Cigarette Taxes, Smoking, and Health in the Long Run

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Will pause for questions at end of background and after discussing methods
Health hazards of cigarettes

1964 Surgeon General’s report
   Evidence consistent with severe health costs of smoking

Subsequent aggressive tobacco control effort
   Cigarette taxes among the most important
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Yet evidence on long-run effects of smoking potentially confounded
   Most studies compare smokers to non-smokers, with limited controls
   Smokers different in hard-to-observe ways (less risk averse, worse health)
   Estimates using economic models to correct for selection find smaller mortality effects

SMOKING and HEALTH
REPORT OF THE ADVISORY COMMITTEE TO THE SURGEON GENERAL OF THE PUBLIC HEALTH SERVICE
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This paper: quasi-experimental evidence on long-run effects of tobacco control policy on smoking and health
Long-run effects of cigarette taxes

Research question: What is the effect of teenage cigarette taxes on adult smoking and mortality?

- Teenage taxes clearly influence teenage smoking
- Smoking initiation typically begins by age 20
- Teenage smoking correlated with adult smoking
- Adult smoking and mortality are key long-run health outcomes

We use quasi-experimental variation in cigarette taxes

- Comparisons involve state-by-year birth cohorts facing higher vs. lower teen taxes
- Avoid the confounding from comparing smokers and non-smokers

Introduction
Data and approach

Combine data from several sources

State cigarette taxes: Tax Burden on Tobacco, 1950-2018

Estimation approach compares people subject to different teenage taxes

Adjusts for cross-state heterogeneity, general trends in mortality, as well as rich set of additional controls

Key assumption: state-specific timing of teenage taxes uncorrelated with pre-existing trends in adult smoking and mortality
Teenage taxes reduce adult smoking

Adult smoking is sensitive to teenage taxes
   Each $1 higher taxes at ages 14-17 reduces adult smoking by 1.8 percentage points
Teenage taxes reduce adult smoking, mortality

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Adult mortality is also sensitive to teenage taxes
   Each $1 higher taxes reduces mortality by 20 per 100,000 (4%)
   Reductions concentrated among men, “smoking related” causes of death
   Teenage years special: no effect of taxes at ages 1-10 or 20-24
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Implications
   Rising cigarette taxes over the 20th century produced long-lasting gains
   Potentially important long-run health benefits of controlling teenage smoking
Background
Background, or why we think there’s something left to learn about cigarettes and health
Main evidence on smoking and health

Early evidence: smoking associated with cancer and mortality
   Case-control studies compare smoking of lung cancer and other cancer patients (e.g. Wynder and Graham, 1950; Doll and Hill, 1950)
   Short-run prospective studies following smokers and non-smokers (Doll and Hill, 1954; Hammond and Horn, 1958)

Large scale, long-running cohort studies confirm smoking-mortality association
   British Doctor’s Study (Hill et al., 2004)

Recent work links health interview surveys to death certificate data
   Jha et al. (2013), Pirie et al. (2013), Carter et al. (2015)
   Adjustment for age, urbanicity, adiposity, some health behaviors
The problem of unobservable confounders

Main evidence compares smokers to non-smokers, with adjustments for observed differences in mortality predictors
The problem of unobservable confounders

Main evidence compares smokers to non-smokers, with adjustments for observed differences in mortality predictors

Leaves open the possibility of unobserved confounding factors
- Risk tolerance
- Baseline health beyond comorbidities
- Expectations of future health and life expectancy

Background
The problem of unobservable confounders

Main evidence compares smokers to non-smokers, with adjustments for observed differences in mortality predictors

Leaves open the possibility of *unobserved* confounding factors

- Risk tolerance
- Baseline health beyond comorbidities
- Expectations of future health and life expectancy

Unobserved confounding seems plausible from prior literature

- People with greater genetic exposure to disease smoke more (Fang et al. 2007)
- Smokers less healthy on multiple dimensions *at initiation* (Add and Lechene 2013)
- Model-based efforts to addressing unobserved confounding → smaller effects (Darden, 2017; Darden et al. 2018)
Our contribution

We show long-run effects of tobacco taxes on adult smoking and mortality

Evidence on health consequences of smoking that avoids confounding from comparing smokers and non-smokers
   Complements large-scale, long-running studies
   Complements model-based approaches to addressing unobserved confounding

First evidence on long-run effects of tobacco taxes on health
   Short-run evidence on mortality: Moore (1996), Bowser et al. (2016)
   Teen taxes and smoking through 20s: Gruber and Zinman (2001), Glied (2002), Auld (2015)
Data
Chronology and data sources

State cigarette taxes  1950  2018
Tax Burden on Tobacco
Chronology and data sources

State cigarette taxes
Tax Burden on Tobacco

1936 - 2004
Birth cohorts with teenage (14-17) taxes observed
Chronology and data sources

State cigarette taxes
1950 - 2018

Tax Burden on Tobacco
1936 - 2004
Birth cohorts with teenage (14-17) taxes observed

Deaths
Death certificates
1990 - 2018

Adult smoking
TUS-CPS
1992 - 2018

Additional sources for state-level covariates
Chronology and data sources

State cigarette taxes

Tax Burden on Tobacco

Deaths

Death certificates

Adult smoking

TUS-CPS

Additional sources for state-level covariates

Birth cohorts with teenage (14-17) taxes observed

Birth cohorts with teenage (14-17) taxes, adult smoking, deaths observed
Defining teenage taxes

Teenage tax: inflation-adjusted average state cigarette tax, ages 14 and 17

Ideally match teenage taxes to adult outcomes using teenage residence

   Teenage residence unobserved

Instead match on adult residence

   Impute teenage (and lifecycle) taxes assuming no mobility

   Born in MA in 1986, live in IN now, impute my tax as 2000-2003 IN values:

   \[ \frac{1}{4} (0.63 + 0.61 + 1.15 + 1.12) \]

Introduces measurement error, likely attenuates our estimates
State cigarette taxes across four eras

- 1950-1971: $0.01/year (4.1%)
- 1972-1981: $0.03/year (-7.3%)
- 1981-1999: $0.01/year (2.3%)
- 1999-2019: $0.05/year (5.4%)

Real (2005) $/pack
State cigarette taxes across four eras

![Graph showing real (2005) $/pack from 1950 to 2019]

- **1950-1971**: Mean: 0.30, SD: 0.15
- **1972-1981**: Mean: -0.26, SD: 0.13
- **1982-1998**: Mean: 0.13, SD: 0.19
- **1999-2019**: Mean: 0.31, SD: 0.73

**Distribution of tax changes**

- **1950-1971**: Mean: 0.30, SD: 0.15
- **1972-1981**: Mean: -0.26, SD: 0.13
- **1982-1998**: Mean: 0.13, SD: 0.19
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Sample formation

Both samples: Born 1936-1998, age 20+, US Born

   Work with micro data
   Main outcome: indicator for “smoke some day or everyday”

Mortality data: 1990-2018 death certificates
   Aggregate to state-birth year-death year(-sex) cells
   Get 1990 population counts for state-birth year cells(-sex) cells
   Main outcome: deaths per 100,000, denominated by 1990 population
Methods
Isolating quasi-experimental variation

Goal is to compare people facing different teen taxes, otherwise similar

Regression specification

$$Y_{it} = \alpha_1 TeenTax_{s(i)} + \alpha_2 Tax_{s(i)} + X_{it} \alpha_3 + \mu_s + Trend + \epsilon_{it}$$

$$\alpha_1: \text{Effect of } $1 \text{ of teen taxes on adult outcome } Y$$
Isolating quasi-experimental variation

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State fixed effect control for permanent, cross-state differences in \( Y_{it} \)

Trend: birth year-age fixed effects, state-by-birth linear trends
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Control for adult taxes because autocorrelation in taxes
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\(\alpha_1\): Effect of $1 of teen taxes on adult outcome \(Y\)
State fixed effect control for permanent, cross-state differences in \(Y_{it}\)
Trend: birth year-age fixed effects, state-by-birth linear trends
Control for adult taxes because autocorrelation in taxes
Control for individual characteristics (race, birth year-age FE) for power, state-policies dated at time of teenage years and current-time dated
Potential concerns and solutions

Confounding from anti-tobacco sentiment
- States with higher taxes have more general opposition to tobacco
  - Addressed by (1) state fixed effects, (2) controls for other tobacco legislation

Confounding from trends in smoking or mortality
- Taxes increasing over time, as mortality and smoking generally decline
  - Addressed by fixed effects for age-by-birth year and state-specific linear trends

Attenuation bias from measurement error
- Likely bias $\alpha_1$ towards zero, so if anything our estimates are too small

Many adult smokers try to quit, or quit but relapse
- Estimates from representative samples, average over current/former/never smokers
Results
# Teenage taxes reduce adult smoking

<table>
<thead>
<tr>
<th></th>
<th>Men and women</th>
<th>Men only</th>
<th>Women only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coef. on <em>teen tax</em></td>
<td>-0.017</td>
<td>-0.018</td>
<td>-0.017</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.009)</td>
<td>(0.008)</td>
</tr>
<tr>
<td>Observations</td>
<td>1,180,499</td>
<td>521,257</td>
<td>659,242</td>
</tr>
<tr>
<td>Mean smoking rate</td>
<td>0.227</td>
<td>0.244</td>
<td>0.215</td>
</tr>
<tr>
<td>Mean <em>teen tax</em></td>
<td>0.77</td>
<td>0.77</td>
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<tr>
<td>Implied teen tax elasticity</td>
<td>-0.06</td>
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Notes: Table reports coefficient on teen tax. Dependent variable is an indicator for “smokes some or every day.” Many additional controls. Robust standard errors, clustered on state, in parentheses.
Teenage taxes reduce adult mortality

<table>
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<td>A. All mortality</td>
<td></td>
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<td>Coef. on <em>teen tax</em></td>
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<td>-20.0</td>
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<td>-7.2</td>
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<td></td>
<td>(9.9)</td>
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<td>(6.8)</td>
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<td>239.5</td>
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<tr>
<td><strong>B. “Smoking-related” mortality</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coef. on <em>teen tax</em></td>
<td>-16.2 (6.8)</td>
<td>-27.7 (8.7)</td>
<td>-6.3 (5.7)</td>
</tr>
<tr>
<td>Mean mortality rate</td>
<td>239.5</td>
<td>294.6</td>
<td>184.5</td>
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No effect on “placebo” causes of death

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<td>Coef. on <em>teen tax</em></td>
<td>-0.3</td>
<td>-1.4</td>
<td>0.9</td>
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<td></td>
<td>(1.5)</td>
<td>(2.1)</td>
<td>(1.1)</td>
</tr>
<tr>
<td>Mean mortality rate</td>
<td>45.9</td>
<td>66.0</td>
<td>25.8</td>
</tr>
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Notes: “Placebo” causes include homicides and non-fire accidents. Table reports coefficient on teen tax from regression of deaths per 100,000. Many additional controls. Robust standard errors, clustered on state, in parentheses.
## Teenage taxes especially important for mortality

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<tr>
<td>Taxes, age 11 to 19</td>
<td>-30.0 (12.3)</td>
<td>-43.2 (16.5)</td>
<td>-17.5 (9.4)</td>
</tr>
<tr>
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<tr>
<td>Taxes, ages 20 to 24</td>
<td>-6.1 (6.2)</td>
<td>-11.5 (9.1)</td>
<td>-2.7 (4.2)</td>
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<tr>
<td>Taxes, ages 1 to 10</td>
<td>-10.1 (18.5)</td>
<td>-22.9 (25.8)</td>
<td>1.1 (13.7)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean mortality rate</td>
<td>325</td>
<td>488</td>
<td>243</td>
</tr>
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Robustness

Alternative controls
  Drop adult-dated controls
  Drop teen-dated controls
  Add education controls (available only in smoking data)

Alternative teenage definition: 11-19, 14-20

Log specification (mortality only)

Alternative data sets (Smoking only)
  PSID
  BRFSS
  Gallup polls (good coverage throughout 20th century)
Conclusions

State cigarette taxes enacted over the last 70 years
- Reduced smoking at the time they went into effect
- Continued to reduce smoking decades later among people exposed as teenagers
- Reduced mortality among those cohorts also
- Taxes at other ages have less pronounced long-run health effects

Long-lasting consequences of cigarette taxes, tobacco control policy
- Potential health benefits from reducing teenage cigarette use
- Though average taxes are high, many states currently have low tax rates