DISCUSSION PAPER SERIES

IZA DP No. 9144

Cigarette Taxes and Youth Smoking: Updated Estimates Using YRBS Data

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June 2015

Forschungsinstitut
zur Zukunft der Arbeit
Institute for the Study
of Labor

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ABSTRACT

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Using data from the state and national Youth Risk Behavior Surveys for the period 1991-2005, Carpenter and Cook (2008) found a strong, negative relationship between cigarette taxes and youth smoking. We revisit this relationship using four additional waves of YRBS data (2007, 2009, 2011, and 2013). Our results suggest that youths have become much less responsive to cigarette taxes since 2005. In fact, we find little evidence of a negative relationship between cigarette taxes and youth smoking when we restrict our attention to the period 2007-2013.

JEL Classification: I18, H71

Keywords: cigarette tax, tobacco control, youth smoking

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1. Introduction

Within the past decade, 31 states have increased their excise tax on cigarettes. Moreover, several of these tax increases have been substantial. For instance, Massachusetts increased its per-pack tax by $1.00 in 2008 and Minnesota increased its per-pack tax by $1.60 in 2013.

Although often motivated by budgetary shortfalls (Ellis 2008; Dewan 2009), increasing the tax on cigarettes has, according to many experts, the added benefit of discouraging youth smoking (Chaloupka et al. 2011). The strongest evidence to date that cigarette taxes are, in fact, negatively related to youth smoking comes from Carpenter and Cook (2008). Using data from the state and national Youth Risk Behavior Surveys (YRBS) for the period 1991-2005, Carpenter and Cook (hereafter C&C) found that a one-dollar increase in the per-pack cigarette tax was associated with a 3-6 percentage point reduction in smoking participation among high school students and a 2-4 percentage point reduction in frequent smoking (defined as having smoked on 20 of the past 30 days).[1]

The current study revisits the relationship between cigarette taxes and youth smoking using the same data sources as used by C&C, the state and national YRBS. Since 2005, the last year of data available to C&C, four additional waves of YRBS data have been collected (2007, 2009, 2011, and 2013). With these extra data, we update the C&C estimates of the relationship between cigarette taxes and youth smoking, test to see if this relationship has changed since 2005, and explore the sensitivity of the C&C estimates and our own updated estimates to various, frequently employed changes in specification.

[1] The national YRBS data used by C&C covered the period 1991-2005; the state YRBS data covered the period 1993-2005. Using local YRBS data for the period 1993-2005, C&C also presented estimates of the effect of cigarette taxes on $\ln(Y_c/1\text{-}Y_c)$, where Y was defined as the proportion of respondents in city c who smoked in the past 30 days. C&C did not translate these estimates into marginal effects.

We highlight three basic results. First, there is a clear negative relationship between cigarette taxes and youth smoking for the period 1991-2013, albeit substantially smaller in magnitude than that found by C&C. Second, despite the fact that many states have increased their per-pack tax since 2005, the relationship between cigarette taxes and youth smoking appears to have become weaker over time; in fact, when we restrict our attention to the four additional waves of data (2007, 2009, 2011, 2013), there is little evidence that cigarette taxes discourage youth smoking. Third, we find that controlling for state-specific trends eliminates the relationship between cigarette taxes and youth smoking regardless of the period examined. We argue that, by controlling for state-specific trends, we run the risk of discarding informative variation in taxes, but cannot rule out the possibility that the state-specific trends capture unobservable changes in, for instance, preferences that are correlated with both the cigarette tax and youth smoking.

We conclude by noting that youth smoking participation fell precipitously from the late 1990s to the mid-2000s. In 1997, more than one-third of high school students were smokers; by 2005, only 23 percent of high school students reported having smoked a cigarette within the last 30 days.[2] We speculate that anti-smoking efforts undertaken prior to 2005—including substantial cigarette tax increases passed by many states in the late 1990s and early 2000s—may have discouraged all but the most price-insensitive youth from experimenting with tobacco. Another possibility is that an increasing reliance on social sources and online vendors (Fix et al. 2006; Hansen et al. 2013) has helped insulate teenagers from anti-smoking policies.

[2] These figures are based on weighted national YRBS data. Respondents to the YRBS were asked, "During the past 30 days, on how many days did you smoke cigarettes?" In 1997, 36.4 percent of respondents answered that they had smoked cigarettes on at least one day during the last month. By 2005, only 23.0 percent of respondents reported having smoked in the past month.

2. Background

The relationship between cigarette taxes and youth smoking has received a fair amount of attention from researchers. Despite this fact, a consensus view has not been reached. For instance, a recent review by Bader, Boisclair and Ferrence (2011) concluded that cigarette taxes discouraged teenagers and young adults from smoking (p. 4123); in contrast, Guindon (2013, p. 13), who reviewed basically the same literature, concluded "existing studies do not provide strong evidence that tobacco prices or taxes affect smoking onset".

Although this is a crowded literature, the C&C study arguably stands out in terms of quality. While many of the studies published prior to 2008 relied on cross-sectional data, C&C relied on within-state variation in cigarette taxes. As noted by DeCicca, Kenkel and Mathios (2002, pp. 148-149) and others, the cross-sectional relationship between cigarette taxes and youth smoking is likely biased due to difficult-to-measure factors such as antismoking sentiment at the state level.

Moreover, C&C were able to exploit substantial within-state changes in the cigarette tax. During the period 1991-2005, 48 states increased how much they taxed cigarettes; 40 of these 49 states increased their per-pack tax by more than $0.25 (in 2005 dollars), and 27 increased their per-pack tax by more than $0.50.[3] In comparison, 47 states increased their per-pack tax during the period 1970-1990, but only two increased it by more than $0.50 (in 2005 dollars).

Finally, C&C were the first researchers in this literature to use state YRBS data. The state YRBS data are school-based and contain many of the same questions as the national YRBS.

[3] For these state counts and all subsequent counts, the District of Columbia is counted as a state

They are coordinated by the Centers for Disease Control (CDC) and are typically administered by state health departments to high school students every other year. As noted by C&C, one of the advantages to using these data is that they are representative at the state level.

3. Data and methods

Our analysis draws on state and national YRBS data at the individual level for the period 1991-2013. Appendix Tables 1 and 2 report observations by state and year. A total of 45 states conducted at least two surveys during this period, gave the CDC permission to distribute their data, or were willing to provide their data directly to us. On average, we have access to data from 21 state YRBS surveys per year during the period 1991-2005, and 40 state YRBS surveys per year during the period 2007-2013.[4]

Although intended to be nationally representative, not all 50 states contributed data to any given wave of the national YRBS. In fact, between 1991 and 2013, only 5 states contributed data to the national YRBS every year (California, Georgia, Michigan, New York, and Texas). On average, 27 states contributed national YRBS data in any given year during the period 1991-2005. During the period 2007-2013, an average of 26 states contributed national YRBS data in any given year.[5]

Following C&C, we use the data described above to estimate a standard logit model in which an indicator of smoking (or frequent smoking), *S*, is equal to 1 if an unobserved variable,

[4] When we restrict our analysis to states that conducted (and made available) state YRBS surveys at least three times during the period 1991-2005 and at least three times during the period 2007-2013, our results are similar to those reported below.

[5] A total of 48 states contributed data to the national YRBS during the period 1991-2013. Each of these states increased its nominal tax on cigarettes at least once during this period. As noted above, 45 states contributed data to the state YRBS analysis. Again, each of these states increased its nominal cigarette tax at least once. During the period 2007-2013, 31 states increased their tax on cigarettes; the average per-pack increase was $0.46 (in 2005 dollars). In comparison, during the period 1991-2005, 49 states increased their nominal excise tax on cigarettes and the average per-pack increase was $0.28 (in 2005 dollars). When we restrict our analysis to states that contributed data to the national YRBS at least three times during the period 1991-2005 and at least three times during the period 2007-2013, our results are qualitatively unchanged from those reported below.

S^*, is positive. Although S^* is unobserved, it is related to a set of observable variables by the equation:

$$(1) \qquad S^*_{ist} = \alpha_0 + \alpha_1 Tax_{st} + \boldsymbol{X}_{ist}\boldsymbol{\beta} + \nu_s + z_t + \varepsilon_{ist},$$

where *i* indexes respondents, *s* indexes states, *t* indexes years, and the distribution of ε_i is logistic. State fixed effects are represented by ν_s and year fixed effects are represented by z_t. The independent variable of interest is *Tax*, equal to the per-pack excise tax on cigarettes in 2005 dollars. The vector $\boldsymbol{X}$ includes measures of race, sex, age and grade. In addition, we control for the state unemployment rate and 6 clean indoor air law indicators.[6]

4. Results

Table 1 presents estimates of equation (1) based on the state YRBS data. Marginal effects, $\delta \Pr(S = 1)/\delta Tax$, are reported and standard errors are corrected for clustering at the state level.

In the first column of Table 1, we restrict our attention to state YRBS surveys conducted during the period 1991-2005. A one-dollar tax increase is associated with a 2.6 percentage point decrease in smoking participation and a 1.9 percentage point decrease in frequent smoking. The semi-elasticities based on these estimates are -9.7 and -14.8, respectively.[7]

[6] Information on clean indoor air laws is available from the ImpacTeen program sponsored by the Robert Wood Johnson Foundation at http://www.impacteen.org/tobaccodata.htm. The indicators are for whether the state restricted smoking in private sector buildings, government buildings, restaurants, shopping areas, public schools and private schools. Appendix Table 3 reports descriptive statistics.

[7] In other words, a one-dollar increase in the cigarette tax is associated with a 9.7 percent decrease in smoking participation and a 14.8 percent decrease in frequent smoking. Using aggregate state YRBS data for the period 1993-2005, C&C found that a one-dollar increase in the cigarette tax was associated with a 2.7 percentage point decrease in smoking participation and a 2.4 percentage point decrease in frequent smoking. The corresponding semi-elasticites were -9.2 and -17.8 (Carpenter and Cook 2008, p. 294).

In the second column of Table 1, we include the additional four waves of state YRBS data and our estimates of α_1 shrink considerably. Specifically, for the period 1991-2013, a one-dollar tax increase is associated with a 1.0 percentage point decrease in smoking participation and a 0.7 percentage point decrease in frequent smoking. The semi-elasticities are -4.8 and -7.6, roughly half the magnitude of the semi-elasticities obtained for the period 1991-2005.[8]

In the third column of Table 1, we restrict our attention to the four additional waves of YRBS data (2007, 2009, 2011, 2013). The estimated relationship between taxes and youth smoking is actually positive during the period 2007-2013: a one-dollar increase in the tax is associated with a (statistically insignificant) 0.7 percentage point increase in smoking participation and a (statistically insignificant) 0.2 percentage point increase in frequent smoking. We can formally reject the hypothesis that α_1 was stable across the two periods (1991-2005 vs. 2007-2013) for both smoking participation and frequent smoking.

Table 2 presents estimates of equation (1) based on the weighted national YRBS data. In column (1) of Table 2, we focus on data collected between 1991 and 2005, the period examined by C&C. We find that a one-dollar tax increase is associated with a 4.6 percentage point decrease in smoking participation and a 2.6 percentage point decrease in frequent smoking.[9] The semi-elasticities based on these estimates are -15.5 and -19.1, respectively. When the four additional waves of data are included in the analysis, a one-dollar tax increase is associated with

[8] In Appendix Tables 4-6, we report estimates of equation (1) for 1991-2005, 1991-2007, 1991-2009, 1991-20011, and 1991-2013. With only a few exceptions, the relationship between taxes and smoking shrinks as additional waves of data are included.

[9] Using national YRBS data for the period 1991-2005, C&C found that a one-dollar increase in the cigarette tax was associated with a 5.9 percentage point decrease in smoking participation and a 4.1 percentage point decrease in frequent smoking. The C&C results were based on weighted national data, which we use in Table 2. In Appendix Table 7, we report estimates of equation (1) based on unweighted national data. For the period 1991-2005, a one-dollar increase in the cigarette tax is associated with a 3.8 percentage point decrease in smoking participation and a (statistically insignificant) 1.9 percentage point decrease in frequent smoking.

a 2.8 percentage point decrease in smoking participation and a 1.6 percentage point decrease in frequent smoking; the corresponding semi-elasticities are -10.9 and -14.1. If we restrict our attention to the period 2007-2013, a one-dollar tax increase is associated with a (statistically insignificant) 1.1 percentage point decrease in smoking participation and a (statistically insignificant) 0.6 percentage point decrease in frequent smoking. We cannot, however, formally reject the hypothesis that α_1 was stable across the two periods.

Finally, in Table 3 we combine the national and state YRBS data in an effort to exploit as much identifying variation as possible. For the period 1991-2005, a one-dollar tax increase is associated with a 3.0 percentage point decrease in smoking participation and a 1.9 percentage point decrease in frequent smoking. When the additional waves of data are included, these estimates fall by more than 50 percent, as do the corresponding semi-elasticities. When we focus just on the period 2007-2013, the relationship between taxes and youth smoking is again positive: a one-dollar tax increase is associated with a (statistically insignificant) 0.7 percentage point increase in smoking participation and a (statistically insignificant) 0.2 percentage point increase in frequent smoking. We can reject the hypothesis that the relationship between smoking and taxes was stable across the two periods.

5. Adding state-specific trends

Equation (1) can be modified to include state-specific linear trends, which are intended to capture the effects of omitted factors at the state level that evolved at a constant rate such as anti-

smoking sentiment. It should be noted, however, that by including state-specific trends, we run the risk of discarding potentially valid (i.e., exogenous) variation.[10]

In general, including state-specific linear trends produces much smaller estimates of the relationship between cigarette taxes and youth smoking (Table 4). For instance, if we restrict our attention to the period 1991-2005 and include state-specific linear trends, a one-dollar tax increase is associated with a (statistically insignificant) 0.7 percentage point decrease in smoking participation. With the four additional waves of data, a one-dollar tax increase is associated with a (statistically insignificant) 0.3 increase in smoking participation percentage points. Including state-specific quadratic trends produces a similar pattern of results (Appendix Tables 8). When we include U.S. Census Region-year interactions, our estimates of α_1 are smaller than those reported in Table 3, but still significant and negative for the period 1991-2013.

6. Discussion

Using state and national YRBS data for the period 1991-2005, Carpenter and Cook (2008) found a strong negative relationship between cigarette taxes and youth smoking. Since 2005, 31 states have increased their cigarette tax and many of these tax increases have been substantial. In this comment, we revisit the relationship between cigarette taxes and youth smoking using four additional waves of YRBS data (2007, 2009, 2011, and 2013).

Our results suggest that the relationship between cigarette taxes and youth smoking has weakened over time. When we combine state and national YRBS data and restrict our attention to the period 1991-2005, a one-dollar tax increase is associated with a 3.0 percentage point

[10] This point has been made in the context of examining the relationship between minimum wages and employment (Neumark et al. 2014). A regression of cigarette taxes on a set of state and year fixed effects and the controls shown in Appendix Table 3 produced an R-squared of 0.83. When we included state-specific linear time trends on the right-hand side of this regression, the R-squared increased to 0.93.

decrease in smoking participation and a 1.9 percentage point decrease in frequent smoking. When the additional waves of data are included, these estimates fall by more than 50 percent, as do the corresponding semi-elasticities.

Why might youth have become less responsive to cigarette taxes since 2005? In 1997, more than one-third of high school students in the United States reported having smoked at least one cigarette in the past month. By 2005, the youth smoking participation rate had fallen by approximately 10 percentage points. It is possible that anti-smoking efforts undertaken prior to 2005—including substantial cigarette tax increases passed by many states in the late 1990s and early 2000s—discouraged all but the most price-insensitive youth from experimenting with tobacco. It is also possible that an increasing reliance on social sources and online vendors (Fix et al. 2006; Hansen et al. 2013) has helped insulate teenagers from anti-smoking policies.

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Table 1. Logit Estimates of the Relationship between Cigarette Taxes and Youth Smoking Using State YRBS Data

	1991-2005	1991-2013	2007-2013
Panel I: Smoking Participation			
Cig Tax	-.026***	-.010**	.007
	(.009)	(.005)	(.006)
Mean	.267	.208	.156
Semi-elasticity	-9.72	-4.81	4.49
Test of equality across periods	z-value = 3.29 (p-value = .001)		
Panel II: Frequent Smoking			
Cig Tax	-.019*	-.007***	0.002
	(.006)	(.003)	(0.003)
Mean	.128	.092	.060
Semi-elasticity	-14.80	-7.63	3.33
Test of equality across periods	z-value = 3.38 (p-value = .001)		
Year and state fixed effects	yes	yes	yes
N	409,385	883,691	474,306

* Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Marginal effects based on unweighted state YRBS data are reported. All regressions include the unemployment rate, clean air laws, demographics, and state and year fixed effects. Standard errors clustered by state are in parentheses.

Table 2. Logit Estimates of the Relationship between Cigarette Taxes and Youth Smoking Using National YRBS Data

	1991-2005	1991-2013	2007-2013
Panel I: Smoking Participation			
Cig Tax	-.046***	-.028***	-.011
	(.022)	(.009)	(.020)
Mean	.297	.258	.175
Semi-elasticity	-15.48	-10.85	-6.29
Test of equality across periods	z-value = .94 (p-value = 0.347)		
Panel II: Frequent Smoking			
Cig Tax	-.026*	-.016***	-0.006
	(.014)	(0.006)	(0.015)
Mean	.136	.113	.060
Semi-elasticity	-19.06	-14.14	-10.00
Test of equality across periods	z-value = .58 (p-value = .561)		
Year and state fixed effects	yes	yes	yes
N	103,408	158,605	55,197

* Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Marginal effects based on weighted national YRBS data are reported. All regressions include the unemployment rate, clean air laws, demographics, and state and year fixed effects. Standard errors clustered by state are in parentheses.

Table 3. Logit Estimates of the Relationship between Cigarette Taxes and Youth Smoking Using Combined State and National YRBS Data

	1991-2005	1991-2013	2007-2013
Panel I: Smoking Participation			
Cig Tax	-.030***	-.011**	.007
	(.008)	(.005)	(.006)
Mean	.269	.213	.158
Semi-elasticity	-11.15	-5.15	4.43
Test of equality across periods	z-value = 3.46 (p-value = .001)		
Panel II: Frequent Smoking			
Cig Tax	-.019***	-.007***	.002
	(.004)	(.002)	(.003)
Mean	.125	.092	.060
Semi-elasticity	-15.19	-7.57	3.33
Test of equality across periods	z-value = 3.29 (p-value = .001)		
Year and state fixed effects	yes	yes	yes
N	512,793	1,042,296	529,503

* Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Marginal effects based on unweighted state and national YRBS data are reported. All regressions include the unemployment rate, clean air laws, demographics, and state and year fixed effects. Standard errors clustered by state are in parentheses.

Table 4. Logit Estimates of the Relationship between Cigarette Taxes and Youth Smoking Controlling for State-Specific Linear Time Trends

	1991-2005	1991-2013	2007-2013
Panel I: Smoking Participation			
Cig Tax	-.007	.003	-.005
	(.008)	(.009)	(.006)
Mean	.269	.213	.158
Semi-elasticity	-2.69	1.41	3.16
Test of equality across periods	z-value = 0.18 (p-value = .856)		
Panel II: Frequent Smoking			
Cig Tax	-.008	.000	.001
	(.006)	(.005)	(.003)
Mean	.125	.092	.060
Semi-elasticity	-6.40	0.00	1.67
Test of equality across periods	z-value = 1.12 (p-value = .262)		
Year and state fixed effects	yes	yes	yes
State-specific linear trends	yes	yes	yes
N	512,793	1,042,296	529,503

* Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Marginal effects based on unweighted state and national YRBS data are reported. All regressions include the unemployment rate, clean air laws, demographics, and state and year fixed effects. Standard errors clustered by state are in parentheses.

Appendix Table 1. National YRBS State by Year Observation Count

	1991	*1993*	*1995*	*1997*	*1999*	*2001*	*2003*	*2005*	*2007*	*2009*	*2011*	*2013*	***Total***
ALABAMA	0	761	96	707	58	301	607	0	461	1,016	309	311	4,627
ARIZONA	0	426	0	1,028	129	396	328	271	499	344	1,083	172	4,676
ARKANSAS	0	372	282	342	0	0	270	0	393	294	0	299	2,252
CALIFORNIA	1,677	1,900	630	1,857	2,410	2,079	1,626	1,477	2,005	2,687	1,796	2,377	22,521
COLORADO	141	254	99	255	0	620	0	0	0	189	275	274	2,107
CONNECTICUT	0	0	228	201	0	0	0	224	0	0	0	61	714
DELAWARE	0	0	209	0	0	0	353	0	0	0	226	0	788
D.C.	0	0	474	0	0	0	0	0	0	0	297	0	771
FLORIDA	1,143	0	520	649	824	1,026	1,435	517	719	220	1,372	952	9,377
GEORGIA	466	879	421	322	789	468	391	1,765	338	1,272	123	352	7,586
HAWAII	0	0	0	0	303	0	0	0	0	0	0	0	303
IDAHO	0	0	0	0	0	144	0	228	0	0	259	251	882
ILLINOIS	394	264	232	0	218	409	300	462	561	1,405	950	620	5,815
INDIANA	263	0	0	0	0	170	403	162	391	0	261	802	2,452
IOWA	0	0	239	732	0	0	0	232	241	0	0	0	1,444
KANSAS	0	166	0	199	0	0	297	271	0	193	293	190	1,609
KENTUCKY	0	0	341	0	0	0	0	514	348	0	208	647	2,058
LOUISIANA	0	0	731	536	586	0	645	141	0	413	0	0	3,052
MAINE	0	241	149	231	192	201	187	0	0	0	0	0	1,201
MARYLAND	200	141	0	759	0	0	247	0	0	0	0	501	1,848
MASSACHUSETTS	0	347	270	1,522	0	248	208	248	696	0	279	0	3,818
MICHIGAN	712	136	1,059	473	502	318	388	287	284	312	605	469	5,545
MINNESOTA	0	317	0	0	0	0	0	93	0	185	0	290	885
MISSISSIPPI	462	348	469	302	623	324	0	0	331	0	91	560	3,510

MISSOURI	237	178	534	0	546	449	253	99	337	81	332	266	3,312
MONTANA	0	0	0	0	0	168	0	0	0	0	0	0	168
NEBRASKA	0	391	0	0	0	0	0	0	0	0	0	0	391
NEVADA	0	0	0	0	0	228	0	0	0	381	195	0	804
NEW HAMPSHIRE	248	0	0	0	0	0	0	0	0	0	0	0	248
NEW JERSEY	429	0	0	682	231	208	286	294	668	471	111	354	3,734
NEW MEXICO	248	640	0	260	0	144	99	0	213	583	0	0	2,187
NEW YORK	354	479	268	336	695	291	878	454	895	1,139	622	372	6,783
NORTH CAROLINA	0	294	109	313	493	651	0	630	544	0	1,067	365	4,466
OHIO	130	513	540	500	546	219	278	261	0	0	0	155	3,142
OKLAHOMA	0	0	0	212	0	388	0	226	269	0	0	0	1,095
OREGON	0	185	0	0	0	181	0	265	0	239	0	0	870
PENNSYLVANIA	465	351	638	255	477	0	310	391	206	1,036	417	256	4,802
RHODE ISLAND	0	0	0	0	70	0	0	0	0	0	0	0	70
SOUTH CAROLINA	274	385	0	484	769	0	839	271	0	0	0	0	3,022
SOUTH DAKOTA	266	0	0	0	0	0	290	0	0	0	0	0	556
TENNESSEE	0	497	0	546	263	584	0	387	156	0	282	0	2,715
TEXAS	2,392	1,300	1,152	896	2,622	1,941	2,460	1,651	1,487	1,286	1,690	380	19,257
UTAH	0	0	0	0	0	0	173	271	196	0	0	0	640
VERMONT	137	0	0	0	0	0	227	0	0	0	0	0	364
VIRGINIA	664	0	62	0	714	0	231	340	421	97	195	1,080	3,804
WASHINGTON	413	373	82	102	0	47	0	100	0	242	161	192	1,712
WEST VIRGINIA	0	294	0	0	0	257	0	222	234	450	249	0	1,706
WISCONSIN	0	0	0	275	525	232	176	235	175	662	636	0	2,916
Total	11,715	12,432	9,834	14,976	14,585	12,692	14,185	12,989	13,068	15,197	14,384	12,548	158,605

Appendix Table 2. State YRBS State by Year Observation Count

	1991	*1993*	*1995*	*1997*	*1999*	*2001*	*2003*	*2005*	*2007*	*2009*	*2011*	*2013*	*Total*
ALABAMA	2,294	0	3,695	3,543	1,980	1,437	1,005	1,006	0	1,329	1,292	1,416	18,997
ALASKA	0	0	0	0	0	0	1,387	0	1,205	1,172	1,203	1,125	6,092
ARIZONA	0	0	0	0	0	0	3,201	2,997	2,694	2,303	2,563	1,470	15,228
ARKANSAS	0	0	2,166	1,885	1,407	1,614	0	1,406	1,463	1,507	1,244	1,366	14,058
COLORADO	0	0	0	0	0	0	0	1,417	0	1,399	1,370	0	4,186
CONNECTICUT	0	0	0	1,671	0	0	0	2,085	1,984	2,310	1,992	2,305	12,347
DELAWARE	0	0	0	0	2,267	2,750	2,887	2,548	2,275	2,162	2,112	2,461	19,462
FLORIDA	0	0	0	0	0	0	3,829	4,273	4,219	5,193	5,933	5,746	29,193
GEORGIA	2,116	1,549	0	0	0	0	1,919	1,582	2,256	1,706	1,722	1,727	14,577
IDAHO	0	0	0	0	0	1,604	1,651	1,374	1,317	2,020	1,610	1,794	11,370
ILLINOIS	0	0	0	0	0	0	0	0	2,239	2,736	3,216	2,943	11,134
INDIANA	0	0	0	0	0	0	1,542	1,452	2,172	1,423	2,659	0	9,248
IOWA	0	0	0	0	0	0	0	1,324	1,388	0	1,482	0	4,194
KANSAS	0	0	0	0	0	0	0	1,580	1,624	1,931	1,749	1,813	8,697
KENTUCKY	0	0	0	0	0	0	1,495	3,073	3,238	1,621	1,639	1,495	12,561
LOUISIANA	0	0	0	0	0	0	0	0	1,201	916	1,004	943	4,064
MAINE	0	0	1,342	1,761	0	1,252	1,550	1,262	1,224	7,987	8,695	7,874	32,947
MARYLAND	0	0	0	0	0	0	0	1,341	1,382	1,488	2,540	48,111	54,862
MASSACHUSETTS	0	3,137	3,970	3,800	4,156	3,808	3,298	3,067	2,899	2,521	2,540	2,594	35,790
MICHIGAN	0	0	0	4,144	2,508	3,282	3,160	3,033	3,239	3,097	3,894	3,930	30,287
MISSISSIPPI	0	1,394	1,214	1,412	1,538	1,686	1,419	0	1,462	1,684	1,719	1,456	14,984
MISSOURI	0	0	4,682	1,407	1,590	1,584	1,490	1,813	1,465	1,540	0	1,505	17,076
MONTANA	0	2,405	2,413	2,443	2,798	2,422	2,513	2,815	3,689	1,715	3,859	4,565	31,637
NEBRASKA	2,278	3,113	0	0	0	0	2,623	3,505	0	0	3,570	1,731	16,820
NEVADA	0	1,943	1,472	1,410	1,638	1,380	1,892	1,474	1,686	1,948	0	1,959	16,802
NEW HAMPSHIRE	0	2,589	2,079	0	0	0	1,276	1,230	1,585	1,450	1,362	1,568	13,139
NEW JERSEY	0	0	0	0	0	1,965	0	1,460	0	1,692	1,582	1,622	8,321

NEW MEXICO	2,776	0	0	0	0	0	0	5,022	2,368	4,562	5,362	4,996	25,086
NEW YORK	0	0	0	3,575	3,261	0	8,663	8,985	12,192	13,289	12,099	9,620	71,684
NORTH CAROLINA	0	2,664	1,888	0	0	2,408	2,422	3,761	3,346	5,445	2,161	1,758	25,853
NORTH DAKOTA	0	0	0	0	1,730	1,495	1,562	1,631	1,636	1,737	1,799	1,843	13,433
OHIO	0	2,373	0	2,111	1,968	0	1,133	1,323	2,355	0	1,281	1,416	13,960
OKLAHOMA	0	0	0	0	0	0	1,316	1,632	2,490	1,361	1,111	1,428	9,338
PENNSYLVANIA	0	0	0	0	0	0	0	0	0	1,977	0	0	1,977
RHODE ISLAND	0	0	0	1,433	0	1,303	1,705	2,206	2,014	2,940	3,585	2,250	17,436
SOUTH CAROLINA	5,286	4,507	5,165	5,175	4,302	0	0	1,198	1,122	1,007	1,304	1,476	30,542
SOUTH DAKOTA	1,287	1,302	1,132	1,519	1,598	1,448	1,682	1,479	1,452	2,012	0	1,210	16,121
TENNESSEE	0	3,200	0	0	0	0	1,850	1,472	1,952	2,122	2,499	1,719	14,814
TEXAS	0	0	0	0	0	6,587	0	3,880	3,162	3,324	3,771	2,889	23,613
UTAH	4,353	4,309	3,139	1,337	0	1,013	1,371	1,455	1,829	1,505	1,597	2,057	23,965
VERMONT	0	0	0	0	8,550	8,937	7,876	9,059	7,294	9,884	8,123	0	59,723
VIRGINIA	0	0	0	0	0	0	0	0	0	0	1,329	6,338	7,667
WEST VIRGINIA	0	2,729	2,007	1,751	1,440	0	1,655	1,301	1,299	1,499	2,031	1,702	17,414
WISCONSIN	0	3,169	0	1,239	1,250	1,955	1,997	2,264	1,986	2,333	2,863	2,691	21,747
WYOMING	0	0	1,629	1,916	1,589	2,643	1,480	2,310	2,035	2,633	2,265	2,745	21,245
Total	20,390	40,383	37,993	43,532	45,570	52,573	72,849	96,095	96,438	112,480	115,731	149,657	883,691

Appendix Table 3. Summary Statistics for Combined State and National YRBS

Dependent Variables	*1991-2005*	*1991-2007*	*1991-2009*	*1991-2011*	*1991-2013*
Smoking Participation	0.269	0.254	0.241	0.228	0.213
	(0.443)	(0.436)	(0.428)	(0.420)	(0.410)
Frequent Smoking	0.125	0.117	0.108	0.101	0.092
	(0.331)	(0.321)	(0.311)	(0.301)	(0.290)
Everyday Smoking	0.094	0.088	0.082	0.076	0.069
	(0.292)	(0.283)	(0.274)	(0.265)	(0.254)
Independent Variables					
Age	16.009	16.003	15.993	15.987	15.971
	(1.254)	(1.250)	(1.251)	(1.250)	(1.248)
Male	0.486	0.486	0.485	0.485	0.485
	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)
Black	0.155	0.152	0.149	0.147	0.149
	(0.362)	(0.359)	(0.357)	(0.354)	(0.356)
Hispanic	0.103	0.100	0.100	0.098	0.093
	(0.303)	(0.300)	(0.301)	(0.298)	(0.290)
Asian	0.032	0.032	0.034	0.035	0.037
	(0.175)	(0.177)	(0.181)	(0.184)	(0.189)
Other Race	0.078	0.089	0.099	0.111	0.122
	(0.268)	(0.285)	(0.299)	(0.315)	(0.327)
Grade	10.306	10.306	10.311	10.319	10.325
	(1.291)	(1.280)	(1.272)	(1.268)	(1.263)
Cigarette Taxes (2005$)	0.556	0.638	0.752	0.866	0.957
	(0.446)	(0.505)	(0.616)	(0.734)	(0.776)
Unemployment Rates	0.050	0.049	0.055	0.059	0.061
	(0.013)	(0.012)	(0.019)	(0.021)	(0.020)
N	512,793	622,299	749,976	880,091	1,042,296

Notes: Unweighted means are reported. Standard deviations are in parentheses.

Appendix Table 4. Logit Estimates of the Relationship between Cigarette Taxes and Youth Smoking Using State YRBS Data

	1991-2005	*1991-2007*	*1991-2009*	*1991-2011*	*1991-2013*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Panel I: Smoking Participation					
Cig Tax	-.026***	-.015*	-.016***	-.012**	-.010**
	(.009)	(.009)	(.006)	(.005)	(.005)
Mean	.267	.251	.237	.224	.208
Semi-elasticity	-9.72	-5.97	-6.75	-5.37	-4.81
Panel II: Frequent Smoking					
Cig Tax	-.019***	-.011**	-.009***	-.008***	-.007***
	(.006)	(.005)	(.003)	(.003)	(.003)
Mean	.128	.119	.109	.101	.092
Semi-elasticity	-14.80	-9.26	-8.22	-7.90	-7.63
State and year FEs	yes	yes	yes	yes	yes
N	409,385	505,823	618,303	734,034	883,691

* Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Marginal effects based on unweighted state YRBS data are reported. All regressions include the unemployment rate, clean air laws, demographics, and state and year fixed effects. Standard errors clustered by state are in parentheses.

Appendix Table 5. Logit Estimates of the Relationship between Cigarette Taxes and Youth Smoking Using National YRBS Data

	1991-2005	*1991-2007*	*1991-2009*	*1991-2011*	*1991-2013*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Panel I: Smoking Participation					
Cig Tax	-.046***	-.033***	-.031***	-.026***	-.028***
	(.022)	(.017)	(.013)	(.011)	(.009)
Mean	.297	.286	.276	.267	.258
Semi-elasticity	-15.48	-11.53	-11.23	-9.75	-10.85
Panel II: Frequent Smoking					
Cig Tax	-.026*	-.022*	-.022***	-.016**	-.016***
	(.014)	(.012)	(.008)	(.007)	(.006)
Mean	.136	.13	.124	.118	.113
Semi-elasticity	-19.06	-16.88	-17.76	-13.56	-14.14
State/year FEs	yes	yes	yes	yes	yes
N	103,408	116,476	131,673	146,057	158,605

* Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Marginal effects based on weighted national YRBS data are reported. All regressions include the unemployment rate, clean air laws, demographics, and state and year fixed effects. Standard errors clustered by state are in parentheses.

Appendix Table 6. Logit Estimates of the Relationship between Cigarette Taxes and Youth Smoking Using Combined State and National YRBS Data

	1991-2005	*1991-2007*	*1991-2009*	*1991-2011*	*1991-2013*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Panel I: Smoking Participation					
Cig Tax	-.030***	-.019**	-.018***	-.014***	-.011**
	(.008)	(.007)	(.005)	(.005)	(.005)
Mean	0.269	0.254	0.241	0.228	0.213
Semi-elasticity	-11.15	-7.47	-7.48	-6.13	-5.15
Panel II: Frequent Smoking					
Cig Tax	-.019***	-.012***	-.010***	-.009***	-.007***
	(.004)	(.004)	(.002)	(.003)	(.002)
Mean	0.125	0.117	0.108	0.101	0.092
Semi-elasticity	-15.19	-10.28	-9.22	-8.91	-7.57
State and Year FEs	yes	yes	yes	yes	yes
N	512,793	622,299	749,976	880,091	1,042,296

* Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Marginal effects based on unweighted state and national YRBS data are reported. All regressions include the unemployment rate, clean air laws, demographics, and state and year fixed effects. Standard errors clustered by state are in parentheses.

Appendix Table 7. Logit Estimates of the Relationship between Cigarette Taxes and Youth Smoking Using Unweighted National YRBS Data

	1991-2005	1991-2013	2007-2013
Panel I: Smoking Participation			
Cig Tax	-.038*	-.034**	0.007
	(.020)	(.018)	(0.016)
Mean	.272	.239	.175
Semi-elasticity	-13.96	-7.97	4.00
Test of equality across periods	z-value = 1.54 (p-value = 0.123)		
Panel II: Frequent Smoking			
Cig Tax	-.019	-.012***	0.002
	(.012)	(0.004)	(0.007)
Mean	.108	.092	.060
Semi-elasticity	-17.53	-13.10	3.33
Test of equality across periods	z-value = 1.26 (p-value = 0.208)		
Year and state fixed effects	yes	yes	yes
N	103,408	158,605	55,197

* Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Marginal effects based on unweighted national YRBS data are reported. All regressions include the unemployment rate, clean air laws, demographics, and state and year fixed effects. Standard errors clustered by state are in parentheses.

Appendix Table 8. Logit Estimates of the Relationship between Cigarette Taxes and Youth Smoking Controlling for State-Specific Quadratic Time Trends

	1991-2005	1991-2013	2007-2013
Panel I: Smoking Participation			
Cig Tax	-.009	.002	-.005
	(.013)	(.010)	(.008)
Mean	.269	.212	.158
Semi-elasticity	-3.35	.94	-3.16
Test of equality across periods	z-value = 1.01 (p-value = .310)		
Panel II: Frequent Smoking			
Cig Tax	.001	.001	.003
	(.009)	(.005)	(.006)
Mean	.125	.092	.060
Semi-elasticity	0.80	1.09	5.00
Test of equality across periods	z-value = .22 (p-value = .824)		
Year and state fixed effects	yes	yes	yes
State-specific quadratic trends	yes	yes	yes
N	512,793	1,042,296	529,503

* Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Marginal effects based on unweighted state and national YRBS data are reported. All regressions include the unemployment rate, clean air laws, demographics, and state and year fixed effects. Standard errors clustered by state are in parentheses.

Appendix Table 9. Logit Estimates of the Relationship between Cigarette Taxes and Youth Smoking Controlling for Region-Year Interactions

	1991-2005	1991-2013	2007-2013
Panel I: Smoking Participation			
Cig Tax	-.009	-0.010**	-.004
	(.007)	(.004)	(.005)
Mean	.269	.212	.158
Semi-elasticity	-3.35	-4.72	-2.53
Test of equality across periods	z-value = -0.81 (p-value = .417)		
Panel II: Frequent Smoking			
Cig Tax	-.004	-0.006***	-.002
	(.003)	(.002)	(.003)
Mean	.125	.092	.060
Semi-elasticity	-3.20	-6.52	-3.33
Test of equality across periods	z-value = 0.58 (p-value = .564)		
State fixed effects	yes	yes	yes
Region-year interactions	yes	yes	yes
N	512,793	1,042,296	529,503

* Statistically significant at 10% level; ** at 5% level; *** at 1% level.

Notes: Marginal effects based on unweighted state and national YRBS data are reported. All regressions include the unemployment rate, clean air laws, demographics, and state fixed effects and three U.S. Census Region indicators (Northeast, Midwest, West) interacted with year. Standard errors clustered by state are in parentheses.