning *et al*. (1991, Appendix A) estimates of the price elasticity of cigarette demand range from -0.22 to -1.0. Based on their expert evaluation of the reliability of the different available estimates, the consensus of a National Cancer Institute sponsored group put the price elasticity in a narrower range, from -0.3 to -0.5 (National Cancer Institute 1993a). It is important to note that aggregate data on cigarette consumption are dominated by adult smoking, while most of the micro-data sets used to date include many more adults than youth or exclude youth entirely. Consequently, the consensus on the price elasticity of the demand for cigarettes should be interpreted as reflecting the price-consumption relationship for adults.

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[3]Our calculations are as follows. Between 1992 and 1993 the average real price of a pack of cigarettes fell by about 14 percent, from $2.12 to $1.82. Chaloupka and Grossman (1996) estimate a smoking participation elasticity of -0.675. From the MTF 1992 baseline daily smoking rate of 17.2 percent, using this elasticity to extrapolate implies that this price decrease will increase smoking participation by 1.6 percentage points (9.45 percent of 17.2) to 18.8 percent. This is almost exactly the increase observed in the MTF data between 1992 and 1993. However, after 1993 the teen smoking rate continued to increase even though the real price of cigarettes began to rise back towards the 1992 level. Repeating the calculations over the longer period from 1992 to 1997, the real price fell by only 8.4 percent. Using the same elasticity estimate this decrease is predicted to increase the teen smoking rate by about 1 percentage point, compared to the 7.4 percentage point increase actually observed in the MTF data. If the prices of cigarettes youth smoke fell by more than the average price decreases used in the calculations, price decreases may explain more of the observed increase in smoking. Of course, if smoking participation is less responsive to price than estimated by Chaloupka and Grossman (1996), price decreases explain even less of the observed increase.

A number of interacting and offsetting influences determine whether youth smoking is more or less price responsive than adult smoking. Theoretical economic models related to this question include the standard model of the consumer (Deaton and Muellbauer 1980), models of habit formation (Houthakker and Taylor 1970), and the model of rational addiction (Becker and Murphy 1988). From standard consumer theory, if youths spend a larger fraction of their incomes on cigarettes than adults, a given price increase will have a greater impact on their purchases. For a normal good the income effect of a price change reinforces the substitution effect, and the size of the income effect depends upon the budget share. In this case the uncompensated price elasticity of demand rises (in absolute value) as cigarettes make up a larger share of youths' budgets . However, Wasserman *et al*. (1991) provide evidence that adult demand for cigarettes falls as income rises, suggesting cigarettes are an inferior rather than normal good. If this is true for youth demand, the income and substitution effects of a price change work in opposite directions and the uncompensated price elasticity falls (in absolute value) as cigarettes' budget share rises.

Second, youths may be less addicted to cigarettes than adults, which intuitively suggests that youth demand will be more price elastic. In the rational addiction model, however, current and future consumption are complementary goods so addicts may respond more to long-run permanent price changes than nonaddicts will (Becker, Grossman, Murphy, 1991). This suggests that youth demand may be less elastic than adult demand. On the other hand, the rational addiction model also suggests that addicts with higher rates of time preference (greater impatience) will respond more to changes in price. If youth are more impatient than adults, youth cigarette demand will be more price elastic than adult demand.

Finally, it has been argued that the role of peer influences makes youth smoking more responsive to higher prices (Lewit, Coate and Grossman 1981), but the prediction is once again not straight-forward. The argument is based on Liebenstein's (1950) model of "bandwagon effects" in consumer demand, where the demand for a commodity is increased when others are also consuming it. Liebenstein shows that consumer demand is more price elastic when there are bandwagon effects. However, when there are "snob effects," where the demand for a commodity is decreased when others are consuming it, Liebenstein shows that consumer demand is less price elastic. Peer influences on adolescent smoking seem to be a combination of bandwagon and snob effects. If higher prices reduce smoking in a peer group, there will tend to be a bandwagon effect with less peer pressure on any individual member of that group. But continuing to smoke at higher prices might make smoking a more effective way for members of one peer group to differentiate themselves from other adolescents, i.e. a snob effect could operate making demand less price elastic. Without knowing whether bandwagon effects or snob effects are more powerful at the prevailing level of smoking, it is impossible to predict whether peer influences make youth smoking more or less price elastic.

The upshot of the various conceptual analyses is that the relative magnitude of the price responsiveness of cigarette demand by adults and youth remains an empirical question. Several studies published in the early 1980s lend empirical support to the notion that youth smoking is at least as price responsive as adult smoking (Lewit, Coate and Grossman 1981, Lewit and Coate 1982). As noted by the Institute of Medicine (1994) and a leading health economics textbook (Folland, Goodman and Stanos 1997), the early consensus later began to crumble: "Two studies have now reported that price has little or no impact on teenage smoking decisions." [4] Table 2 summarizes the results of eleven available econometric studies of the of the price-responsiveness of youth smoking in the U.S. Because these studies use micro data from surveys of youths and young adults, most are able to report separate estimates of the effect of price on smoking participation and the effect on conditional demand (*i.e.*, the number of cigarettes smoked, conditional on being a smoker). These two effects are combined in the estimates of the overall or total elasticity. Of the eleven studies summarized in Table 2, six find statistically significant and substantial price elasticities, three find statistically insignificant effects of price, and two have somewhat mixed results.[5]

[4]Folland, Goodman and Stanos (1997 p. 209) refer to studies by Wasserman et al. (1991) and Douglas and Hariharan (1994). Although the Institute of Medicine (1994) recommends substantially higher cigarette taxes, they are careful to point out that the research base is thin: "The conflicting results of the few U.S. studies that have examined the impact of cigarette prices on consumption by adolescents...reinforce the need for new research to assess the potential for using higher tobacco taxes to deter adolescent tobacco use."

[5]Although the CDC (1998) reports a statistically significant effect of prices on young adult smoking pooled across race/ethnicity, other results are more mixed. For all adults they find a small and statistically insignificant price effect for non-Hispanic white smoking in a very large sample (N=281,482) but strong effects for Hispanic adult smoking. They state that the pattern across race/ethnic groups was consistent across all age groups. From their published Figure 1 (CDC 1998 p. 608) it appears that higher prices have a small effect on smoking by non-Hispanic white young adults. In unreported results, the effect of prices on smoking participation for young adults is statistically insignificant but there is a statistically significant negative effect on demand conditional on participation (Matthew Farrelly, personal communication). A recent study by Chaloupka and Pacula (1998) extends the analysis of Chaloupka and Grossman (1996) to explore differences in price-responsiveness by gender and race. Some important differences emerge, but because it uses the same data and methods as Chaloupka and Grossman the study does not provide new information on the average price responsiveness of youth smoking.

The studies with statistically significant results yield elasticity estimates for youth or young adults that are larger than the consensus price-elasticity range of -0.3 to -0.5 for adults. This comparison is somewhat misleading, however. Because smoking participation rates and conditional demand are lower for youths, the same change in the amount of smoking is a larger percentage change and implies a larger price elasticity. For example, in the sample analyzed by Lewit, Coate and Grossman (1981) the youth smoking participation rate is about 13 percent while the adult smoking participation rate is at least twice as high (depending upon the time period). So even if a given price increase reduces youth smoking participation from 13 percent to 12 percent and reduces adult smoking participation from 25 percent to 24 percent, the implied youth price elasticity is twice as large as the adult price elasticity.

The only study in Table 2 that focuses on starting behavior is Douglas and Hariharan (1994). The results of Douglas (1998) are also relevant, but do not fit the summary format of Table 2. Both studies estimate hazard models using retrospective data from adults on the age of smoking onset. Neither study finds that the decision to start smoking is statistically significantly related to the cigarette prices the respondents faced as teenagers. Douglas and Hariharan (1994) stress that their findings on starting smoking "do not contradict the notion that cigarette price may significantly affect decisions on quitting and levels of consumption." In his further analysis, Douglas (1998) in fact finds that higher future cigarette prices increase adult quitting behavior. A limitation of both studies is that state of residence at age 18 was not available, so prices are matched to respondents using the state of residence at the time of the interviews, when the average respondent was 32 to 34 years old. This causes an errors in variables problem that biases their estimates toward finding no effect of prices on teen starting behavior.

In reviewing the studies listed in Table 2 as a group, at least three general limitations stand out: (i) There are more studies of cigarette demand of young adults than of demand by youth under the age of 18; (ii) Nearly all the studies are based on cross-sectional data rather than longitudinal or panel data; and (iii) None of these studies estimates cigarette demand functions for high school dropouts. The Youth Risk Behavior Survey (YRBS) shows dramatic differences in the smoking behavior by dropout status: about 1/3 of out-of-school youth report smoking cigarettes during the 30 days preceding the survey, compared to only 1/5 of in-school youth (USDHHS 1994b). Clearly, including dropouts is of fundamental importance in understanding youth smoking behavior. Moreover, (ii) and (iii) are inherent limitations that can not be easily remedied by re-specifying demand functions using the same data or most other available data sets.

Future analyses of the MTF data, along the lines of Chaloupka and Grossman (1996), can provide additional cross-sectional estimates of the price-elasticity of demand by 8th, 10th, and 12th grade students. However, neither MTF or YRBS provide longitudinal data on youth smoking, and as a school-based survey the MTF can not include dropouts.[6] Lack of longitudinal data makes inferences regarding the determinants of the onset of smoking problematic.

For the analysis of policy proposals that involve large cigarette tax or price hikes, all U.S. studies share another limitation: Price increases of this size have never been observed in this country. Other countries' experiences may shed some light on cigarette demand at much higher prices. The Canadian experience has received attention, because the real price per pack more than doubled between 1980 and 1990. Although the available data on youth smoking behavior are incomplete, the apparent decline in youth smoking rates over this period is consistent with a substantial price elasticity (Ferrence et al. 1991, GAO 1998). With these aggregate data, however, it is hard to disentangle the effects of price increases on youth smoking from the effects of general time trends, and from the effects of other anti-smoking policies introduced at about the same time. Most notably, in 1985 Canada launched a $1.5 million anti-smoking campaign aimed at youth. Compared to studies using national aggregate data, studies using U.S. microdata have more ability to isolate tax or price effects, but may not be very informative about the effects of very large tax or price hikes.

3. DATA AND EMPIRICAL APPROACH

The main objective our study is to use cross-sectional and panel data from the NELS:88 survey to examine the responsiveness of youth cigarette consumption to cigarette taxes or prices and other socioeconomic factors. Following a brief description of the NELS:88 data set, we describe the alternative econometric specifications to be estimated: (i) cross-sectional demand functions with contemporaneous taxes; and (ii) smoking onset functions. The description of the first specification also contains a discussion of the explanatory variables that are common to both

[6]There are MTF panels that use the MTF 12th grade cross section for the baseline survey with follow-up surveys of the young adults into their 20s. Tauras and Chaloupka (1999) report preliminary results of a study of cigarette smoking in young adults using these data. But these MTF panels do not include youth, i.e. children between the ages of 12 and 18. It is our understanding that for a limited period of time the MTF 8th grade and 10th grade respondents were also followed, but this has been discontinued. To our knowledge these 8^{th} or 10^{th} grade MTF panels have not yet been used for a longitudinal study of youth smoking.

specifications. This section concludes with a brief discussion of descriptive statistics from the data, to set the stage for the results from the econometric models presented in section 4.

Data

The National Education Longitudinal Study of 1988 (NELS:88) is a large-scale study which provides a variety of data regarding American 8th graders as they move through the school system and into early adulthood. The study administered questionnaires and subject-specific achievement tests to 24,599 eighth graders in more than 1,000 public and private schools in the spring of 1988. At that time, data were also collected from the student respondents' parents, teachers, and school principals. These data take the form of separate files that allow researchers to merge relevant information to any given student in the main file of the study. Students are from diverse racial, sex, and ethnic backgrounds, with oversampling of certain groups.

NELS:88 continued with a second collection of information from these students in the spring of 1990 when most were high school sophomores, as well as a third collection when most were seniors. By design, NELS:88 staff re-sampled a subset of 21,474 members of the original 8th grade (1988) sample. Of the potential re-sample, 17,424 or 81.1 percent were successfully re-interviewed in 1990. In 1992, 16,489 individuals or 94.6 percent of those in both the 8th (1988) and 10th grade (1990) surveys were successfully re-interviewed. This last number represents the potential sample of students available in all three surveys. We focus on this group for several reasons. Most obviously, it allows us to study smoking onset. In addition, as described below in more detail, it allows us to measure eventual school dropout status. Finally, by focusing on individuals present in all three cross sections we estimate the cross-sectional models and the smoking onset model on about the same samples, allowing more direct comparisons.

There are several additional sample restrictions that vary somewhat year by year. Using the 12th grade survey to illustrate these restrictions, restricting the sample to those to whom we can assign state of residence reduces the sample to 16,047. Further restricting the sample to those with smoking information yields 15,108 individuals. Additional restrictions due to missing data on other control variables reduces our 12th grade cross-sectional sample to 12,889 individuals, so we use about 85 percent of the potential sample with information on smoking and state residence.[7]

[7] We exploit information in different data files of the NELS:88 data set to fill in missing information where possible. Missing information is mainly an issue for family background variables, such as family income, family structure, parental education and occupation, and so on. For most students these variables are measured as of the 8th grade survey year (1988) using responses to the student questionnaires. Many of these same questions

A probit model shows no statistically significant relationships between smoking status or taxes and the probability an observation is excluded because of this last sample restriction (missing information on control variables).[8] Somewhat larger samples are available for the 8th and 10th grade cross sections, because there was less missing information on smoking.

Cross-Sectional Demand Functions

In the first step of our analysis, we estimate benchmark models that can be directly compared to previous econometric studies of the price elasticity of adult and youth smoking. In the models described by equations (1), (2) and (3) the three years of data from NELS:88 are treated as three separate cross-sections. In these equations the subscript i refers to the individual, the subscript j refers to the state the individual resides in, and the 8th, 10th or 12th subscript refers to the grade.[9] Student response variables have three subscripts. Variables that vary only at the state level have only a j subscript. Vectors of variables are italicized. The models to be estimated are of the general form:

(1) $\text{Cigarette Use}_{ij,12th} = a_o + a_1 \text{ Cigarette Tax}_{j,12th} + a_2 \textit{ Tobacco Regulations}_j + a_3 \textit{ Student Control Variables}_{ij,} + a_4 \textit{ Parent Control Variables}_{ij,} + a_5 \text{ Dropout}_{ij,12th} + e_{ij,12th}$

(2) $\text{Cigarette Use}_{ij,10th} = b_o + b_1 \text{ Cigarette Tax}_{j,10th} + b_2 \textit{ Tobacco Regulations}_j + b_3 \textit{ Student Control Variables}_{ij,} + b_4 \textit{ Parent Control Variables}_{ij,} + b_5 \text{ Dropout}_{is,10th} + e_{ij,10th}$

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were also included in the parent questionnaires in 1988, and were repeated in the 12th grade (1992) student questionnaires. While there is more family income information missing in the 12th grade student file than in the 8th grade file, some of the students who failed to provide the information in 8th grade did so in 12th grade. We therefore use information from these other data files to fill in the missing information in the 8th grade student file. For some measures, such as number of older siblings or parental education, the date of measurement (8th or 12th grade) is unlikely to be relevant. For other variables, notably family income, we are essentially using the family income category when the student was in 12th grade to proxy for family income category when the student was in 8th grade. If a continuous measure of income were available, it would be natural to account for inflation when using 12th grade family income to proxy for 8th grade family income. We do not make this adjustment for the categorical measures of income, however, because the width of the income categories substantially exceeds nominal income growth between 1988 and 1992.

[8]Results available upon request. The sample for the probit model consists of the observations with complete information on smoking status, state of residence, and a short list of other explanatory variables. The dependent variable takes a value of one if the observation has missing information on other control variables and zero otherwise. Statistically significant results indicate that missing information on the control variables is more likely for high school dropouts, blacks, and students from the northeast.

[9]For ease of exposition, the demand functions for the 1990 and 1992 cross sections will usually be referred to as the 10th grade and 12th grade equations. This terminology is not precise, because the 1990 and 1992 cross sections include high school dropouts, and some students may skip or miss a grade.

(3) $\text{Cigarette Use}_{ij,8th} = c_o + c_1 \text{ Cigarette Tax}_{j,8th} + c_2 \textit{ Tobacco Regulations}_j + c_3 \textit{ Student Control Variables}_{ij,} + c_4 \textit{ Parent Control Variables}_{ij,} + c_5 \text{ Eventual Dropout}_{ij,8th} + e_{ij,8th}$

where a_i's, b_i's and c_i's are parameters to be estimated and the $e_{ij,}$ terms are normally distributed error terms.

The dependent variable for equations (1), (2), and (3) are based on the responses to the question: *How many cigarettes do you currently smoke in a day?* The possible response categories were 0, 1-5, 6-10, 11-40, and 40 or more.[10] The responses are treated as categorical variables to be used in an ordered response model. The right-hand-side variables include the cigarette taxes or prices in the state in which the student resides, two vectors of different types of control variables, and measures of dropout status. Each of these are described below.

With restricted use data (attained through special licensure with the National Center for Education Statistics) we are able to link individual NELS:88 respondents to the states in which they reside. This allows us to examine the impact of state excise taxes, prices and state tobacco control regulations on youth smoking. We merged data on state excise taxes and prices in 1988, 1990, and 1992 from the Tobacco Institute (1993) with the NELS:88 data.[11] When states changed tax rates during the year, we used the tax rate in effect at the time the NELS:88 survey was administered; prices are measured in November of each year. For 1990 and 1992 we use the average prices calculated exclusive of generic brand cigarettes, because almost all youth smokers purchase premium brands (96 percent of youth in the sample of Cummings *et al.* 1997). For 1988 only the average price inclusive of generics is available from the Tobacco Institute. However, Cummings *et al.* (1997) report that only 6.6 percent of adult smokers in their sample purchased generic brands in 1988, compared to 24.5 percent in 1992. With such a low market share for generics, the average price data for 1988 are probably not seriously distorted by their inclusion.

A potential problem with our measures is that residents of states with high cigarette excise taxes may be able to purchase cigarettes from nearby states with lower tax rates (Saba *et al.*

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[10] In the 10th and 12th grade surveys, <1 cigarette a day was a possible response. For the purposes of analysis this category was combined with the 1-5 category, to be consistent with the 8th grade survey.

[11] We use nominal taxes and prices and do not adjust for inflation. In the cross-sectional models adjusting for national inflation scales all state tax rates equally and so will have no meaningful effect on the estimated parameter on the tax variable. It might be more important to adjust for differential inflation rates across states. However, to the extent state-specific cost of living indices are unreliable, making this adjustment will introduce more noise than information about relative prices.

1995). If this avenue is open to youths, our estimated elasticities will be biased towards zero. However, although cross-border purchases of cigarettes appear to be significant for adults, they should be much less common for youths, many of whom will not be licensed drivers, have access to a car, or make regular trips out of state. The empirical results of Lewit, Coate and Grossman (1981) lend additional support to the argument that border crossing can be neglected when estimating youth smoking demand.[12]

To more fully capture the policy environment, some specifications reported below include a set of three measures of smoking-related state legislation as explanatory variables in the smoking demand functions. These variables are based on information from Jacobson and Wasserman (1997). The first is an index of restrictions on smoking in public places such as workplaces and restaurants. The second is an index of restrictions specific to youth smoking, including limitations on cigarette vending machines and licensing requirements for cigarette vendors. The third variable indicates if the state had passed legislation banning discrimination against smokers. Similar variables have been used in some recent studies (e.g. Wasserman *et al.* 1991, Chaloupka and Grossman 1996) but not in others (e.g. Evans and Farrelly 1995, Evans and Huang 1998). Therefore, we present the results of both specifications for comparison purposes.

A second goal of our study is to explore the relationship between schooling and smoking. To accomplish this, equations (1), (2), and (3) include variables that control for high school dropout status. Because this is a unique aspect of the NELS:88 data, it is useful to describe how high school dropouts were followed. First, NELS:88 staff contacted the sampled schools to verify the enrollment status of every original sample member. If the school identified a student as having dropped out, NELS:88 staff attempted to confirm this information directly with the sample member. If the sample member could not be contacted, staff attempted to corroborate this information with an adult member of the sampled student's household. When successful in reaching these dropouts, staff administered dropout questionnaires and cognitive tests during off-campus administrative sessions.[13] Dropouts attending these sessions were reimbursed for travel

[12] Lewit, Coate and Grossman (1981) include the difference between own-state price and low price in a bordering state as an explanatory variable. This variable is estimated to have a statistically insignificant effect on youth smoking, and the estimated effect of own-state price is not altered by its inclusion.

[13] When needed, the staff administered the appropriate survey and tests in one-on-one sessions. The staff strived to procure sites for these sessions that closely replicated the surroundings of the in-school surveying of non-dropouts. Further, a number of cases were completed over the telephone or by mail. Most of these involved dropouts who were institutionalized.

expenses at the end of the sessions. Overall, 88 percent of these identified as dropouts completed a questionnaire, providing well over a thousand observations on high school dropouts.[14]

The panel nature of the data allow us to specify equations that help disentangle whether being a high school dropout leads to higher propensities to smoke or if instead unobserved heterogeneity is responsible for the strong correlation between dropout status and cigarette consumption. To disentangle these effects, the equation for 8th graders (equation (3)) includes a dummy variable for whether the individual eventually drops out of high school. Since none of the students in 8th grade have, as yet, dropped out of high school, being a dropout cannot contribute to these smoking propensities. Similarly, the equation for 10th graders (equation (2)) includes a variable indicating whether the individual had already dropped out of high school, and another indicating whether he or she will eventually drop out. For obvious reasons, the equation for 12th graders (equation (1)) controls only for whether the individual is a high school dropout.

One of the major advantages of the NELS:88 data is the availability of a rich set of measures of socioeconomic status, school, and parent characteristics. The variables included in *Student Control Variables* are race, sex, rural residence, region, family size, religion and academic achievement scores. *Parent control variables* include educational attainment of both parents, occupation, family income, and marital status. In most cases the student and parent control variables are measured when the student was in 8th grade (but see footnote 7 above).

The demand functions given by equations (1), (2), and (3) do not incorporate habit-formation or addiction. In a habit-formation or myopic addiction model of cigarette demand, current consumption is a function of past consumption (Houthakker and Taylor 1970). The rational addiction model implies that current demand is a function of both past and future consumption (Becker, Grossman and Murphy 1991). Although addiction is undoubtedly an important feature of adult cigarette demand, it is not so clearly important here. Youth in the NELS:88 data typically do not have high levels of past consumption; in the terminology of Becker and Murphy (1988), they do not have large stocks of addictive capital. For example, in a habit-formation version of the 10th grade demand function only 5 percent of the sample would have a

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[14] Of those who completed a questionnaire, 71.1 percent received a full version of the questionnaire and the remaining 28.9 percent completed a questionnaire that was modified slightly for telephone administration. Of those completing a full version of the questionnaire, 56.7 percent completed the associated cognitive tests. Those who had to be surveyed by telephone did not complete these tests. To avoid losing observations with missing test scores, we mainly rely on the 8th grade cognitive test scores, which are available for most NELS:88 respondents. Filling in missing information on 8th grade test scores with information on 10th grade test scores further increases the available sample for analysis.

positive level of past consumption. Moreover, empirical tests of the rational addiction model concern the steady state behavior of consumers with ongoing addictions. In contrast, the behavior considered here is the beginning of an addiction. While developing an empirical model of the beginning of a rational addiction is an interesting avenue for future research, the simpler specification we adopt seems an appropriate step at this time.

Smoking Onset

The second and third specifications focus on the determinants of the onset of smoking. As indicated in the introduction, a large number of students begin to smoke between 8th and 12th grade. In this section we develop empirical specifications based on the panel nature of the NELS:88 data to identify the key determinants of the onset of smoking and the role of cigarette taxes or prices in preventing onset. In the first empirical model to investigate the onset of smoking we limit our sample to those that are not smoking in the 8th grade (almost 95 percent of the available sample). The onset of smoking is then modeled in a parallel fashion to the ordered probability model estimated from the cross-sectional data.[15] The dependent variable is a categorical variable defined as follows:

$Onset_{ij}$ = 0 if student i residing in state j did not smoke any cigarettes in 8th grade and did not smoke any cigarettes in 12th grade.

= 1 if student i residing in state j did not smoke any cigarettes in 8th grade and smoked between 1 and 5 cigarettes per day in the 12th grade.

= 2 if student i residing in state j did not smoke any cigarettes in 8th grade and smoked between 6 and 10 cigarettes per day in the 12th grade.

= 3 if student i residing in state j did not smoke any cigarettes in 8th grade and smoked between 11 cigarettes and 40 cigarettes per day in 12th grade.

= 4 if student i residing in state j did not smoke any cigarettes in 8th grade and smoked 2 or more packs of cigarettes in 12th grade.

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[15]As an alternative to our approach, Maddala (1987) discusses estimation of fixed and random effects models with qualitative dependent variables. For example, a fixed effects specification would be an attractive way to control for unobservable person-specific heterogeneity. Considering the binary dependent variable smoke/ not smoke, we could apply the fixed effects logit model discussed by Maddala. This approach only uses observations of starters (0 in 8th grade, 1 in 12th grade) and quitters (1,0) and discards observations of people who never change states (0,0 or 1,1) because they contribute zero to the likelihood function. However, there are very few quitters in the NELS:88 data so there would be extremely little variation in the dependent variable. Where the fixed effect logit model compares starters to quitters, our onset models compare starters to non-starters.

The following equation is estimated for this definition of smoking onset:

(4) $\text{Onset}_{ij} = d_o + d_1$ (Cigarette $\text{Tax}_{j,12th}$ - Cigarette $\text{Tax}_{j,8th}$) + d_2 *Tobacco Regulations*$_j$ + d_3*Student Control Variables*$_{ij,8th}$ + d_4 *Parent Control Variables*$_{ij,8th}$ + d_5 $\text{dropout}_{ij,12th}$ + e_{ij}

This specification of the onset function can be motivated by considering the first difference of the cross-sectional 8th grade and 12th grade demand functions (equations (1) and (3)). In general, smoking onset could be a function of both the levels and the changes of the explanatory variables.[16] Below we discuss results from alternative versions of equation (4) that capture the effects of both the levels and changes in cigarette taxes or prices.

Descriptive Statistics

Before turning to the econometric results, Table 3 illustrates the significant variation in cigarette taxes across the 50 states and over the time period considered. The time and cross-sectional variation allows us to examine changes in consumption by the same individuals within states as states change their tax policies, and differences in individual consumption across states with different tax rates. The cross-sectional variation in tax rates is very large. For example, in 1988 North Carolina had a cigarette tax of only 2 cents per pack whereas Minnesota had a cigarette tax of 38 cents per pack; 1988 cigarette prices varied from a low of $1.04 per pack to a high of $1.53 per pack. The data also indicate that cigarette tax rates and prices changed dramatically between 1988 and 1992. For example, in New York the tax rate rose from 21 cents per pack in 1988 to 39 cents per pack in 1992. From Table 4, the average state excise tax on cigarettes rose from approximately 19 cents a pack in 1988 to approximately 27 cents a pack in 1992, a rise of 40 percent. Cigarette prices rose even more on average, from about $1.30 a pack to $2.02 a pack. The rate of cigarette tax and price increases exceeded the general inflation rate, so on average students faced higher real taxes and prices when they were in 12th grade compared to when they were in 8th grade.

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[16]To derive equation (4) explicitly requires the assumption that the coefficients on tax in equations (1) and (3) are the same, i.e. $a_1 = c_1$. We specify an alternative onset equation that does not make this assumption, in which case smoking onset can be expressed as a function of both the 8th grade tax and the change in tax between 8th and 12th grade. Assuming the coefficients on the tobacco regulation, student, and parent control variables in equations (1) and (3) are the same, i.e. $a_2 = c_2$, $a_3 = c_3$, $a_4 = c_4$ and $a_5 = c_5$, implies smoking onset should also be a function of changes in these variables only. However, these variables show little variation between 8th and 12th grade. Instead, we specify smoking onset as a function of the levels of these variables, which is consistent with the assumption that the coefficients of the demand functions (1) and (3) differ.

Table 3 also shows the significant increases in cigarette consumption in all states during the high school years. From Table 4, for the samples used in the econometric analysis the average smoking participation rate rises from 5.2 in 1988 to 23.6 percent by 1992. Table 4 also provides descriptive statistics for some of the other key variables used in the analysis.

4. CROSS-SECTIONAL DEMAND FUNCTIONS

Tables 5 and 6 provide the results from the benchmark models of youth smoking behavior estimated for the 8th, 10th, and 12th grade cross sections. These cross sections are treated separately so that the coefficients on the right hand side variables are not restricted to be the same in each year. For each cross section, results are presented from four models. Models (1) and (2) estimate the relationship between youth smoking and cigarette taxes, the directly policy-manipulable variable. Model (1) does not include measures of smoking-related state legislation, while model (2) includes these measures. Models (3) and (4) use cigarette prices instead of taxes, without and with the measures of legislation, respectively. Using prices instead of taxes makes the specification more similar to standard demand models and most previous studies.

In both models (1) and (2) cigarette taxes have negative and statistically significant effects on cigarette consumption in the 8th, 10th, and 12th grade cross sections (see Table 5). In the 8th grade and 10th grade cross sections the estimated effects of taxes are not very sensitive to the inclusion of the three smoking legislation variables. In the 12th grade cross section inclusion of these variables reduces the estimated coefficient by about one third, but it remains statistically significant. The same patterns are apparent in Table 6, when cigarette prices are used instead of taxes, but the estimated coefficients are smaller. Nevertheless, the estimated effects of prices are statistically significant in all of the cross-sectional models except model (4).

To explore the size of the tax and price effects in the cross-sectional models, Table 7 shows the predicted impacts of alternative tax or price increases on youth smoking participation rates in 8th, 10th, and 12.[17] As noted earlier, it has been suggested that younger students' smoking responds more to tax or price changes than will older students' or adults'. As reported

[17]The first step is to calculate the predicted probability that each individual in the sample smokes, Φ_i, given by $\Phi(\mu - X_i \beta)$ where Φ is the cumulative distribution function for the standard normal, μ is the estimated first threshhold in the ordered probit models, X_i is a vector of the individual's values for the explanatory variables, and β is the vector of estimated slope parameters. The average of Φ_i in the samples are used as the predictions of baseline smoking participation rates. To predict the impact of tax increases, the next step re-calculates Φ_i, replacing each individual's observed tax rate with the observed tax rate plus either $0.20 or $1.50. Averaging the re-calculated Φ_i s provides the predicted smoking participation rates under the two tax scenarios. An advantage of this method is that predicted smoking participation rates are constrained to be between zero and 100 percent.

in Table 7, from model (1) a \$0.20 tax increase in 8th grade decreases predicted smoking participation by about 1.5 percentage points, while the same size tax increase decreases predicted smoking participation by about 2.6 percentage points in 10th grade and by 2.3 percentage points in 12th grade. The \$1.50 tax increase decreases predicted smoking participation by 5 percentage points in 8th grade, 13.4 percentage points in 10th grade and 13.9 percentage points in 12th grade. Thus in terms of the absolute magnitudes of the changes in predicted smoking participation, our results do not show that younger students are more tax- or price-responsive.[18] By way of further comparison, with similar calculations Chaloupka and Grossman's (1996) model predicts that the \$0.20 and \$1.50 tax increases would cause smoking participation rates to drop by 1.2 and 8.1 percentage points, respectively.[19]

Table 7 also reports the price elasticities of smoking participation that are implied by the changes in predicted smoking participation rates. From models (1) and (2) we compute tax elasticities of smoking participation as the percentage change in the predicted probability that an individual smokes (i.e., is not in the 0 category) associated with a percentage increase in the cigarette tax. If taxes are passed through to prices at a rate α, the relationship between the tax elasticity, η_{TAX} and the price elasticity η_{PRICE}, is given by $\eta_{PRICE} = \eta_{TAX} \times (\alpha\, T/P)^{-1}$. The reported price elasticities for models (1) and (2) in Table 7 are calculated in this way assuming $\alpha = 1$; models (3) and (4) yield price-elasticities directly.[20]

The estimated elasticities over a \$1.50 tax or price increase are smaller than the corresponding elasticities over a \$0.20 increase because of the inherent nonlinearity of a probability model of smoking participation. Failing to recognize this and using point elasticities

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[18] Note that the \$1.50 increase is predicted to drive 8th grade smoking participation to nearly zero. The constraint that smoking participation can not fall below zero constrains the size of the predicted impact of the tax or price increase.

[19] Instead of calculating Φ_i for each individual in Chaloupka and Grossman's sample, we calculated $\Phi(X\beta)$ at the sample mean values for the vector of X variables to predict smoking participation at baseline to be 0.23. This compares to the sample proportion of 0.229 reported by Chaloupka and Grossman. Replacing the average price with the average price plus \$0.20 or \$1.50 yields predicted smoking participation rates of 0.218 and 0.149. Note that this method predicts that a \$1.50 tax increase causes the smoking participation rate to decrease by about 35 percent (8.1 percentage points from a baseline of 23 percent), instead of the 51 percent decrease predicted by Chaloupka's extrapolation referenced in footnote 2.

[20] To provide more details: for models (1) and (2) we first compute $\eta_{TAX} = (\Delta S/\Delta T)(T/S)$ where ΔS is the predicted change in the smoking participation rate for the assumed ΔT (\$0.20 or \$1.50) and T and S are the average tax and smoking participation rate for the relevant samples (8th, 10th, or 12th grade cross-sections). To obtain η_{PRICE}, we then multiply η_{TAX} by $(T/P)^{-1}$ where P is the sample average price (P). For models (3) and (4) we similarly calculate $\eta_{PRICE} = (\Delta S/\Delta P)(P/S)$.

to predict the impact of large changes in taxes or prices can provide misleading policy implications. For example, from model (1) for the 8th grade cross section the elasticity over a \$0.20 tax increase is -1.875, but this falls to -0.825 over a \$1.50 tax increase. Over the smaller tax or price increase, the implied elasticities from the 12th grade cross sections are comparable to many previous studies, ranging from -0.29 to -0.98.

Models (3) and (4) that use prices yield smaller price elasticities than the implied elasticities from models (1) and (2) that use taxes. This is partly because the higher implied price elasticities from models (1) and (2) are based on the assumption that taxes are passed through to prices at a rate $\alpha = 1$. Several recent studies that suggest that taxes are passed through at a rate of $\alpha = 1.1$ or 1.2 (Sung *et al.* 1994, Keeler *et al.* 1996). If the true pass-through rate α is around this size, the implied price elasticities from the tax models are 10 to 20 percent smaller than those reported. However, a pass-through rate of about this size does not fully reconcile the differences between the tax and price models.

As an alternative specification to the ordered probit model, we re-estimated the 8th, 10th, and 12th grade cross-sectional demand functions using a two part model (Duan *et al.* 1982). The first part is a probit model of smoking participation. The second part is a model of the amount smoked, conditional on participation. Following Chaloupka and Grossman (1996) the second part can be estimated using ordinary least squares, after creating a "continuous" measure of smoking using the midpoints of the response categories. The results from this specification (available upon request) are qualitatively and quantitatively very similar to those reported in Tables 5 and 6. In general, cigarette taxes or prices are estimated to have negative and statistically significant effects on both smoking participation and on the demand for cigarettes conditional on participation.

5. SMOKING ONSET

Impact of Taxes and Prices on Smoking Onset

In contrast to the benchmark cross-sectional results, the results reported in most of the models in Table 8 suggest that cigarette taxes or prices are not important determinants of the onset of smoking between 8th and 12th grade. Four specifications are reported in Table 8. The first two specifications model smoking onset as a function of the change in taxes between 8th and 12th grade. The third and fourth specification model smoking onset as a function of the change in prices between 8th and 12th grade. As in the cross-sectional models, some specifications (models 2 and 4) include measures of smoking-related state legislation as additional explanatory variables.

The results in Table 8 indicate that changes in cigarette prices are insignificant determinants of smoking onset whether or not other state smoking regulations are controlled for. The coefficient on the change in taxes is marginally significant (*i.e.* at the 90 but not the 95 percent confidence level) without these regulation measures but drops markedly and loses statistical significance when they are included in the specification. In practical terms, the onset models (3) and (4) that use prices predict that a $0.20 price increase would leave the smoking onset rate virtually unchanged (see Table 9). Even a $1.50 price increase is predicted to reduce smoking onset by as little as 0.6 percentage point (model 4) and at most by 3 percentage points (model 3). Only model (1), the specification with taxes and without the smoking regulation measures, predicts that tax increases would substantially decrease the smoking onset rate.

The results of the onset models may be misleading if tax or price increases have different impacts on the onset into light versus heavy smoking. The onset into light smoking may not respond much to higher taxes or prices because light smokers' cigarette expenditures are low; in fact, about 75 percent of occasional and light smokers "borrow" most of the cigarettes they smoke from friends (Emery *et al.* 1998). In addition, onset into heavy smoking is arguably the most policy-relevant outcome because of the addiction and health consequences. To explore this issue, we re-define the dependent variable to measure onset from no smoking in 8^{th} grade into heavy smoking (more than one half a pack a day) by 12^{th} grade. This different definition of smoking onset treats light and moderate smokers in 12^{th} grade as nonsmokers, so a probit model replaces the ordered probit model. The results presented in Table 10 show that changes in taxes and prices are not important determinants of the onset into heavy smoking. The estimated coefficients are small, positive, and statistically insignificant. It is interesting to note that by and large other variables such as dropout status, race, and student ability remain statistically significant determinants of the onset into heavy smoking.

We further explored the sensitivity of the estimated effects of taxes or prices to additional specifications of the smoking onset models. To conserve space the results are not presented here but are available upon request. In one set of models, the level of 8^{th} grade (1988) prices or taxes is added as an explanatory variable in the ordered probability models of smoking onset. Another specification explored is to estimate two part models of smoking onset (instead of ordered probit). In yet another set of models, we expanded the sample of analysis by using conditional mean imputation to fill in information for observations with missing values for control variables (DeCicca, Kenkel and Mathios 1998). The patterns of results from these alternative specifications are similar to those reported.

In sum, the pattern of results from a variety of specifications suggests that cigarette taxes and prices are not strongly related the onset of smoking between 8th and 12th grade. This is especially notable given that in most specifications of the 12th grade cross-sectional models cigarette taxes and prices are related to youth smoking. While the onset and the 12th grade cross-sectional models yield diverging tax and price effects, they yield very similar estimates of the influence of the other determinants of smoking behavior. Conceptually, the main difference between the onset and 12th grade cross-sectional models is that students who smoked in 8th grade are not included in the sample used to estimate the onset model.[21] If there were no smokers in 8th grade, the dependent variable in the smoking onset equation would be identical to the dependent variable in the 12th grade cross-sectional demand function. When the 12th grade cross-sectional model is estimated with 8th grade smokers eliminated from the sample, the estimated tax and price effects in the 12th grade cross-sectional models become similar to the onset-models.

Bias from Unobservable Heterogeneity

One explanation for the difference between the onset and cross-sectional results is that unobservable heterogeneity across states results in biased estimates of tax and price responsiveness in the cross-sectional models. For example, cigarette taxes and prices may be high in states with strong anti-smoking sentiment, so the estimated effects of taxes or prices reflect the influence of anti-smoking sentiment on youth smoking decisions. If early smoking onset decisions are particularly influenced by cultural attitudes towards smoking, eliminating the 8th grade smokers from our sample reduces this source of bias. To explore whether unobservable heterogeneity is the likely explanation we utilize several approaches.

To begin to explore this explanation, we examine students in the NELS:88 data set from the three major tobacco producing states, North Carolina, Kentucky, and Virginia, where there may be less stigma attached to smoking. Cummings *et al.* (1991) report the results of surveys of public attitudes about tobacco control policies conducted in 10 U.S. communities in 1989. Respondents from Raleigh, North Carolina -- the only community sampled in a tobacco producing

[21] Students whose smoking status in 8th grade is unknown are also not included in the onset model but could be included in the 12th grade cross-sectional model if they provided the necessary information.

state -- were much less likely to favor regulating minors' access to tobacco or to favor regulating advertising, promotion, and sale of tobacco products generally. North Carolina and the other tobacco producing states also tax tobacco at the lowest rates in the nation. Students residing in the three tobacco-producing states account for 7 percent of our 8th grade sample but 11.8 percent of the 8th grade smokers. This provides suggestive evidence that 8th grade smokers come predominantly from states where smoking is viewed more favorably and taxes and prices are low, suggesting that their inclusion in the 12th grade cross section biases estimates of tax and price effects away from zero.

Moreover, the estimated tax and price effects in the cross-sectional models are sensitive to restricting the samples to students not in the three major tobacco producing states. (Complete results available upon request). For example, in the 8th grade model (1) the estimated coefficient on taxes is reduced from -0.0090 to -0.0036 and is no longer statistically significant; in the corresponding 8th grade model (3) the estimated coefficient on prices is reduced from -0.0041 to -0.0024 and again loses statistical significance. The estimated effects of taxes or prices in the 8th grade cross-sectional models (2) and (4) that include the measures of state smoking regulations are also sensitive, but somewhat less so, to this sample restriction. The estimated effects of taxes or prices in the 10th and 12th grade models are less sensitive to the sample restriction than are the 8th grade models. This is consistent with the argument that the 8th grade models are subject to more heterogeneity bias because early onset of smoking is particularly influenced by anti-smoking sentiment.

Of course, changes in taxes may also be correlated with anti-smoking sentiment or other unobservable influences, implying that our estimates of the effects of taxes or prices on smoking onset may also be subject to heterogeneity bias. For example, effective January 1989 California increased the cigarette tax from 10 cents to 35 cents per pack and earmarked 20 percent of the revenues raised for other anti-smoking programs. A multimedia campaign began in April 1990 and expenditures were heaviest between then and March 1991. By exploiting differences in the timing of the tax increase and these expenditures, Hu, Sung and Keeler (1995) estimate that both the tax policy and the multimedia campaign were effective in reducing aggregate cigarette sales. Because aggregate sales are dominated by adults' smoking decisions, this study can not estimate the effect of the multimedia campaign on youth smoking in California. But to the extent it and other unmeasured state policies influence youth smoking, the estimates in Table 8 are potentially biased away from zero towards finding negative tax and price effects. Focusing on the effects of changes in taxes or prices on smoking onset reduces this source of bias but does not eliminate it.

In fact, the pattern of results across specifications reported in Table 8 provides evidence that heterogeneity bias remains in the models of smoking onset. Including the measures of smoking-related legislation substantially reduces the estimated effects of taxes or prices on smoking onset. In addition, statistically significant results indicate that smoking onset is higher in states that had passed anti-discrimination legislation. The size of the effects are modest, corresponding to about a 2 percentage point higher rate of smoking onset in states with anti-discrimination legislation. The discrimination prohibited by this legislation involves actions like basing employment decisions on tobacco use, and so seems unlikely to be a very important direct influence on youth smoking. But assuming that states with the strongest anti-smoking sentiment were the least likely to pass these laws, these results are consistent with the argument that anti-smoking sentiment plays a role in youth smoking decisions. In a similar vein, Wasserman *et al* (1991) report that estimates of the price responsiveness of adult smoking are sensitive to the inclusion of an index of state smoking regulations, and argue to the extent the index proxies for unobserved differences in anti-smoking sentiment its inclusion reduces the omitted variable bias in the estimated price coefficient.

Discrete Time Hazard Model with State Fixed Effects

An alternative approach to examining onset behavior, and one that can be used to explicitly account for unobserved heterogeneity, is a discrete time hazard model.[22] In this approach the sample consists of each individual who is at risk of the event occurrence (beginning to smoke) at each point in time. In the NELS:88 sample, it is assumed that all 8th graders are assumed to be at risk of starting to smoke. Only about 5% actually started to smoke at this time and these individuals are no longer at risk of starting to smoke after 8th grade.[23] All others are still at risk in the 10th grade and thus are included as another observation in the sample. Finally, all those who did not start to smoke in the 10th grade are still at risk in the 12th grade and continue

[22] See Allison (1984) for details about the discrete hazard model.

[23] Quitting behavior is not considered in this model in part because it is such a rare event in the NELS88 data. Conceptually it is possible for an 8th grade smoker to quit by the 10th grade and be at risk again for starting to smoke in the 12th grade.

to contribute to the sample. At the end of each wave of data the risk set is diminished by the number who experienced the event during that period.

The dependent variable in this model is the hazard rate, which is the probability that an event will occur at a particular time to a particular individual, given that the individual is still at risk at that time. This probability is modeled as a probit and the right hand side variables are identical to those included in the onset model (equation 4), augmented by dummy variables that permit the hazard rate to change over time. This is especially important because of the large increase in the hazard rate that occurs between 8th and 12th grade.

The discrete time hazard model has several advantages. First, there is no need to omit those 8th graders who are smoking in 8th grade.[24] Second, compared with the onset model of equation (4), 10th grade information is utilized in estimation of onset behavior. Third, and most importantly, having multiple observations on tax or price in the same state allows the use of state fixed effects to account for unobserved heterogeneity. In the previous model, represented by equation (4), all observations in a particular state are assigned the same values of (Cigarette $Tax_{j,12th}$ - Cigarette $Tax_{j,8th}$). This eliminates the possibility of using within state variation in taxes to identify the relationship between taxes and smoking onset. The discrete time hazard model includes information on taxes or prices in 8th grade, 10th grade, and 12th grade. This provides three observations on taxes within a state allowing for state fixed effects. If cross-sectional variation in taxes reflect unobserved heterogeneity the coefficients on taxes and prices should change significantly once state fixed effects are included in the discrete time hazard model.

The results of the discrete time hazard model, with and without state fixed effects, are presented in Table 11. Model 1 includes taxes on the right hand side whereas Model 2 includes prices.[25] The results are consistent with the hypothesis that relying on cross sectional variation yields estimates of tax or price effects on youth smoking that are subject to heterogeneity bias. When state fixed effects are not included in the hazard model, the coefficients on the tax and price variables are negative and significant. When state fixed effects are included, the coefficients on theses variables are no longer statistically significant. The coefficient on cigarette taxes becomes positive and insignificant. The coefficient on price remains negative but is much smaller in absolute value and no longer statistically significant. These results must, however, be interpreted

[24] Inclusion of 8th grade smokers reflects the hazard rate of smoking onset between some earlier grade and 8th grade. It should be noted that almost no one starts smoking before 6th grade.

[25] The price and tax variables are converted into constant dollars using the CPI index.

with caution since we only measure taxes and prices at three different time periods within a state. Moreover, in contrast with the onset model (equation 4) the discrete hazard model only considers whether starting behavior occurs and ignores variation in the quantity smoked.

Other Determinants of Cigarette Demand

The estimated demand functions show many of the expected systematic relationships between individual characteristics and youth smoking. Of particular interest is the evidence on the relationship between smoking and schooling. As reported in Table 8 high school dropout status has a strong influence on smoking onset between 8th and 12th grade. Even more interestingly, as reported in Table 5, the coefficients on the dummy variable indicating that the student eventually drops out of school are large and statistically significant in both the 8th and 10th grade cross-section models. This suggests that years before students actually drop out of high school, they already have significantly higher smoking propensities. One explanation is that the eventual dropout variable proxies for time preference: youth with high discount rates have higher propensities to smoke and to drop out. A similar explanation is that dropout and smoking propensities reflect an unobservable taste for deviant behavior. Of course, there may be other differences between students who drop out and students who remain in school. But the models control for many important factors including the student's math/reading ability, parents' income and education, and whether there was a disruption in the family like divorce. The strong impact of eventual dropout status even controlling for such factors reinforces the interpretation that it proxies for factors like time preference or a taste for deviancy. A somewhat different explanation is that youths who anticipate dropping out plan different lifetime income and health trajectories and make their smoking decisions accordingly: the costs of smoking in high school are lower for these youth compared to youth who plan to make larger investments in education.[26] In terms of other determinants of youth smoking, the results in Table 8 show that students that score higher on standardized tests of math and reading ability have lower smoking onset rates. One interpretation is that higher ability students smoke less because they have a better understanding of the eventual health consequences (Kenkel 1991, Viscusi 1992). Results for the complete list of explanatory variables (not reported but available upon request) reveal additional

[26]If smoking and schooling decisions are made simultaneously, eventual dropout status should be considered an endogenous explanatory variable in the demand functions. Estimating this simultaneous system is beyond the scope of this paper.

interesting patterns. Students with more highly educated fathers and students from intact families are less likely to smoke. All of these patterns suggest it may be useful to think of families investing in "smoking prevention" as part of child quality or human capital, because these same factors are also important determinants of other aspects of child quality (Becker 1981).

6. CONCLUSIONS

In this paper we use a rich panel data on adolescent smoking to develop new estimates of the likely impact of cigarette excise tax or price increases. Our strategy is to estimate models that are comparable to previous studies, and then exploit the panel nature of the data. Treating the three waves of the NELS:88 survey as separate cross-sections yields results that are strikingly similar to previous estimates. For example, several recent studies yield price-elasticity estimates of smoking participation for high school seniors and college students from -0.49 to -0.67 (Evans and Huang 1997, Chaloupka and Grossman 1996, Chaloupka and Weschler 1997); our models imply price elasticities ranging from -0.29 to -0.98 in the 12th grade cross section. Thus, policy predictions from our cross-sectional models appear to lend support to the claim that tax or price increases can substantially reduce youth smoking.

To exploit the panel features of NELS:88, we next estimate models of smoking onset between 8th and 12th grade. In contrast to the cross sectional results, the results suggest that increases in cigarette taxes and prices are not likely to reduce smoking onset. This conclusion is not based solely on statistical significance, but on the preponderance of evidence and the pattern of results across specifications. McCloskey and Ziliak (1996) argue that empirical economists should pay less attention to statistical significance and pay serious attention to the scientific question: How large is the estimated effect in terms of the present conversation? Our answer is that our results do not provide evidence that modest tax or price hikes are likely to be very useful policies to reduce youth smoking.[27]

If cigarette tax rates proxy for an unobserved factor such as anti-smoking sentiment, the price elasticity estimates from our cross-sectional models and from previous cross-sectional

[27] As noted earlier, our study and other studies using U.S. data are not very informative about the effects of very large price hikes. Judgements about the policy significance of our results depend on the assumed loss function. McCloskey and Ziliak (1996) quote Wald's argument that the loss function should be chosen based on the consequences of type I and type II errors and so is not a mathematical or statistical question. It could be argued that the consequences of failing to increase cigarette taxes because we incorrectly fail to reject the null hypothesis are the smoking-related deaths that could have been prevented. On similar grounds, it could be argued that the consequences of relying on ineffective taxes because we incorrectly reject the null hypothesis are also the smoking-related deaths that could have been prevented by developing alternative anti-smoking policies.

studies are suspect. These elasticity estimates rely on a standard but usually implicit assumption that cross-sectional models can be interpreted as follows: differences in smoking behavior between youth who face different tax rates or prices can be used to predict how youth smoking changes when tax rates or prices change. We provide several pieces of suggestive evidence that youth who face different tax rates also face different anti-smoking sentiment, meaning that this interpretation of the cross-sectional results is invalid. Moreover, our longitudinal data allow us to directly examine the impact of changes in taxes and prices on youth smoking behavior, and our results indicate this impact is small or nonexistent. It is worth re-stating that even if prices do not influence youth decisions to start smoking, they may still influence adult decisions to quit. Thus our results are not necessarily in conflict with the evidence from studies including Becker, Grossman and Murphy (1994) that aggregate cigarette sales are quite price responsive.[28]

In addition to the role of taxes, the NELS:88 data allow us to explore the influence of a rich variety of other factors on youth smoking. The results reported above suggest that students who drop out of high school have higher smoking propensities years before they actually drop out. This suggests that dropout status per se may not be the cause of higher smoking rates among dropouts. Students who score poorly on standardized achievement tests are also more likely to smoke.

To meet the goals for reducing youth smoking set out by President Clinton and in *Healthy People 2000* (USDHSS 1990), it is crucial to identify policies that work. Higher taxes or prices have been a prominent feature of many plans to prevent youth smoking. But our results suggest that taxes are not as salient to youth smoking decisions as are individual characteristics and family background. Although not a major focus of our study, the results presented also provide no evidence that regulations that limit youth access to cigarettes reduce youth smoking. Differences in attitudes, plans for the future, and peer groups may be the root causes of youth smoking. If so, it is not so surprising that taxes and regulations are relatively ineffective prevention policies. Instead of using taxes or regulations to drive up the costs youth incur to smoke, it may be more effective to emphasize policies such as health education programs and media campaigns that shift youth cigarette demand.

[28]Becker, Grossman and Murphy (1994) analyze a time series of state cross-sections, which allows them to include state fixed effects in their demand models. This approach reduces the potential bias in cross-sectional demand studies because the state fixed effects may capture much of the unobservable heterogeneity in anti-smoking sentiment. However, adult smoking decisions drive the aggregate sales data they analyze.

A promising direction for future work is to explore differences in smoking behavior among youth of different racial and ethnic backgrounds. In data from the MTF surveys and other national surveys the prevalence of youth smoking is highest for whites and lowest for blacks, with the rate of smoking by Hispanics and other races falling in between. These different groups have also experienced much different trends in youth smoking (USDHHS 1998, p. 32). For example, smoking rates for African-American youths declined steeply for several decades, from about 33 percent in the late 1970s to under 10 percent by the early 1990s, while there were much less dramatic changes in smoking prevalence among white youth. Because youth of different ethnic groups faced similar trends in cigarette prices, understanding their different smoking trends could shed light on the relative importance of prices, peers, and other influences. DeCicca, Kenkel and Mathios (1999) extend the work reported in this paper to estimate smoking onset models by race/ethnicity. They find no effects of taxes or prices on smoking onset for whites (about 70 percent of the sample) but large and statistically significant tax and price effects for Hispanics. A recent study also finds small and statistically insignificant price effects on smoking prevalence in white adults in a very large sample (N=281,482) but strong effects for Hispanic adult smoking, with similar patterns for young adults.[29] Higher taxes or prices might prevent youth smoking in certain population sub-groups, but strong policy conclusions seem premature until the apparent differences in price-responsiveness across races and ethnic groups are better understood.

[29]The CDC (1998) briefly reports a study that updates the study by Wasserman *et al.* (1991) and uses data on adults aged 18 and over from available years of the NHIS from 1976 to 1993. The estimated effect of price on smoking participation in the white, non-Hispanic subsample (N=281,482) is small and statistically insignificant, implying a participation elasticity of -0.05. The estimated price effect for the Hispanic subsample (N=21,926) is much larger and statistically significant, implying a participation elasticity of -1.31. The same pattern holds in age-specific models estimated for individuals 18-24 years old, 25-39 years old, and over 40.

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Table 1 - Starting and Quitting Rates, By Age			
Age	Percent Who Start Smoking	Percent of Smokers Who Quit	Smoking Participation Rate
< 10	1.66	0.18	1.61
11	0.7	0.08	2.3
12	2.42	0.15	4.65
13	3.65	0.23	8.12
14	4.54	0.23	12.53
15	5.7	0.23	18.05
16	7.22	0.2	25.06
17	4.34	0.56	29.07
18	5.45	0.71	34.1
19	1.99	0.86	35.68
20	1.78	0.89	37.04
21	1.8	1.37	38.21
22	0.8	1.42	38.36
23	0.53	1.22	38.34
24	0.34	1.3	38.11
25	0.71	1.63	38.1
26	0.25	1.86	37.53
27	0.3	1.75	37
28	0.26	1.78	36.36
29	0.14	2.29	35.03
30	0.17	3.28	33.63
31	0.22	3.48	32.31

Note: Calculated from retrospective data from the 1992 wave of National Longitudinal Survey of Youth.

Table 2- Studies of the Price-Responsiveness of Smoking among Youths and Young Adults

Study	data set	sample period	age group	price-elasticity		
				overall	partic.	cond.
Lewit, Coate and Grossman (1981)	HES-III	1966-70	12-17	-1.44	-1.2	-0.25
Lewit and Coate (1982)	NHIS	1976	20-25	-0.89	-0.74	-0.15
Chaloupka (1991)	NHANES-II	1980	17-24	0.016* to -0.103*	n.a.	n.a.
Wasserman et al. (1991)	NHANES-II	1976-80	12-17	0.859*	n.a.	n.a.
Douglas and Hariharan (1994)	NHIS	1978-79	18	0.001*	n.a.	n.a.
Evans and Farrelly (1995)	NHIS	1976-92	18-24	-0.63	-0.36	-0.27
Chaloupka and Grossman (1996)	MTF	1992-94	12-18	-1.313	-0.68	-0.64
Chaloupka and Wechsler (1997)	Harvard College Alcohol Study	1993	18-22	-0.906 to -1.309	-0.52 to -0.536	-0.729 to -0.472
Lewit et al. (1997)	Community Intervention Trial for Smoking Cessation	1990-92	36175	n.a.	-1.02 (boys) -0.06* (girls)	n.a.
Evans and Huang (1998)	MTF	1977-92 1985-92	17-18	n.a.	-0.201 -0.490	n.a.
CDC (1998)	NHIS	1976-80, 83,85,87-93	18-24	-0.58	-0.37	-0.21

Notes: * denotes estimated effect of price was statistically insignificant. HES-III = Health Examination Survey, Cycle III. NHANES-II = Second National Health and Nutrition Examination Survey. Evans and Huang (1998) report results from alternative specifications; elasticities reported are from their Table 5, specification with state and state*time effects.

Table 3 - State Taxes on Cigarettes and State-Level Smoking Rates					
State	Cigarette Taxes		Percent that smoke from NELS data		
	1988	1992	8th (1988)	10th (1990)	12th (1992)
AL	16.5	16.5	7.36	17.83	25.11
AK	16	29	2.94	6.25	30.3
AZ	15	18	8.46	20.16	31.78
AR	21	21	1.82	15.89	29.52
CA	10	35	3.3	10.23	15.88
CO	20	20	3.23	13.56	15.6
CT	26	45	4.67	17.21	28.21
DE	14	24	0	9.38	27.59
FL	24	33.9	3.78	13.19	16.18
GA	12	12	1.89	16.33	20
HI	33	48	7.69	15.63	20.51
ID	18	18	8.08	23.47	38.83
IL	20	30	2.6	16.82	25.9
IN	15.5	15.5	3.92	20	25.79
IA	34	36	6.21	19.65	21.91
KS	24	24	1.23	15.29	24.38
KY	3	3	10.18	20.83	32.06
LA	16	20	9.47	23.89	27.02
ME	28	37	2.13	17.39	22.73
MD	13	36	4.64	16.95	24.56
MA	26	26	3.66	17.27	22.85
MI	25	25	8.56	22.38	28.21
MN	38	43	3.98	16.67	30
MS	18	18	3.91	17.24	22.88
MO	13	13	6.84	18.45	26.47
MT	16	18	2	18	18.37
NE	27	27	11.01	23.85	22.55
NV	20	35	2.33	16.47	22.62

NH	17	25	8.16	18.37	25.53
NJ	27	40	2.77	11.17	19.89
NM	15	15	6.59	23.93	27.33
NY	21	39	5.31	17.79	24
NC	2	5	7.84	20.35	25
ND	27	29	1.98	10.89	22.11
OH	18	18	6.4	19.97	27.28
OK	23	23	4.11	18.52	27.88
OR	27	28	2.8	11.85	16.13
PA	18	31	5.02	20.72	25.56
RI	27	37	2.17	26.09	16.67
SC	7	7	7.31	20.6	22.74
SD	23	23	0	31.25	46.67
TN	13	13	5.11	16.77	20.6
TX	26	41	4.48	15.3	20.41
UT	23	26.5	0.79	7.63	16.52
VT	17	19	6.9	26.67	39.39
VA	2.5	2.5	8.83	18.18	23.33
WA	31	34	9.02	14.35	20.94
WV	17	17	8.79	21.95	30
WI	30	30	4.9	22.67	29.83
WY	8	12	5.17	22.41	24.53

Table 4 - Descriptive Statistics for Selected Variables Used in Cross-Section Models				
Variable	Mean	Std Dev	Min	Max
1988 Cigarette Tax (in cents)[1]	18.9	7.99	2	38
1988 Cigarette Price (in cents)[1]	129.7	10.72	103.8	152.5
1990 Cigarette Tax (in cents)[2]	25.36	11.41	2	41
1990 Cigarette Price (in cents)[2]	163.86	18.8	128	203.1
1992 Cigarette Tax (in cents)[3]	26.66	11.36	2.5	48
1992 Cigarette Price (in cents)[3]	202.19	17.78	163.3	241.4
High School Dropout[3]	0.057	0.233	0	1
Reading/Math Score[1]	52.01	9.99	25.45	70.52
Cigarette Usage-8th Grade				
0 Cigarettes	0.948	0.222	0	11111
1-5 Cigarettes	0.034	0.181		
6-10 Cigarettes	0.010	0.100		
11-40 Cigarettes	0.005	0.071		
> 40 Cigarettes	0.003	0.054		
Cigarette Usage-10th Grade				
0 Cigarettes	0.826	0.379	0	1
1-5 Cigarettes	0.107	0.309		1
6-10 Cigarettes	0.036	0.186		1
11-40 Cigarettes	0.028	0.165		1
> 40 Cigarettes	0.004	0.063		1
Cigarette Usage-12th Grade				
0 Cigarettes	0.764	0.425	0	1
1-5 Cigarettes	0.115	0.319		1
6-10 Cigarettes	0.059	0.236		1
11-40 Cigarettes	0.057	0.232		1
> 40 Cigarettes	0.005	0.071		1

Notes: 1=8th Grade Cross-Section, 2=10th Grade Cross-Section, 3=12th Grade Cross-Section.

Table 5 - Ordered Probability Model - Cross Section Results Using Taxes						
Regressors	8th Grade		10th Grade		12th Grade	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Contemporaneous State Cigarette Tax (in cents)	-0.0090 (-3.35)	-0.0097 (-3.38)	-0.0058 (-4.58)	-.0056 (-4.23)	-0.0041 (-3.39)	-0.0028 (-2.13)
Eventual High School Dropout	0.4779 (7.68)	0.4762 (7.64)	0.5587 (9.71)	0.5544 (9.70)	----	----
High School Dropout	----	----	0.8932 (10.89)	0.8976 (10.95)	0.7524 (15.70)	0.7549 (15.75)
Male	0.0457 (1.18)	0.0467 (1.20)	-.0327 (-1.25)	-0.0313 (-1.20)	0.0797 (3.29)	0.0804 (3.32)
White	0.0342 (0.53)	0.0248 (0.39)	0.1757 (3.82)	0.1698 (3.69)	0.1993 (4.72)	0.1968 (4.65)
Hispanic	-0.2543 (-2.90)	-0.2377 (-2.70)	-0.1066 (-1.70)	-0.0973 (-1.55)	-0.2118 (-3.66)	-0.2121 (-3.65)
Black	-1.0458 (-8.03)	-1.0692 (-8.13)	-0.8252 (-10.24)	-0.8370 (10.36)	-0.8610 (-11.65)	-0.8653 (-11.69)
Test Score	-0.0201 (-8.69)	-0.0198 (-8.54)	-.0156 (-10.04)	-0.0155 (-9.93)	-0.0154 (-10.73)	-0.0155 (-10.77)
Non-Discrimination Statute	----	0.1426 (3.33)	----	0.1402 (4.83)	----	0.1067 (3.78)
Index of Restrictions on Public Smoking	----	0.0184 (0.78)	----	0.0000 (0.00)	----	-0.0184 (-1.19)
Index of Restrictions on Youth Smoking	----	0.1158 (3.49)	----	0.0707 (3.12)	----	0.0297 (1.40)
Log-likelihood	-3123.7	-3113.7	-7866.9	-7853.3	-9938.4	-9931.2
Sample size	13316	13316	13132	13132	12889	12889

Notes: t-values appear in parentheses under estimated coefficients. To control for other factors in a very flexible manner, all models also include 3 dummy variables for region, a dummy variable for suburb, a dummy variable for rural, a dummy variable for catholic, a dummy variable for protestant, 3 dummy variables for birth year, 14 dummy variables for family income, 7 dummy variables for mother's education, 7 dummy variables for father's education, 4 dummy variables for mother's occupation, 4 dummy variables for father's occupation, 6 dummy variables for family size, 6 dummy variables for the number of older siblings, and 5 dummy variables for family composition. Results for these variables are not presented but are available upon request.

Table 6 - Ordered Probability Model - Cross Section Results Using Prices						
Regressors	8th Grade		10th Grade		12th Grade	
	Model 3	Model 4	Model 3	Model 4	Model 3	Model 4
Contemporaneous State Cigarette Price (cents)	-0.0061 (-3.21)	-0.0068 (-3.41)	-0.0041 (-4.95)	-0.0040 (-4.59)	-0.0017 (-2.13)	-0.0012 (-1.45)
Eventual High School Dropout	0.4784 (7.68)	0.4770 (7.65)	0.5584 (9.78)	0.5549 (9.71)	----	----
High School Dropout	----	----	0.8934 (10.89)	0.8969 (10.93)	0.7530 (15.72)	0.7555 (15.77)
Male	0.0455 (1.17)	0.0464 (1.19)	-0.0326 (-1.25)	-0.0311 (-1.19)	0.0795 (3.28)	0.0803 (3.32)
White	0.0329 (0.51)	0.0233 (0.36)	0.1738 (3.78)	0.1685 (3.65)	0.2004 (4.74)	0.1970 (4.65)
Hispanic	-0.2569 (-2.93)	-0.2384 (-2.71)	-0.1130 (-1.81)	-0.1023 (-1.63)	-0.2214 (-3.83)	-0.2176 (-3.75)
Black	-1.0399 (-7.99)	-1.0658 (-8.11)	-0.8229 (-10.21)	-0.8364 (10.35)	-0.8551 (-11.58)	-0.8631 (-11.67)
Test Score	-.0201 (-8.69)	-0.0198 (-8.53)	-0.0156 (-10.03)	-0.0154 (-9.92)	-0.0155 (-10.78)	-0.0155 (-10.81)
Non-Discrimination Statute	----	0.1482 (3.48)	----	0.1376 (4.74)	----	0.1186 (4.34)
Index of Restrictions on Public Smoking	----	0.0273 (1.15)	----	0.0079 (0.47)	----	-0.0184 (-1.16)
Index of Restrictions on Youth Smoking	----	0.1101 (3.36)	----	0.0639 (2.84)	----	0.0289 (1.36)
Log-likelihood	-3124.2	-3113.7	-7865.1	-7851.7	-9941.9	-9932.5
Sample size	13316	13316	13132	13132	12889	12889

Notes: t-values appear in parentheses under estimated coefficients. To control for other factors in a very flexible manner, all models also include 3 dummy variables for region, a dummy variable for suburb, a dummy variable for rural, a dummy variable for catholic, a dummy variable for protestant, 3 dummy variables for birth year, 14 dummy variables for family income, 7 dummy variables for mother's education, 7 dummy variables for father's education, 4 dummy variables for mother's occupation, 4 dummy variables for father's occupation, 6 dummy variables for family size, 6 dummy variables for the number of older siblings, and 5 dummy variables for family composition. Results for these variables are not presented but are available upon request.

Table 7: Predicted Impacts of Alternative Tax or Price Increases on Youth Smoking from Cross-Section Demand Models

Model		$0.20 Tax or Price Increase			$1.50 Tax or Price Increase		
	Baseline Smoking Rate	Predicted Smoking Rate	Change from Baseline	Implied price-elasticity	Predicted Smoking Rate	Change from Baseline	Implied Price-Elasticity
8th Grade Model (1)	0.0521	0.037	-0.015	-1.875	0.002	-0.05	-0.825
8th Grade Model (2)	0.0521	0.0361	-0.016	-1.994	0.002	-0.05	-0.835
8th Grade Model (3)	0.0521	0.0413	-0.011	-1.34	0.007	-0.045	-0.746
8th Grade Model (4)	0.0521	0.0402	-0.012	-1.467	0.006	-0.047	-0.771
10th Grade Model (1)	0.1748	0.1484	-0.026	-1.24	0.0407	-0.1341	-0.838
10th Grade Model (2)	0.1749	0.1496	-0.025	-1.185	0.0441	-0.1308	-0.817
10th Grade Model (3)	0.1748	0.1558	-0.019	-0.889	0.066	-0.1088	-0.68
10th Grade Model (4)	0.1748	0.1566	-0.018	-0.853	0.0692	-0.1056	-0.66
12th Grade Model (1)	0.2379	0.2148	-0.023	-0.982	0.0988	-0.1391	-0.788
12th Grade Model (2)	0.238	0.2222	-0.016	-0.67	0.1352	-0.1028	-0.582
12th Grade Model (3)	0.2379	0.2285	-0.01	-0.403	0.1723	-0.066	-0.372
12th Grade Model (4)	0.238	0.2311	-0.01	-0.29	0.1895	-0.049	-0.274

Notes: Predictions are based on models reported in Tables 5 and 6. Models (1) and (2) use the change in tax; while Models (3) and (4) use the change in price. Models (1) and (3) exclude the three variables measuring smoking-related legislation; the legislation variables are included as explanatory variables in Models (2) and (4).

Table 8 - Ordered Probability Model - Onset of Smoking Between 8th and 12th Grade				
Regressors	Model 1	Model 2	Model 3	Model 4
Change in State Cigarette Tax from 1988-92 (in cents)	-0.00308 (-1.68)	-0.00136 (-0.69)	----	----
Change in State Cigarette Prices from 1988-92 (in cents)	----	----	-0.00076 (-0.64)	-0.00015 (-0.12)
High School Dropout	0.6997 (12.92)	0.7009 (12.94)	0.7002 (12.93)	0.7013 (12.95)
Male	0.0837 (3.27)	0.0844 (3.30)	0.0833 (3.26)	0.0843 (3.29)
White	0.1799 (3.99)	0.1787 (3.96)	0.1816 (4.03)	0.1795 (3.97)
Hispanic	-0.1548 (-2.52)	-0.1560 (-2.54)	-0.1613 (-2.64)	-0.1592 (-2.60)
Black	-0.7486 (-9.76)	-0.7562 (-9.84)	-0.7470 (-9.74)	-0.7556 (-9.84)
Test Score	-0.0136 (-8.92)	-0.0137 (-8.97)	-0.0136 (-8.94)	-0.0137 (-8.99)
Non-Discrimination Statute	----	0.0889 (2.95)	----	0.0945 (3.26)
Index of Restrictions on Public Smoking	----	-0.0180 (-1.07)	----	-0.0207 (-1.22)
Index of Restrictions on Youth Smoking	----	0.00088 (0.04)	----	0.00295 (0.13)
Log-likelihood	-8642.2	-8637	-8643.4	-8637.2
Sample size	12089	12089	12089	12089

Notes: t-values appear in parentheses under estimated coefficients. To control for other factors in a very flexible manner, all models also include 3 dummy variables for region, a dummy variable for suburb, a dummy variable for rural, a dummy variable for catholic, a dummy variable for protestant, 3 dummy variables for birth year, 14 dummy variables for family income, 7 dummy variables for mother's education, 7 dummy variables for father's education, 4 dummy variables for mother's occupation, 4 dummy variables for father's occupation, 6 dummy variables for family size, 6 dummy variables for the number of older siblings, and 5 dummy variables for family composition. Results for these variables are not presented but are available upon request.

Table 9: Predicted Impacts of Alternative Tax or Price Increases on Youth Smoking from Onset Models (full sample)

Model		$0.20 Tax or Price Increase			$1.50 Tax or Price Increase		
	Baseline Smoking Onset Rate	Predicted Smoking Onset Rate	Change from Baseline	Implied price-elasticity	Predicted Smoking Onset Rate	Change from Baseline	Implied Price-Elasticity
Onset Model (1)	0.212	0.196	-0.016	-0.505	0.108	-0.104	-0.424
Onset Model (2)	0.212	0.205	-0.01	-0.226	0.161	-0.052	-0.211
Onset Model (3)	0.212	0.208	0	-0.126	0.182	-0.03	-0.121
Onset Model (4)	0.212	0.211	0	-0.025	0.206	-0.01	-0.025

Notes: Predictions are based on models reported in Table 8. Models (1) and (2) use the change in tax; while Models (3) and (4) use the change in price. Models (1) and (3) exclude the three variables measuring smoking-related legislation; the legislation variables are included as explanatory variables in Models (2) and (4).

Table 10 - Ordered Probability Model - Onset into Heavy Smoking Between 8th and 12th Grade

Regressors	Model 1	Model 2	Model 3	Model 4
Change in State Cigarette Tax from 1988-92 (in cents)	0.00054 (0.17)	0.00278 (0.83)	----	----
Change in State Cigarette Prices from 1988-92 (in cents)	----	----	0.00121 (0.61)	0.00197 (0.93)
High School Dropout	0.7790 (10.31)	0.7801 (10.32)	0.7798 (10.31)	0.7799 (10.31)
Male	0.2270 (5.35)	0.2273 (5.35)	0.2267 (5.34)	0.2271 (5.34)
White	0.0891 (1.23)	0.0863 (1.19)	0.0911 (1.26)	0.0881 (1.21)
Hispanic	-0.5654 (-4.88)	-0.5675 (-4.89)	-0.5671 (-4.91)	-0.5652 (-4.88)
Black	-0.8875 (-5.98)	-0.8978 (-6.04)	-0.8879 (-5.98)	-0.8981 (-6.04)
Test Score	-0.0151 (-6.09)	-0.0153 (-6.14)	-0.0151 (-6.09)	-0.0152 (-6.13)
Non-Discrimination Statute	----	0.1234 (2.49)	----	0.1159 (2.42)
Index of Restrictions on Public Smoking	----	-0.0279 (-0.99)	----	-0.0294 (-1.03)
Index of Restrictions on Youth Smoking	----	0.00053 (0.01)	----	-0.00426 (-0.12)
Log-likelihood	-2106.8	-2103	-2106.67	-2102.92
Sample size	12089	12089	12089	12089

Notes: t-values appear in parentheses under estimated coefficients. To control for other factors in a very flexible manner, all models also include 3 dummy variables for region, a dummy variable for suburb, a dummy variable for rural, a dummy variable for catholic, a dummy variable for protestant, 3 dummy variables for birth year, 14 dummy variables for family income, 7 dummy variables for mother's education, 7 dummy variables for father's education, 4 dummy variables for mother's occupation, 4 dummy variables for father's occupation, 6 dummy variables for family size, 6 dummy variables for the number of older siblings, and 5 dummy variables for family composition. Results for these variables are not presented but are available upon request.

Table 11 - Discrete Time Hazard Model With and Without State Fixed Effects				
Regressors	Model 1	Model 1 (Fixed Effects)	Model 2	Model 2 (Fixed Effects)
Year 92	0.5982 (22.51)	0.5870 (21.25)	0.6948 (17.38)	0.6343 (8.03)
Year 90	.6590 (25.82)	0.6459 (24.05)	0.6928 (24.33)	0.6689 (16.31)
State Cigarette Tax (in cents)	-0.00412 (-3.61)	0.00141 (0.48)	----	----
State Cigarette Price (in cents)	----	----	-0.00273 (-3.64)	-0.00109 (-0.58)
High School Dropout	0.5551 (13.24)	0.5538 (13.14)	0.5552 (13.25)	0.5542 (13.15)
Male	0.0001 (0.00)	0.0029 (0.15)	0.0005 (0.02)	0.0029 (0.15)
White	0.1762 (5.01)	0.1683 (4.70)	0.1749 (4.97)	0.1683 (4.70)
Hispanic	-0.0067 (-0.14)	-0.0086 (-0.18)	-0.0110 (-0.23)	-0.0086 (-0.17)
Black	-0.6461 (-10.65)	-0.6684 (-10.82)	-0.6437 (-10.62)	-0.6686 (-10.82)
Test Score	-0.0138 (-11.72)	-0.0137 (-11.49)	-0.0138 (-11.74)	-0.0137 (-11.48)
Log-likelihood	10207.02	10157.25	10206.9	10157.2
Sample size	33392	33392	33392	33392

Notes: t-values appear in parentheses under estimated coefficients. To control for other factors in a very flexible manner, all models also include 3 dummy variables for region, a dummy variable for suburb, a dummy variable for rural, a dummy variable for catholic, a dummy variable for protestant, 3 dummy variables for birth year, 14 dummy variables for family income, 7 dummy variables for mother's education, 7 dummy variables for father's education, 4 dummy variables for mother's occupation, 4 dummy variables for father's occupation, 6 dummy variables for family size, 6 dummy variables for the number of older siblings, and 5 dummy variables for family composition. Results for these variables are not presented but are available upon request.