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Publication Date
2001-02-01

impacTEEN

A Policy Research Partnership to Reduce Youth Substance Use

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February 2001

Research Paper Series, No. 6

ImpacTeen is part of the Bridging the Gap Initiative: Research Informing Practice for Healthy Youth Behavior, supported by The Robert Wood Johnson Foundation and administered by the University of Illinois at Chicago.

Differential Effects of Cigarette Price on Youth Smoking Intensity

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ACKNOWLEDGEMENTS

Support for this research was provided by grants from The Robert Wood Johnson Foundation (ImpacTeen – A Policy Research Partnership to Reduce Youth Substance Use) and the Centers for Disease Control and Prevention (Price, Availability and Youth Tobacco Use) to the University of Illinois at Chicago. We thank Lloyd D. Johnston and Patrick J. O'Malley of the University of Michigan's Institute for Social Research for providing us with selected data from the 1992, 1993 and 1994 Monitoring the Future Surveys. The Monitoring the Future Project is supported by a grant from the National Institute on Drug Abuse.

Abstract

Objectives: Data from the 1992, 1993, and 1994 Monitoring the Future Surveys were used to investigate the differential effects of cigarette price on the intensity of youth cigarette smoking.

Methods: Respondents are classified into nonsmokers; individuals who smoked less than one cigarette per day; individuals who smoked one to five cigarettes per day; individuals who smoked one-half pack a day; and individuals who smoked one pack or more a day. A Threshold of Change Model was estimated with information on cigarette prices as the main explanatory variables.

Results: Dummy variables indicating medium and high prices were found to have varying effects on different levels of smoking intensity, even though higher prices were associated with lower smoking in all cases. The differences are more striking in the high price case. The effects of higher prices are largest at the heaviest smoking levels.

Conclusion: Cigarette prices an effective tool to discourage youth smoking. The differential effects of cigarette price on smoking intensity warrant further investigation.

Introduction

The prevalence of youth smoking increased for much of the 1990s before beginning to decline in 1998. In spite of the recent downward trend, about one-third high school seniors reported past month smoking in 1999, while nearly one-quarter reported daily smoking. [1]

Higher cigarette prices that result from increased cigarette excise taxes have been shown to be an effective tool in reducing cigarette smoking among youth.[2,3,4,5,6] These papers, with a few exceptions, utilized different versions of the two-part model introduced by Cragg (1971). [7] Two separate yet related equations are estimated. One is a discrete choice model on participation with the dependent variable being a dichotomous variable of indicating whether the individual is a smoker or not. The other is an ordinary least square model of the conditional demand by those who do smoke. The overall price elasticity includes both the participation elasticity and the conditional demand price elasticity. This literature has not examined the differential effects of price on the level at which youths smoke. In other words, once the smoking participation decision is made, the approach that has commonly been used assumes that there is no qualitative difference in the impact of price on young smokers who consume at different levels. The only decision those individuals who choose to smoke make is the quantity to consume.

Treating quantity of cigarettes consumed as a continuous variable in these analyses suffers from two weaknesses. First, most surveys on smoking behavior obtain categorical information on the quantity of cigarettes consumed. For example, the Monitoring the Future Survey conducted by the University of Michigan has six categories of cigarette consumption: less than one cigarette per day, one to five per day, about one-half pack per day, about one pack per day, about one and one-half packs per day, and two packs or more per day. Log transformation of the respective number of cigarettes of the above categories may resemble

normal distribution, but it is at the best taking a partially observed distribution as fully observed. Second, and more importantly, data suggest that smokers have the tendency to either report around the "multiples of fives" or actually consume around these "even numbers". Even when a survey asks the actual number of cigarettes consumed, the answers tend to cluster at 10, 15, 20, and so on. Both statistically and behaviorally, this tendency calls for an analysis that explicitly models the level of smoking intensity.

The purpose of this study was to examine the differential effects of cigarette price on youth smoking intensity using the 1992 to 1994 Monitoring the Future Surveys of eighth, tenth, and twelfth grade students. A Thresholds of Change Model[8] was estimated to explore the impact of living in a higher price area on the thresholds of change from one level of smoking intensity to the next. We find that higher prices increased the thresholds of moving from a lower level of cigarette consumption to a higher level of cigarette consumption, and that the effects of cigarette prices on the thresholds of change differed across smoking levels in the sense that higher prices increased the thresholds of change more at the highest levels of smoking.

Methods

Data

Data for this study came from the 1992, 1993, and 1994 Monitoring the Future Surveys of eighth, tenth, and twelfth grade students conducted by the Institute for Social Research (ISR) at the University of Michigan.[1] Every year since 1975, ISR has collected a nationally representative sample of 15,000 to 19,000 high school seniors. Annual surveys of similar numbers of eighth and tenth grade students were added in 1991.

Dependent Variable

All respondents were asked about their recent cigarette smoking. We defined five different levels of cigarette smoking intensity based on the seven categories reported in the survey. We collapsed the last three responses into one category due to the small numbers of students responding in those categories. The resulting five categories are defined as: nonsmokers; individuals who smoked less than one cigarette per day; individuals who smoked one to five cigarettes per day; individuals who smoked one-half pack a day; and individuals who smoked one pack or more a day.

Cigarette Price

Based on each respondent's county of residence, cigarette price and tobacco control policy information was merged with the survey data. State level average cigarette price came from the annual Tax Burden on Tobacco published by the Tobacco institute.[9] This price measure is inclusive of state level excise taxes on cigarettes and reflects the average price for a pack of twenty cigarettes, based on the prices of single packs, cartons, and vending machine sales, and includes generic cigarettes. We obtained the real price by deflating the nominal price by the national Consumer Price Index for the first two quarters of the survey year. For reasons to be explained in the methods section, this real price measure was categorized into three ranges: low, medium, and high. The cutoff points were chosen so that there were approximately equal numbers of respondents in each category. Two dummy variables indicating medium price and high price were included in the statistical analysis. To capture potential cross-border shopping for cigarettes, a variable representing the largest price difference between the youth's state of residence and states within 25 miles of the youth's county of residence was also included. This variable was set equal to zero for those respondents who lived in states with lower prices than nearby states and for those living in counties more than 25 miles from another state.

Other Policies

Four variables capturing state and local tobacco-related policies were included in the analysis. The first was a dummy variable set equal to one if the respondent lived in a state that earmarked a portion of cigarette tax revenue for anti-tobacco activities and zero otherwise. It is generally believed that states that have taken this measure are more aggressive in discouraging smoking. The second was another dummy variable set equal to one if the respondent lived in a state that had some form of smoker protection legislation and equal to zero otherwise. In contrast to tax revenue earmarking, states that enacted smoker protection laws are thought to have a more favorable climate for smoking. The other two variables were indices of state and local clean indoor air restrictions and limits on youth access. The index of clean indoor air restrictions was the sum of five independent measures reflecting the fraction of the population in the respondent's county of residence subject to state or local restrictions on smoking in private work sites, restaurants, retail stores, schools, and other public places. The index for youth access also consisted of five independent measures of restrictions on youth access. Two of these are dummy variables indicating whether or not the state had a minimum legal purchase age of at least 18 and whether or not the state required a point of sale sign stating the minimum legal purchase age. The index also included the fractions of the county population in the respondent's residence that were subject to restrictions on vending machine sale, restrictions on distribution of free sample, and tobacco retailer licensing requirements. The data on state level policies came from the Coalition on Smoking or Health's (CSH) annual State Legislated Actions on Tobacco Issues. Similar information on the county and city level policies was obtained from the National Cancer Institute's monograph summarizing major local control policies and the Americans for Nonsmokers' Rights Foundation. [10]

Other Independent Variables

We controlled for an extensive set of socioeconomic and demographic variables that might affect smoking intensity. These include: an indicator for males; indicators for being black and other races; age, in years; indicators for frequency of participation in religious services (infrequent participation and frequent participation); an indicator for being in rural area; an indicator for living with parents relative to other living arrangements; an indicator for having siblings; indicators for parental education (less than high school graduate, and more than high school graduate for father and mother respectively; the omitted groups are high school graduates); indicators for mother's working status while youth was growing up (mother working part-time or full-time); average number of hours worked weekly; real average weekly income from employment, allowance, and other sources; an indicator of youth in the eighth or tenth grade; and indicators for the years 1992 and 1993. After deleting all observations with missing data, we arrived at a sample size of 110,717.

Statistical Analysis

To best explore the discrete and ordinal nature of the dependent variable, an ordered probability model is needed. However, standard ordered logit analysis implicit assumes the cumulative odds ratios are proportional, i.e. that an explanatory variable has an equal effect across different values of the dependent variable. A Threshold of Change Model is used instead to capture the differential effects of cigarette prices on the level of smoking intensity. Compared to the standard ordered probability model, the generalized ordered probability model allows the effects of explanatory variables to change in addition to allowing for different intercepts (thresholds in the standard ordered probability model). Therefore, the variables can have varying effects on different levels of smoking intensity.

We estimated a version of the generalized ordered logit model by maximum likelihood techniques as described in Peterson and Harrell (1990)[11] and Hedeker, Mermelstein, and Weeks (1999). Standard Likelihood Ratio tests and Ward tests were used in testing various hypotheses about equal effects. One caveat of this model is that a negative predicted probability might occur as the result of specifying a continuous variable to have varying effects. For this reason, we used the two dummy variables for different price levels discussed above instead of a continuous price measure. For the sake of parsimony, all other explanatory variables are assumed to have equal effects across stages.

Results

Table 1 shows the distributions of respondents at different levels of smoking intensity across the different price categories. Overall, 23 percent of respondents reported cigarette smoking in the previous 30 days. More students in low price areas reported smoking than students in the medium price and high price areas. A chi-square test rejected the null hypothesis that there was no relation between cigarette prices and level of smoking intensity.

Table 2 shows the estimates for the effects of cigarette prices on the level of smoking intensity. Table 2a reports the odds ratios from both the equal effect and varying effect estimation. Thresholds 1 through 4 refer to the four thresholds between the five different levels of smoking intensity reported in Table 1. Living in a medium price area or a high price area significantly increased the thresholds between the levels of smoking intensity at all levels. In both cases, the equal effect odds ratio from the simple ordered logit model fell into the range of the varying effects odds ratios. Students who lived in a medium price area were about 1.057 times more likely to stay in the nonsmoking stage while students who lived in a high price area were 1.132 times more likely to remain in the nonsmoking stage (both are relative to individuals

who lived in a low price area). With only one exception, the effects of higher prices were more pronounced at higher levels of smoking intensity. This is especially true for the case of high price vs. low price. Individuals who lived in a high price area were 30 percent less likely to cross the threshold into smoking one pack or more of cigarettes per day. Figure 1 illustrates the increasing odds ratios.

The results of the Likelihood Ratio Tests for equal odds are reported in Table 2b. The hypothesis of equal effects of both medium price and high price were rejected ($P<0.01$). So was the hypothesis that the effects of high price are equal across levels of smoking intensity ($P<0.05$). However, we could not reject the hypothesis that the effects of medium price are equal across the stages. Pairwise Wald tests on the effects of the high price rejected the null hypothesis of equal odds ratio with only one exception (between the two highest stages). We could not, however, reject the null hypothesis of pair-wise equal odds in most cases for the medium prices.

The parameter estimates of the other explanatory variables from the Threshold of Change Model were almost identical to those from the simple ordered probability model, and the results on other policy and demographic variables largely had the expected effects. A greater difference between price in the respondent's county of residence and price in a nearby state increased the youth's odds of being in a higher level of smoking intensity ($P<0.05$). Cigarette tax earmarking decreased a respondent's cumulative probability of being in a higher category by 27 percent ($P<0.001$). The two indices for clean indoor air laws and youth access restrictions also had the expected impact, although the impact of each was relatively small ($P<0.001$ and $P<0.01$ respectively). Smoker protection laws, on the other hand, were not statistically significant at the conventional levels. The other predictors of being at a lower level of smoking intensity included being male, being black, being of other race, infrequent religious attendance, frequent religious

attendance, living in a rural area, living with both parents, having siblings, and having more educated parents. Being older, having less educated parents, having a mother who worked full-time while the youth was growing up, working more hours, on average, and being an eighth or tenth grader were positively related to higher stages of smoking uptake. Finally, the estimates indicated an increasing trend in smoking intensity from 1992 to 1994.

Discussion

The estimates presented in this paper again demonstrated the effectiveness of higher cigarette prices in controlling youth smoking. The negative impact of price was robust when allowing for varying effects of price across different levels of smoking intensity. These differential effects are expected in part because of the different sources through which experimental smokers and regular smokers obtain cigarettes. Experimenting youth smokers who smoke infrequently and at very low levels often get their cigarettes from friends rather than by buying them. Therefore, experimentation is less likely to respond to higher cigarette prices. Regular smokers, on the other hand, are more likely to purchase their own cigarettes.[12] When the amount of money they spend on cigarettes constitutes a larger share of their budgets, economic theory predicts that they will be more responsive to price. The results from the above analysis conform to the theory and suggest that higher prices have an increasing impact as individual's level of cigarette consumption gets higher. These estimates are also consistent with the findings from recent econometric research suggesting that higher cigarette prices have their greatest impact on initiation of regular smoking, while having relatively little effect on experimental smoking.[13,14,15]

The above analysis suffers from several limitations. First, the use of cross-sectional data limits the ability to observe a longitudinal change in smoking intensity. The use of longitudinal

data following youth for an extended time period would provide more convincing evidence. With longitudinal data, respondents could be separated into different groups based on their initial smoking levels and their transitions in smoking intensity could be modeled dynamically. In addition to being more intuitive, a dynamic model would eliminate the necessity to employ a discrete price measure. This would allow for the calculation of demand elasticities often used in this literature to quantify the effects of prices on cigarette demand. Second, we were not able to observe the effects of price changes on cigarette consumption within each level of smoking intensity. More detailed information of cigarette consumption would be useful in testing for additional differences in youth price responsiveness among those in the one pack or more per day group. Given the estimates above, it is likely that there are further differences between teens that smoke one pack of cigarettes per day and those who smoke two packs per day. Overall, we found that higher cigarette prices are effective in discouraging youth from reaching a higher level of cigarette intensity. This finding is consistent with the existing evidence that has largely supported the idea that cigarette taxation is an effective tool for reducing tobacco use among youths. More complete longitudinal data are needed to explore the issue further.

Table 1. Percentage of Individuals in Different Stages of Smoking Uptake

	Low Price	Medium Price	High Price	Total
Nonsmokers	75.17	76.91	79.40	77.11
Smokers who smoke less than one per day	10.74	10.11	9.75	10.20
Smokers who smoke 1-5 per day	6.73	6.51	5.60	6.30
Smokers who smoke one-half pack per day	3.84	3.50	2.89	3.42
Smoker who smoke more than one pack per day	3.52	2.97	2.37	2.97
Sample Size	36604	39543	34570	110717

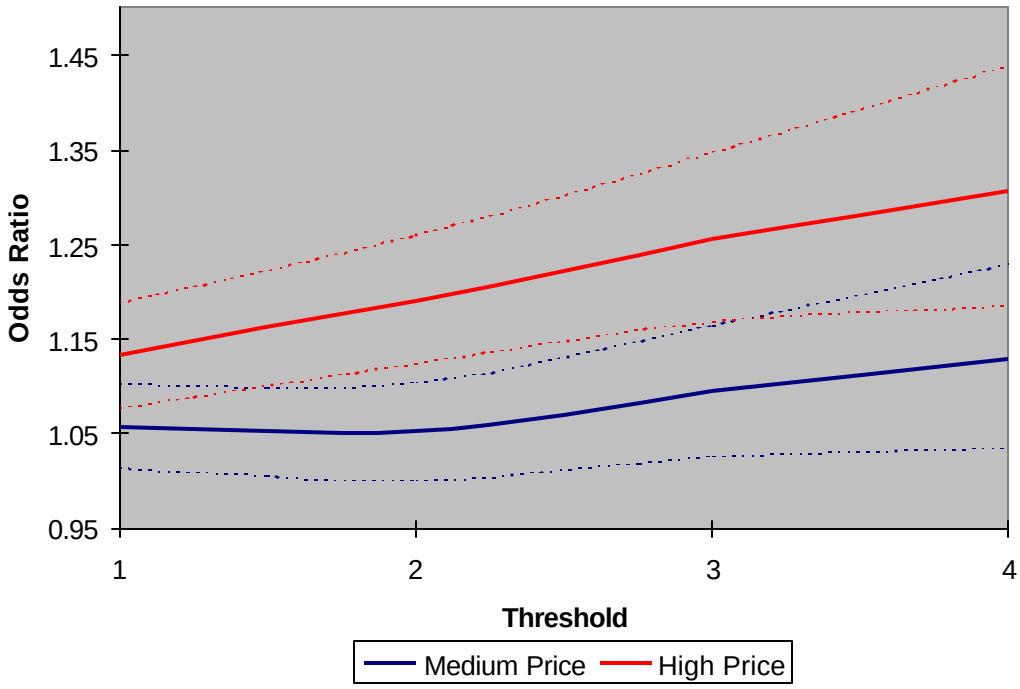
Table 2a. The Effects of Cigarette Prices on Stages of Smoking Uptake					
Cigarette Price	Equal Effect Odds Ratio (95% CI)	Varying Effects Odds Ratio (95% CI)			
		Threshold 1	Threshold 2	Threshold 3	Threshold 4
Medium	1.060** (1.017, 1.105)	1.057** (1.014, 1.102)	1.051* (1.001, 1.104)	1.094** (1.027, 1.165)	1.128** (1.035, 1.229)
High	1.146*** (1.091, 1.204)	1.132*** (1.077, 1.188)	1.190*** (1.124, 1.260)	1.255*** (1.169, 1.348)	1.307*** (1.186, 1.439)
Note: odds ratio greater one means less likely to cross the threshold; * P<0.05; **P<0.01; P<0.001.					

Table 2b. Likelihood Ratio Tests of Equal Effects	
Equal Effects	P-value
Medium and High	P<0.01
Medium Only	n.s
High Only	P<0.05

Table 3. Other Results from the Threshold of Change Model				
	Equal Effect Odds Ratio	(95% CI)	Varying Effects Odds Ratio	(95% CI)
Real Price Differences	0.998 *	(0.996, 1.000)	0.998 *	(0.996, 1.000)
Cigarette Tax Earmarking	1.265 ***	(1.205, 1.329)	1.266 ***	(1.206, 1.330)
Smoking Protection	1.022	(0.987, 1.057)	1.022	(0.987, 1.057)
Clean Indoor Air Laws Index	1.033 ***	(1.020, 1.047)	1.033 ***	(1.020, 1.047)
Youth Access Laws Index	1.023 **	(1.007, 1.039)	1.023 **	(1.007, 1.039)
Male	1.098 ***	(1.066, 1.131)	1.098 ***	(1.067, 1.131)
Black	5.306 ***	(4.947, 5.690)	5.301 ***	(4.948, 5.679)
Other Race	1.286 ***	(1.238, 1.335)	1.286 ***	(1.240, 1.334)
Age	0.858 ***	(0.845, 0.871)	0.858 ***	(0.845, 0.871)
Infrequent Religious Attendance	1.393 ***	(1.339, 1.449)	1.393 ***	(1.340, 1.448)
Frequent Religious Attendance	2.496 ***	(2.387, 2.609)	2.494 ***	(2.387, 2.607)
Rural	1.047 **	(1.012, 1.083)	1.047 **	(1.012, 1.082)
Live with Parents	1.318 ***	(1.272, 1.366)	1.318 ***	(1.273, 1.364)
Siblings	1.150 ***	(1.112, 1.190)	1.150 ***	(1.113, 1.189)
Father Less Than High School Graduate	0.875 ***	(0.834, 0.918)	0.875 ***	(0.836, 0.916)
Father MoreThan High School Graduate	1.073 ***	(1.036, 1.111)	1.073 ***	(1.036, 1.111)
Mother Less Than High School Graduate	0.917 ***	(0.873, 0.963)	0.917 ***	(0.875, 0.962)
Mother MoreThan High School Graduate	1.058 **	(1.023, 1.095)	1.058 ***	(1.024, 1.094)
Mother Worked Part-time	0.964	(0.922, 1.009)	0.964	(0.922, 1.008)
Mother Worked Full-time	0.919 ***	(0.885, 0.955)	0.919 ***	(0.885, 0.954)
Average Hours Worked	0.989 ***	(0.987, 0.991)	0.989 ***	(0.987, 0.991)
Real Weekly Income	0.994 ***	(0.993, 0.994)	0.994 ***	(0.993, 0.994)
Grade 8 or 10	0.783 ***	(0.741, 0.827)	0.783 ***	(0.742, 0.827)
Year=1992	1.120 ***	(1.075, 1.167)	1.120 ***	(1.075, 1.167)
Year=1993	1.104 ***	(1.064, 1.145)	1.104 ***	(1.064, 1.145)

Note: odds ratio greater one means less likely to cross the threshold;
* P<0.05; **P<0.01; P<0.001.

Figure 1. The Effects of Cigarette Prices On Different Thresholds of Smoking Uptake



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