Effects of E-cigarette Minimum Legal Sales Age Laws on Youth Tobacco Use in the United States

Journal of Risk and Uncertainty
Available online; in press.

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Funding

- Funding Sources for Presented Work:
  - National Institutes of Health
  - University of Kentucky's Institute for the Study of Free Enterprise
- Related Funding Over the Past 10 Years:
  - National Institutes of Health
  - Food and Drug Administration
  - American Cancer Society
  - Health Canada
  - Centers for Disease Control and Prevention
  - Agency for Healthcare Research and Quality
  - Virginia Foundation for Healthy Youth
  - University of Kentucky's Institute for the Study of Free Enterprise
- I have never been funded directly or indirectly by the tobacco industry.

NIH Disclosure: Research reported in this publication was supported by the National Institute On Drug Abuse of the National Institutes of Health under Award Number R01DA045016. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Background

- E-cigarettes were first imported to the United States in 2006.
  - Originally sold online and in specialty shops.
  - In 2010, e-cigarettes began to appear on retail shelves in traditional stores.
  - By 2011, 3.3% of all school-attending youth (grades 6+) and 12.2% of adult smokers had already used e-cigarettes at some point (NYTS 2011 and TUS-CPS 2011).

Background

- E-cigarettes were not immediately classified as a tobacco product in the United States.
  - Without e-cigarettes being defined as a tobacco product, existing tobacco minimum legal sale age laws did not cover e-cigarettes.
    - At the time, these laws were 18 or 19 depending on state.
    - Some states issued administrative rulings that current statue language covered e-cigarettes.
    - Other states passed new legislation to include e-cigarettes in existing MLSA laws.
  - The FDA deemed e-cigarettes to be a tobacco product in August 2016.
    - By this point, only two states had not yet adopted e-cigarette MLSAs.

Minimum Legal Sales Age laws

- Laws prohibiting the sale of e-cigarettes to minors.
- E-cigarette MLSAs were the first regulation widely used on e-cigarettes.
- State e-cigarette MLSAs by year:
    - 2010: 5
    - 2011: 7
    - 2012: 12
    - 2013: 24
    - 2014: 39
    - 2015: 47
    - August, 2016: Federal Law

Literature on Minimum Legal Sale Ages

- One study (Nguyen 2020) uses Canadian data on youth e-cigarette use from 2013-17 to study province-level e-cigarette MLSAs.
- Two-way fixed effect (TWFE) models are estimated:
  - Fixed effects for area and time.
  - Removes omitted variable bias from national, time-varying sources, and province-specific, time-invariant sources.
  - TWFE models are powerful because only remaining sources of bias would need to come from within-province, time-varying sources.
- Findings:
  - E-cigarette MLSAs reduce e-cigarette use among youth by 4.3 percentage points (pp).
  - Reduce belief that regular e-cigarette use poses no harm by 2.6 pp.
  - Increase self-reported greater difficulty in obtaining e-cigarettes by 6.2 pp.
  - No estimates provided for cigarette use.

Literature on Minimum Legal Sale Ages

- USA-specific studies have generally been limited in studying first-stage effects of e-cigarette use because e-cigarette questions were added relatively late to many survey data sources.
- Dave et al. 2019 and Abouk and Adams 2017 find suggestive evidence that e-cigarette MLSAs reduce e-cigarette use from a single wave of data (due to limited data availability).
  - Dave et al. 2019: E-cigarette MLSA reduces ever use of e-cigarettes by 4.3 pp and current e-cigarette use by 0.9 pp (latter not statistically significant).
  - Abouk and Adams 2017: E-cigarette MLSA reduces current e-cigarette use among underage 12th graders by 10.2 pp.

Literature on Minimum Legal Sale Ages

- Could e-cigarette MLSAs effect youth cigarette use?
  - Individuals make consumption choices based on their preferences and relative ease of obtaining different products (e.g., prices, access).
  - Some individuals may have used e-cigarettes instead of cigarettes on account of greater availability despite having stronger preferences for cigarettes.
    - E-cigarette MLSAs could thus equalize access and cause these individuals to use cigarettes instead.
  - E-cigarette MLSAs could also reduce youth cigarette use if e-cigarettes are a gateway and MLSAs closed this gateway.

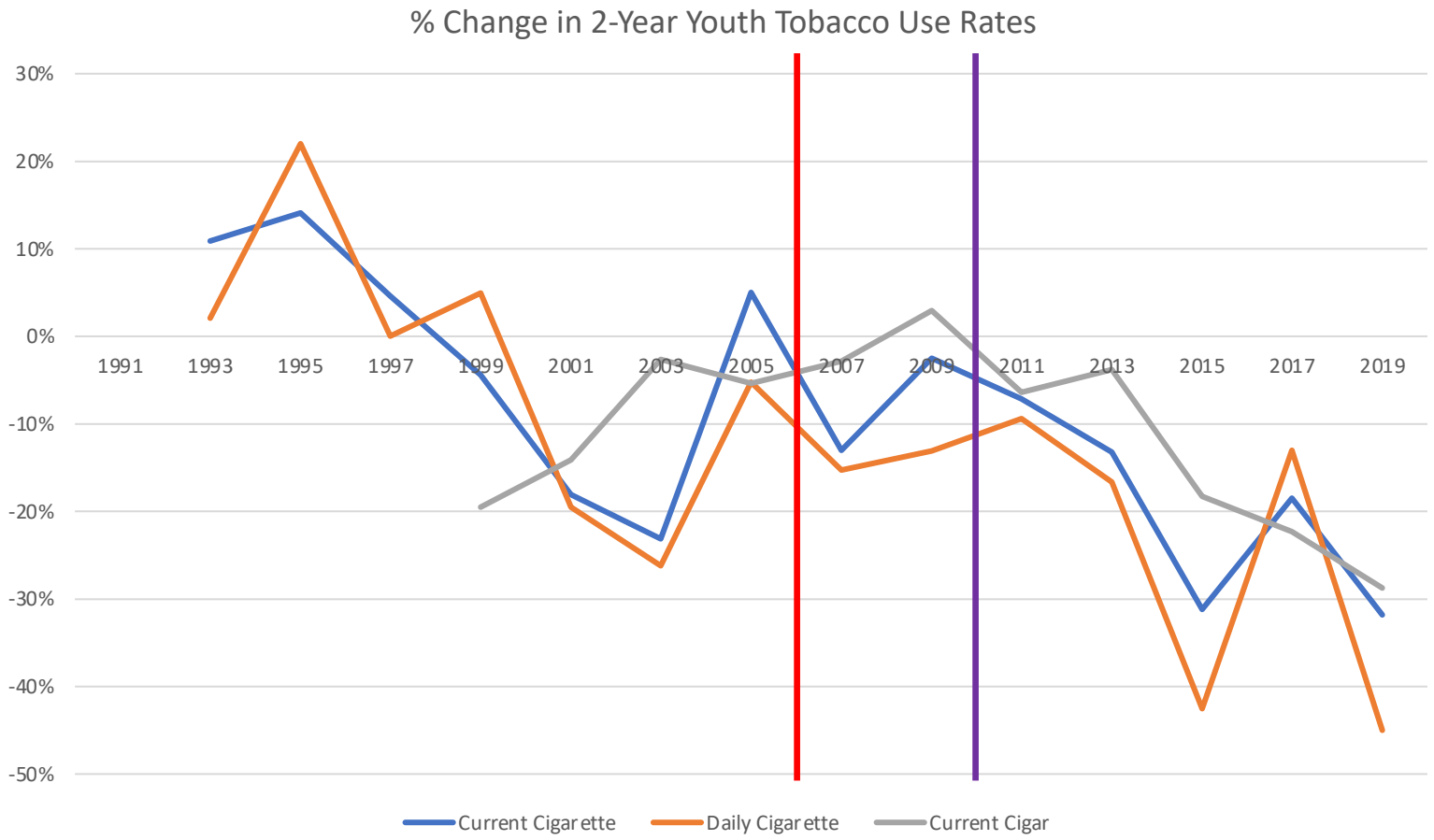
Literature on Minimum Legal Sale Ages

- Cigarette use information more readily available in early e-cigarette years.
- Three studies estimate the effect of e-cigarette MLSA laws on a general population of teenagers (Friedman 2015; Pesko et al. 2016; Dave et al. 2019) using TWFE models.
  - National Survey on Drug Use and Health and Youth Risk Behavior Surveillance System
  - Effects range from 0.8 to 1.0 pp increase in cigarette use
- Two TWFE studies explore the effect of e-cigarette MLSA laws on subgroups of youth:
  - E-cigarette MLSAs decrease high school senior smoking participation by 2.0 pp in Monitoring the Future data (Abouk and Adams 2017).
  - E-cigarette MLSA laws increase prenatal smoking by 0.8 pp among underage pregnant teenagers (Pesko and Currie 2019).

Background

- Recent large and unexpected decline in youth cigarette use.
  - In 2012 Surgeon General report, Secretary of Health Kathleen Sebelius said youth smoking rate declines have stalled.
  - In 2009, HealthyPeople 2020 set of a goal of a 16% youth smoking rate by 2019 (from 19.5% in 2009)
    - Reached 6% by 2019!
  - YRBSS data reports that two-year reductions in current smoking exceeded 30% in 2015 and 2019, and daily smoking reductions exceeded 40%.
    - % change over recent years may be a preferable way to evaluate trends over time as it compensates for remaining smokers being hardened.
    - E.g., if smokers have hardened preferences, then it is easier for policymakers to reduce smoking from 50% to 45% than from 10% to 5%.

Background


% Change in 2-Year Youth Tobacco Use Rates
30%
20%
10%
0%
-10%
-20%
-30%
-40%
-50%
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
Current Cigarette
Daily Cigarette
Current Cigar

Background

- Decline does not seem to be fully explained by tobacco control policies or changing demographics.
  - SimSmoke model finds significantly lower smoking rates than would be predicted based on changing demographics and policies.
  - More recent studies find little in the way of cigarette tax responsiveness (Hansen, Sabia, Rees 2017).
  - Tobacco-21 appears to have reduced smoking according to many studies, but the larger-than-expected reductions in youth smoking exceed estimates from these studies.

Background

- Did e-cigarette availability cause this large, unexpected decline?
- E-cigarette MLSAs affect e-cigarette availability, so their adoption can be used as a natural experiment to study the effect that e-cigarette availability has on cigarette use.
  - Can provide causal inference if outcome trends in the pre-period can be shown to be parallel between adopters and non-adopters
- The effect of e-cigarette availability on youth smoking is an important question in FDA regulatory activities as the FDA has wide latitude to control e-cigarette availability by approving or denying PMTA applications.

Contributions

1. Estimate the effect of e-cigarette MLSAs on e-cigarette use in the United States using multiple waves of data.
2. Contribute to and synthesize the effect e-cigarette availability on youth cigarette use using variation in e-cigarette availability from e-cigarette MLSA laws.
3. Evaluate the effect of e-cigarette MLSAs using recent advancements in difference-in-differences methods for situations of staggered adoption (Calloway-Sant'anna, 2021).

Data

- National Youth Tobacco Survey (NYTS) data from 2011-17.
  - Nationally-representative data source of 6-12th graders.
  - Years: 2000, 2002, 2004, 2006, 2009, and 2011-17.
  - 125,820 respondents under the age of 18 years of age from 2011-17.
    - E-cigarette information added starting in 2011.
  - 251,229 respondents under the age of 18 years of age starting in 2000.
    - Allowing longer time horizon to evaluate cigarette and cigar use outcomes.
  - Imbalanced data: collected for between 30-42 states per year.
  - Archived version of the NYTS that includes state-identifying information (see paper's data appendix for further details).

Methods

- Outcomes:
  - Current (past-30 day) use of e-cigarettes, cigarettes, and cigars
    - Changes in current use reflect change in recent initiation and/or cessation
  - Daily use of cigarettes and cigars
  - Ever use of e-cigarettes
    - Changes in ever use reflect changes in initiation only
    - In our context, ever use outcomes reflect cumulative changes in initiation since e-cigarette MLSAs came into place.
    - NYTS does not provide exact date of initiation that would otherwise provide a more precise measure.

Methods

Table 1 Descriptive statistics for estimation sample, NYTS

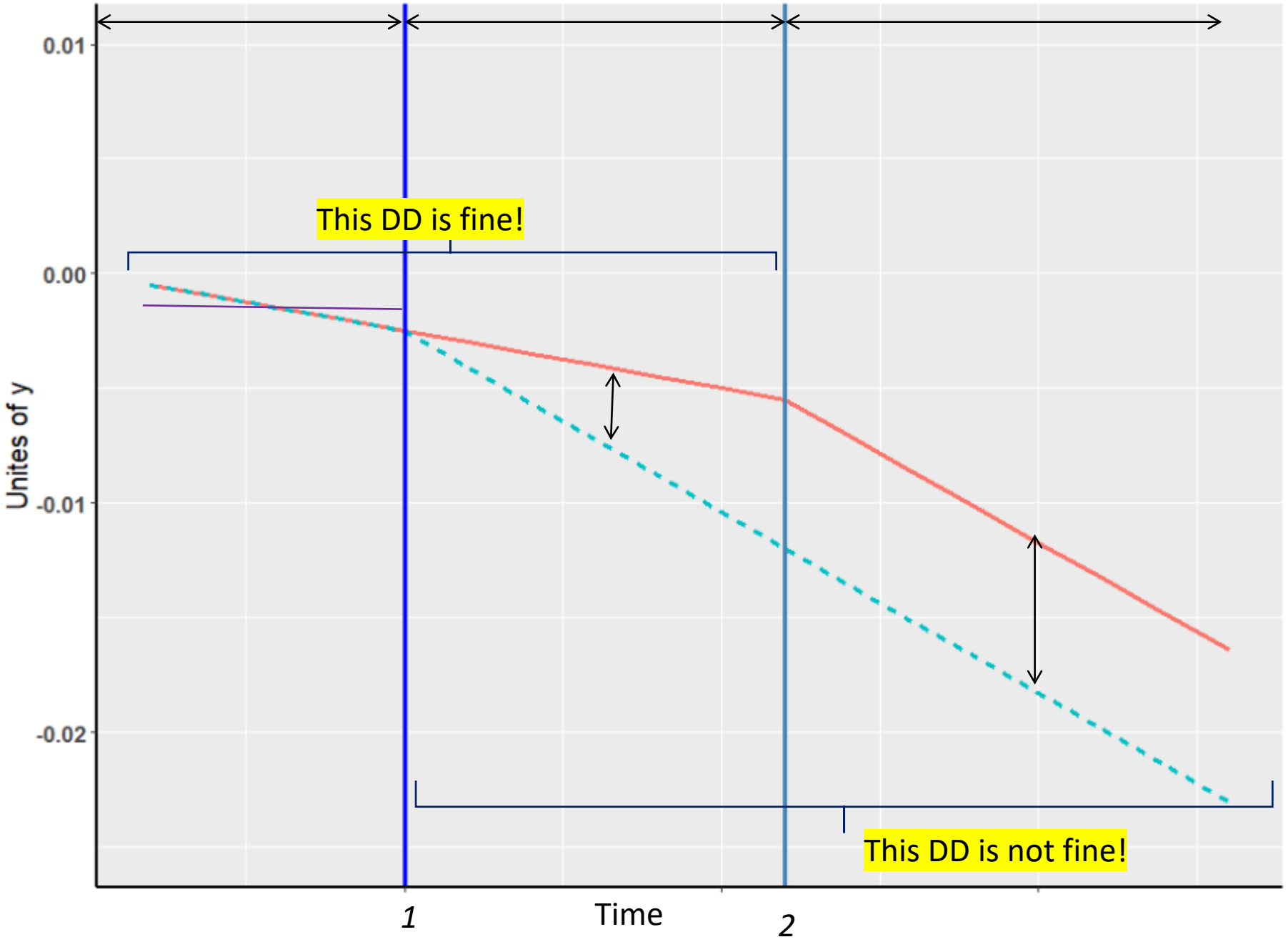
Sample Time Period:	**2011–2017**		**2000–2017**	
Outcomes				
Ever E-Cig Use	0.142	[0.349]	NA	
Current E-Cig Use	0.055	[0.227]	NA	
Current Cig Use	0.066	[0.249]	0.103	[0.304]
Daily Cig Use	0.013	[0.113]	0.023	[0.151]
Current Cigar Use	0.060	[0.237]	0.073	[0.261]
Daily Cigar Use	0.006	[0.079]	0.007	[0.080]

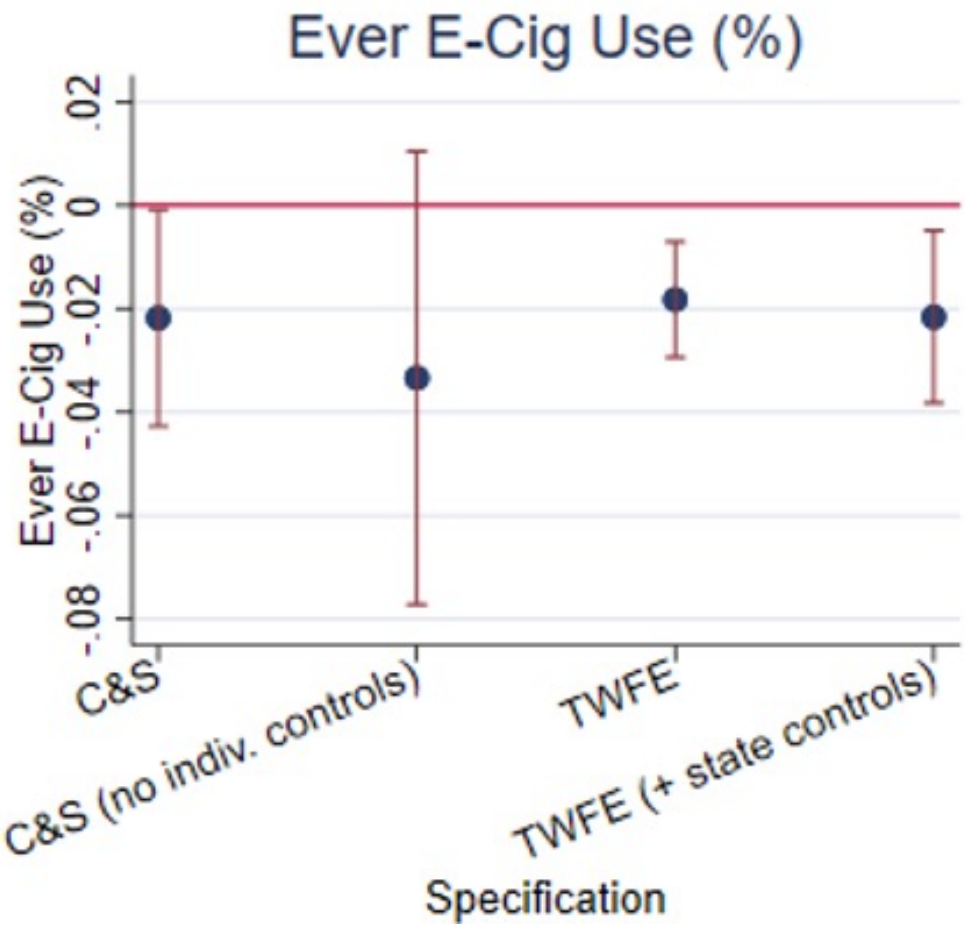
Methods

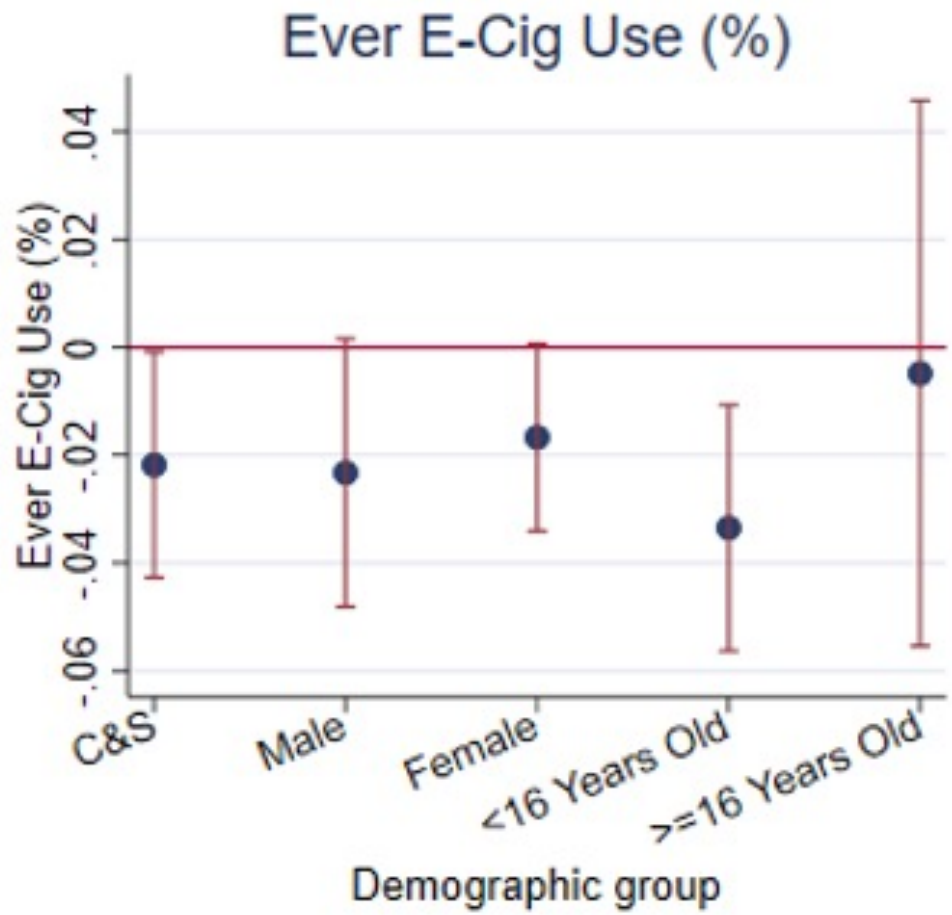
- Treatment:
  - E-cigarette MLSA in place at the start of survey year *t*.
- Controls:
  - Two-way fixed effects: state and year
  - Demographics (gender, age, race/ethnicity)
  - State-specific, time-varying controls:
    - Other tobacco control policies (cigarette and e-cigarette taxes, smoking/vaping indoor air laws, Tobacco 21, cigar taxes)
    - Policies affecting potential substitutes/complements: beer taxes, marijuana laws (medical and recreational)
    - Economic climate: minimum wage, poverty rate, unemployment rate

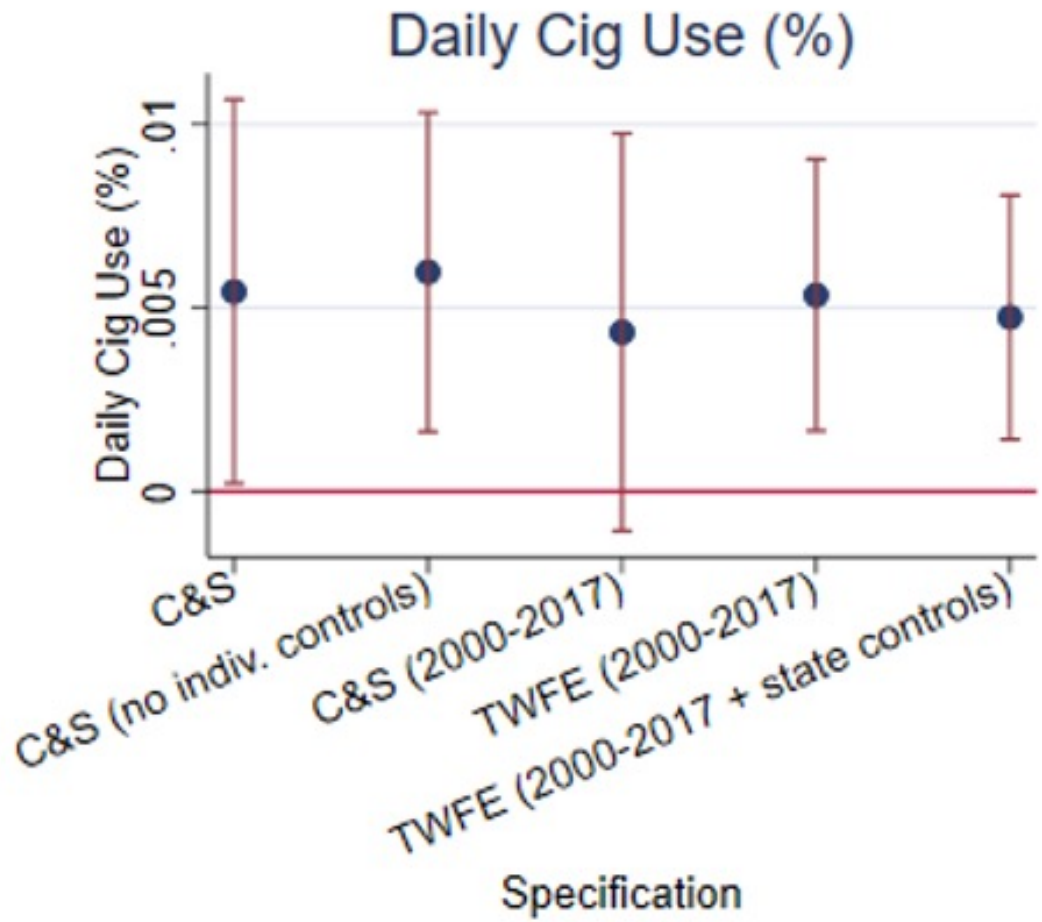
Methods

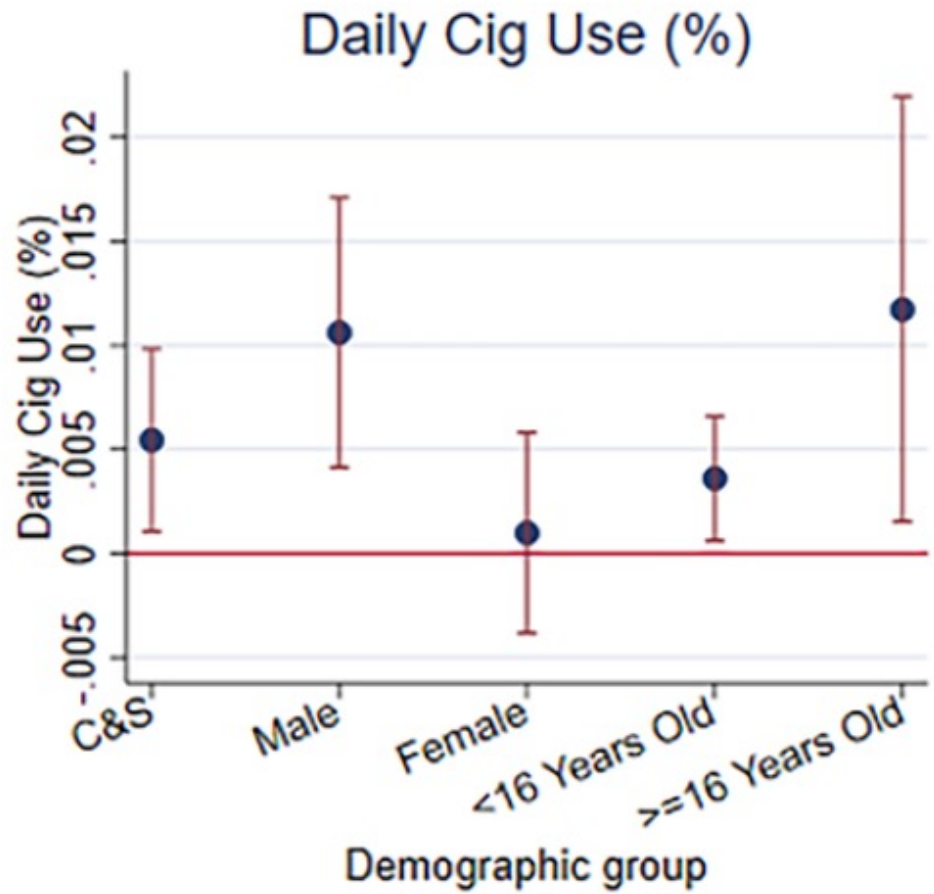
- Problem: Potential bias from staggered treatment adoption (Callaway and Sant'Anna 2021; Goodman-Bacon 2021).
- For example, such bias could be introduced if:
  - (1) earlier-adopting (e-cigarette MLSA) states are poor controls for later-adopting states due to dynamic treatment effects across adoption timing
  - (2) heterogeneity in adoption timing giving greater (less) weight to jurisdictions that implement e-cigarette MLSAs around (away from) the mid-point panel.
- Solution: Use a new estimator proposed by Callaway and Sant'anna (2021) to expunge these biases.
  - Package -csdid- in Stata
  - Do not use state-specific, time-varying controls when using C&S estimator

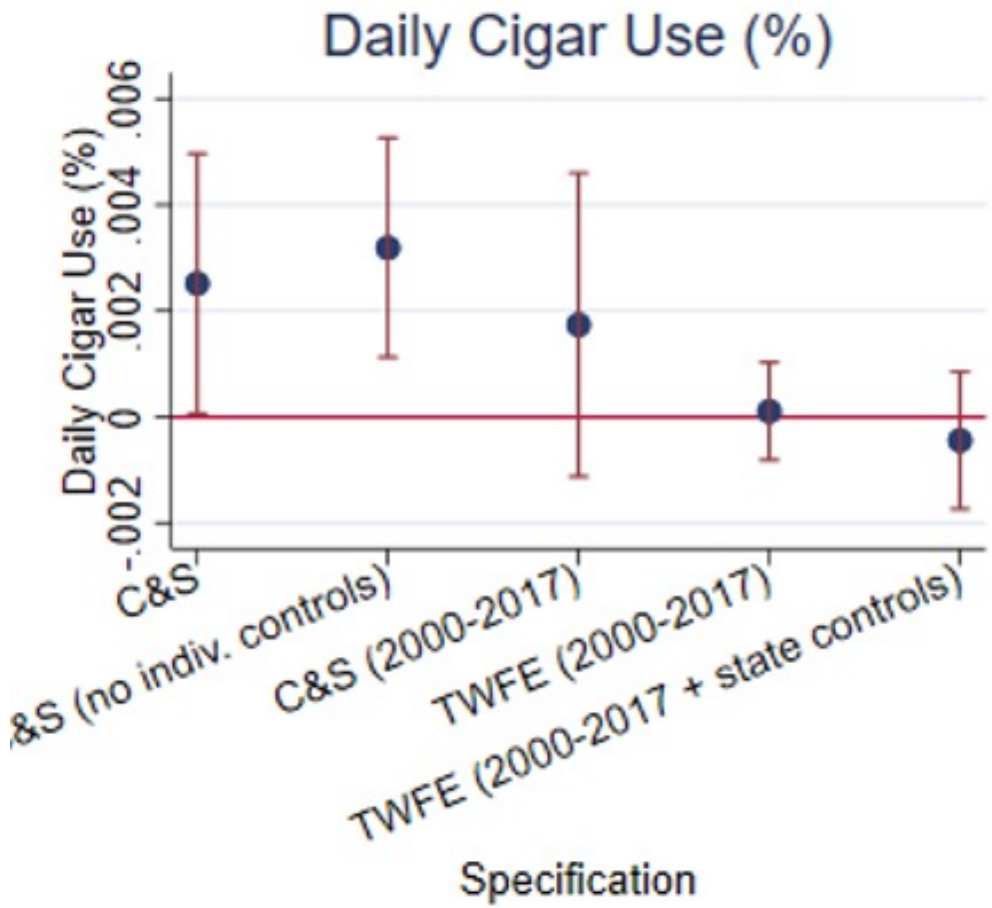

0.01
0.00
-0.01
-0.02
Unites of y
This DD is fine!
This DD is not fine!
1
Time
2


Ever E-Cig Use (%)
Ever E-Cig Use (%)
-.08
-.06
-.04
-.02
0
.02
C&S
C&S (no indiv. controls)
TWFE
TWFE (+ state controls)
Specification


Ever E-Cig Use (%)
Ever E-Cig Use (%)
-.06
-.04
-.02
0
.02
.04
C&S
Male
Female
<16 Years Old
>=16 Years Old
Demographic group

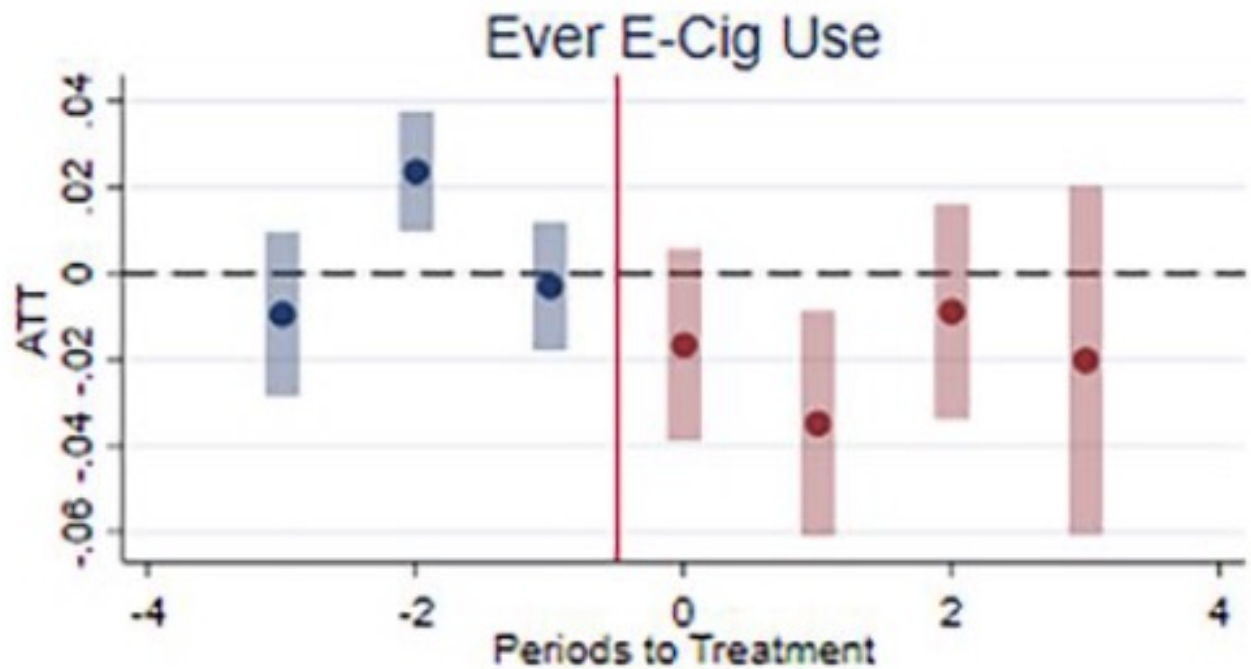

Daily Cig Use (%)
Daily Cig Use (%)
0
.005
.01
C&S
C&S (no indiv. controls)
C&S (2000-2017)
TWFE (2000-2017)
TWFE (2000-2017 + state controls)
Specification

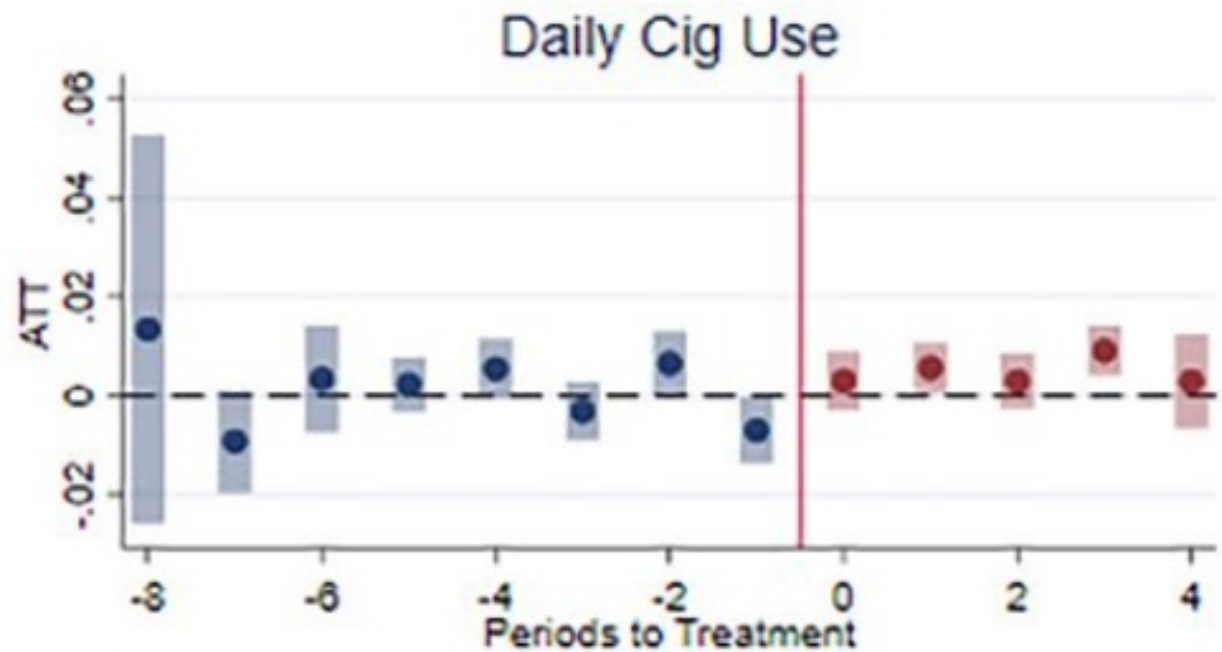

Daily Cig Use (%)
Daily Cig Use (%)
-.005
0
.005
.01
.015
.02
C&S
Male
Female
<16 Years Old
>=16 Years Old
Demographic group


Daily Cigar Use (%)
Daily Cigar Use (%)
-.002
0
.002
.004
.006
C&S
&S (no indiv. controls)
C&S (2000-2017)
TWFE (2000-2017)
TWFE (2000-2017 + state controls)
Specification

Results

- Current use estimates are all statistically insignificant and relatively small.
  - Similar to evidence from the e-cigarette tax literature (Abouk et al. 2021; Pesko et al. 2020) that current use margins respond relatively imprecisely to policy changes, but ever and daily use margins respond more precisely.
  - Recall bias?
- Event studies are sometimes noisy for three potential reasons:
  - "Traditional" event study imbalance in that some states do not contribute to each event period's time bin depending on when they adopted their MLSA
  - Imbalance from many states not being surveyed in a given year
  - Imbalance from the NYTS not being collected annually prior to 2011
- Despite noise, event studies do not depict obvious evidence of parallel trends violations (i.e., monotonically increasing or decreasing policy lead coefficients).


Ever E-Cig Use
ATT
-.06
-.04
-.02
0
.02
.04
-4
-2
0
2
4
Periods to Treatment


Daily Cig Use
ATT
-.02
0
.02
.04
.06
-8
-6
-4
-2
0
2
4
Periods to Treatment

Sensitivity

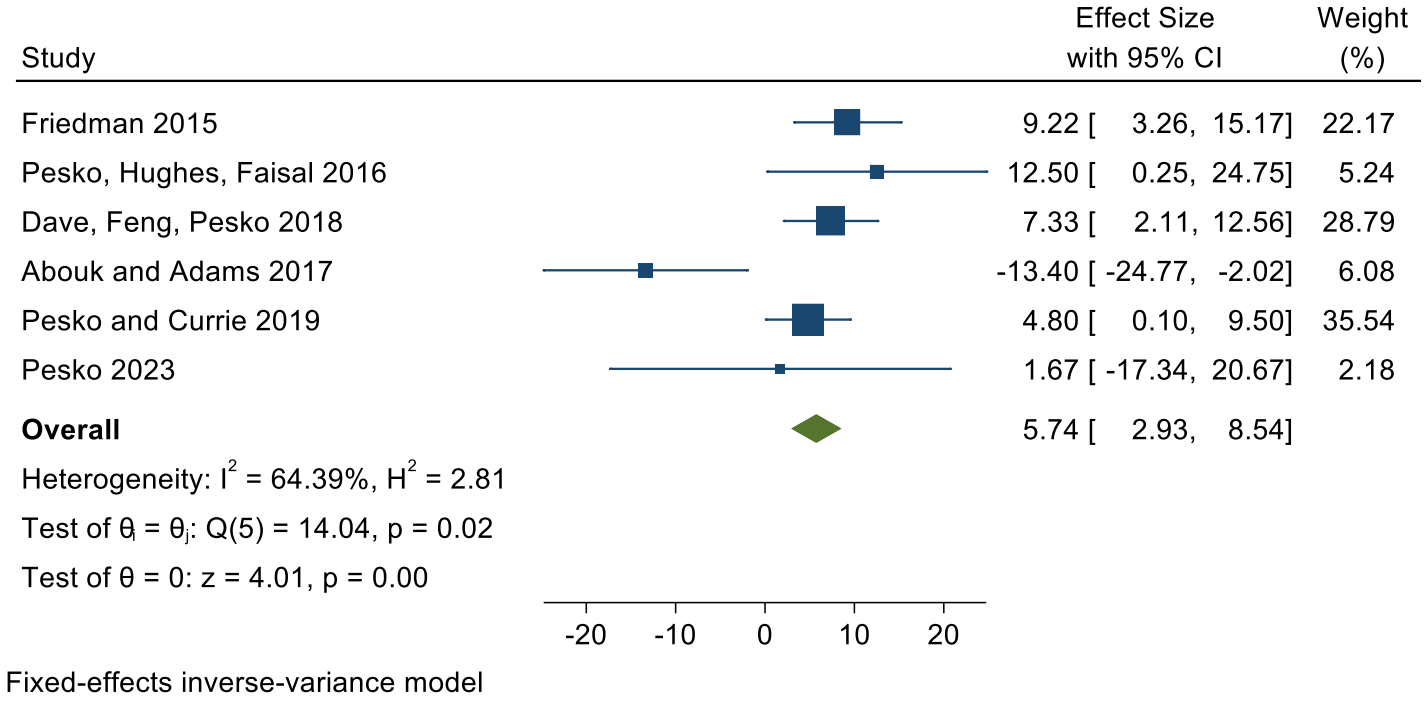
- Results relatively insensitive to the following:
  - Using NYTS survey weights.
  - Dropping five states with county-level MLSAs pre-dating state MLSAs.
  - Dropping five state-year pairs that had an MLSA occur within a given NYTS survey year (January to May) and four state-year pairs with statewide/districtwide Tobacco-21 laws in place.

Discussion

- Provide the first estimate showing that e-cigarette MLSAs reduce e-cigarette use using multiple years of data.
  - Study finds effects only for ever e-cigarette use, which represents the effect on cumulative initiation.
  - Another recently published concurrent study finds that e-cigarette MLSAs reduce underage current and regular e-cigarette use for 12th graders using a regression discontinuity design (DeSimone, Grossman, and Ziebarth 2022).
- Study provides evidence that e-cigarette MLSAs increase daily smoking among youth.
  - In other words, e-cigarette availability may have public health benefit in reducing more harmful combustible tobacco use among kids.

Discussion

Meta-analysis of TWFE estimates that provide evidence of parallel trends finds that e-cigarette MLSAs increase current teen cigarette use by 5.7%



Discussion

- E-cigarette MLSAs, tax rates, and advertising restrictions are all shown to reduce e-cigarette use.
  - To date, 16 fixed effect studies have explored effects of these policies on cigarette use (and provide evidence of parallel trends). Of these, 14 studies find that the policies increases cigarette use (Friedman 2015; Pesko et al. 2016; Dave et al. 2019; Pesko and Currie 2019; Pesko 2023; Cotti et al. 2022; Pesko, Courtemanche, Maclean 2020; Saffer et al. 2020; Abouk et al. 2023; Pesko and Warman 2022; Pesko and Friedman 2022; Abouk et al. 2022; Tuchman, 2019; Dave et al., 2019), 1 finds no relationship (Allcott and Rafkin 2022), and 1 finds that the policies reduce cigarette use (Abouk and Adams 2017).
  - Collectively, these studies suggest that e-cigarette availability reduces smoking.
    - Ex-post validated by youth smoking rates falling far lower than predicted during a decade with high e-cigarette availability.

Discussion

- These 16 studies evaluate the effect of e-cigarettes as consumer products using “real world data.”
- They provide the FDA with a strong, fairly homogenous evidence base for a public health benefit of e-cigarettes: less smoking.
  - This benefit should be compared to other costs and benefits of e-cigarettes as the FDA considers whether to approve e-cigarettes for legal sale.
- These 16 studies collectively provide evidence matching RCTs that medical e-cigarettes improve smoking cessation (Cochrane 2023).
  - RCTs have strong internal validity by using randomization.
  - Natural experiments can have relatively strong internal validity by using policy variation (for example) to quasi-randomize.
    - Policy adoption does not need to be random, but establishing parallel trends is essential.

Discussion

- Longitudinal cohort studies of course offer more conflicting evidence on the relationship between cigarettes and e-cigarettes.
  - Common liability concerns cannot be fully controlled
  - No use of randomization or quasi-randomization (such as from policy changes)
  - Poor forecasting abilities: Many of these studies forecasted that high youth e-cigarette use would lead to high youth smoking, but smoking rates have fallen far lower than expected.
  - Given these concerns, the FDA may wish to wish to de-emphasize the role of longitudinal cohort studies in regulatory decision-making and elevate the role of alternative study designs with stronger internal validity (and more accurate forecasting abilities).

Thank You!

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