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E-cigarette taxes on pre-pregnancy & prenatal smoking and birth outcomes

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Blurb

- Applied health economist by trade (GSU PhD in Public Policy, 2018)
- Two main work streams @AIR
  - Operation and implementation support for the Advanced APMs
  - Development and testing of healthcare quality measures
- External research on program and policy evaluation

Disclaimer

- Research reported in this publication was supported by the National Institute on Drug Abuse of the National Institutes of Health under Award Number R01DA045016 (PI: Michael F. Pesko)
  - My involvement in the study is independent of the Award
- Tobacco-related funding source over the last 10 years: None.
- Content is solely the responsibility of the authors & does not necessarily represent the official views of the National Institutes of Health and does not represent the views of AIR

Overview

- What's the impact of e-cig tax rates on pre-pregnancy & prenatal smoking and birth outcomes?
  - Expectant mothers and those expecting to become pregnant may be motivated to quit smoking using e-cigs
- A growing number of states & counties have levied e-cig taxes
  - MN was the first state to levy an ad valorem tax on e-cigs in 2010
  - E-cig taxes have been in effect in 34 jurisdictions by Dec 2020
  - Tax adoption is staggered
  - *Standardized e-cig tax rate*
- U.S birth records data (2013 to 2020) – collaborative effort btwn National Center for Health Statistics (NCHS) and the States
  - Pre-pregnancy (3mo before pregnancy) smoking
  - Prenatal smoking (any & avg. number smoked/day)
  - Birth outcomes
- *Presenting new results from those in the working paper; results subject to change*

Preview

- Hypothesis
  - ⇧ E-cig tax adoption → ⇧ cost of e-cigs → ⇩ use of e-cigs → ⇧ or ⇩ cig smoking → ⇧ or ⇩ birth outcomes
- E-cig taxes
  - ⇩ pre-pregnancy & 3rd trimester vaping
  - ⇧ pre-pregnancy & prenatal smoking by 0.4 – 0.5 ppt (7% – 9%)
  - Limited impact on birth outcomes

Structure

1. Background
2. Data, variables, and methods
3. Results
4. Extensions (brief)
5. Summary and discussion

E-cigarette Regulations

- Potential substitutability of traditional cigs & e-cigs presents a challenge to policymakers
  - » Taxing & restricting access to e-cigarettes may help ⇩ nicotine intake
  - » But may ⇩ harm reduction & cessation efforts among smokers
  - » E-cigs contain fewer toxicants than combustible tobacco, but are not harmless (National Academies of Sciences, Engineering, and Medicine 2018)
- States & localities have adopted e-cig policies in various forms
- As of October 2021
  - » Early policies focused on youth access (51 states)
  - » Next, states adopted policies prohibiting use in bar (19 states), restaurants (20 states), & private worksites (18 states)
  - » More recent efforts have focused on taxation (30 states)

Tobacco Product Use During Pregnancy

- Per CDC, smoking while pregnant increases the risk for pregnancy complications, is harmful to babies before and after they are born, and is strongly discouraged by healthcare professionals
  - 7.2% of women smoked cigs while pregnant (CDC, 2018)
  - Behavior linked with low birthweight, preterm birth, & birth defects

Tobacco Product Use During Pregnancy

- Vaping while pregnant is also discouraged, as nicotine
  - is a health danger for pregnant women and developing babies
  - can damage a developing baby's brain and lungs
  - can lead to
    - » low birthweight
    - » preterm birth
    - » impaired early life health and human capital development
    - » infant mortality
    - » later-life proclivity to nicotine-containing products
- PRAMS data for two states in 2015 (Kapaya et al., 2019)
  - 10.8% vaped in the three months prior to pregnancy
  - 7.0% vaped at the time of pregnancy
  - 5.8% vaped in the first trimester
  - 1.4% vaped at birth

Tobacco Product Use During Pregnancy

- Many pregnant women perceive e-cigs as less harmful than traditional cigs for the fetus & helpful in smoking cessation
  - e.g., Wagner, Camerota, & Propper (2017)
- Vaping while pregnant can cause similar harms to the fetus as does the use of traditional cigs
  - Whittington et al. (2018) – Literature review
- **Health benefits of vaping over smoking during pregnancy aren't clear**
  - Vaping during pregnancy is worse than not using any nicotine products

Literature

- Small literature on the effects of e-cigarette policies on pre-pregnancy & prenatal smoking, & birth outcomes
- Three studies explore the effect of e-cigarette policy variation on prenatal smoking using birth records
  - » E-cig indoor air laws ⇩ prenatal smoking cessation for pregnant women, had little effect on birth outcomes (Cooper & Pesko, 2017), but ⇧ infant mortality (Cooper & Pesko, 2022)
  - » E-cig MLSA laws ⇩ prenatal smoking cessation rates for rural pregnant teens but had little effect on birth outcomes (Pesko & Currie, 2019)
- Few studies examine how cigarette taxation affected pre-pregnancy and prenatal smoking
- Studies focusing on e-cig tax rates generally found evidence of substitution in other populations

Birth Records Data

National Center for Health Statistics

- Administrative data; Restricted use; Contain geocodes
- Collected and used the most recent data available (2020)
- Introduced the revised birth record form in 2003
  - » Revised form contains Qs on smoking in each trimester & 3 months prior to pregnancy (pre-pregnancy)
    - ◦ However, this info is self-reported
  - » State's adoption of revised form is staggered
- No info on e-cigarette use yet

Building The Main Analysis Sample

Started sample in Jan 2013, defined by **conception month** and **conception year**

- Birth records data only provide birth delivery date. Thus, need to estimate pregnancy date
  - » 3 critical pieces: birth year, birth month, and gestational length (weeks)
  - » Few assumptions:
    - Birth month = the end of the month (not start of the month) (e.g., June means 6/30 and not 6/1)
    - Gestational length (week) = start of the week (e.g., week 30 means full 29 weeks and day 1 in the 30th week and not full 30 weeks)
    - Baby was born in the middle of the month and middle of the week
    - 1st trimester = point of ovulation (16 days since conception)
    - 2nd trimester = week 14 of conception
    - 3rd trimester = week 28 of conception
    - Pre-pregnancy = 3 months prior to the point of ovulation

Building The Main Analysis Sample

- Ended sample in Dec 2019, defined by **conception month** and **conception year**
  - Doesn't mean births occurred in 2020 are excluded; therefore, births in 2020 from conception in 2019 are included
- Removed CT, NJ, and RI due to low adoption rate of revised birth record form by 2013 (sample starting year)
- Removed moms with missing smoking info, gestational length info, residing overseas, and non-singleton births (very modest deletion in each)
- Removed births in HI in 2013 due to very high pct. of missing smoking info
- Retained moms with missing info in demographics (very few records)
  - Recoded missing into a separate category and controlled for in model
- Main analysis sample ≈ 25M records (births) over study period

Other Analysis Samples

- Infant mortality data (2013 – 2018)
  - Generally, a one-year lag
  - Similar data cleaning logic applied
- Panel version of birth records data (2013 – 2020)
  - Take advantage of four time points in the birth records data
    - » 3 months before pregnancy, 1st trimester, 2nd trimester, and 3rd trimester
  - Data reshape (wide ⇢ long)
- Pregnancy Risk Assessment Monitoring System (PRAMS)
  - Vaping questions; descriptive analysis

Main Outcome Variables (Cigarette Consumption)

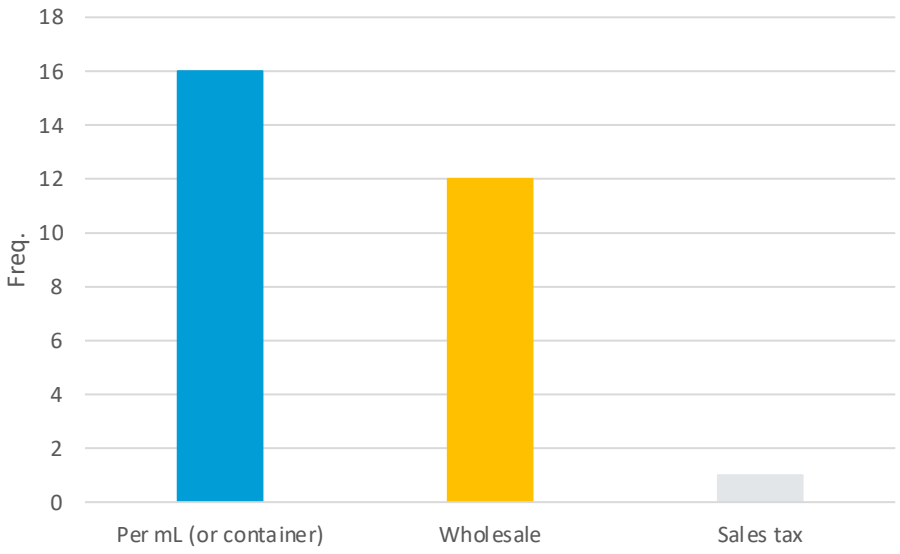
- Any prenatal smoking (0-1)
  - 1: reported smoking cigarettes in any of the trimesters. 0: otherwise
- Avg. number of cigarettes smoked per day during pregnancy (continuous)
  - Simple weighted avg. of # of cigs smoked in each of the trimesters
- Number of trimesters smoked cigs
  - Categorical (0, 1, 2, 3)
- Any pre-pregnancy smoking (0-1)
  - Pre-pregnancy means no more than 3 months prior to pregnancy
- Any pre-pregnancy vaping (0-1); any 3rd trimester vaping (0-1)

Main Outcome Variables (Birth Outcomes)

- Gestational length (weeks)
- Premature birth (0-1)
  - 1: gestational length < 37 weeks; 0: otherwise
- Birth weight (in grams)
- Low birth weight (0-1)
  - 1: birth weight < 2500 grams; 0: otherwise
- Small for gestational age (0-1)
  - 1: for a given gestational length, birth weight < 25th pctl. of the birth weight dist. 0: otherwise
- Extra small for gestational age (0-1)
  - 1: like the above, but use 10th pctl. as cutoff
- Five min Apgar score (categorical)
  - 5 categories; each is scored 0, 1, or 2; so Apgar ranges from 0 to 10
- Same-year infant death (0-1)

Main Regressor (Standardized E-cig Tax Rate)

- By 2020, a total of 29 localities (mostly states; excluding localities in AK) has levied taxes on e-cigs **However,**
  - Unlike cig taxes (fixed amt. per pack), e-cig taxes are *unit-specific*
  - Fixed tax amt. per fluid milliliter (mL) and/or container
  - Percent tax on the wholesale price; ad valorem
  - Percent tax on the retail price; sales taxes



Main Regressor (Standardized E-cig Tax Rate)

- Cotti C, et al. (2021) – **Tob Control** introduced a publicly available dataset of standardized e-cig taxes, measured as *an average tax rate per mL of fluid* at the state-county-year-quarter level.
- How they did it (high-level)
  - NielsenIQ Retail Scanner Data (store-UPC-week level)
  - UPC-level e-cig sales (qty. and $) + e-cig product characteristics
  - Convert ad valorem and other taxes to their excise tax equivalent for each tax jurisdiction
  - Ad valorem ➞ Tax per fluid mL

$$Tax\ per\ mL_{loc,t} = ad\ valorem\ rate_{loc,t} \times wholesale\ price\ per\ mL_{t=2013} \times (1 - markup)$$

  - Estimation of wholesale price per fluid mL in 2013
    - » Calculate the sales-weighted avg. retail price per fluid mL across jurisdictions NOT adopting e-cig tax by the end of 2020 in year 2013
    - » Use only 2013 (year 1 NRSD started categorizing e-cigs) to reduce the influence of other time-varying factors
    - » Subtract an estimated retailer markup of 35%

Main Regressor (Standardized E-cig Tax Rate)

- Analogously,
  - Sales tax ➞ Tax per fluid mL

$$Tax\ per\ mL_{loc,t} = sales\ tax\ rate_{loc,t} \times retail\ price\ per\ mL_{t=2013}$$

    - » Calculate the sales-weighted avg. retail price per fluid mL across jurisdictions NOT adopting e-cig tax by the end of 2020 in year 2013
    - » Use only 2013 to reduce the influence of other time-varying factors
  - Tax per container ➞ Tax per fluid mL

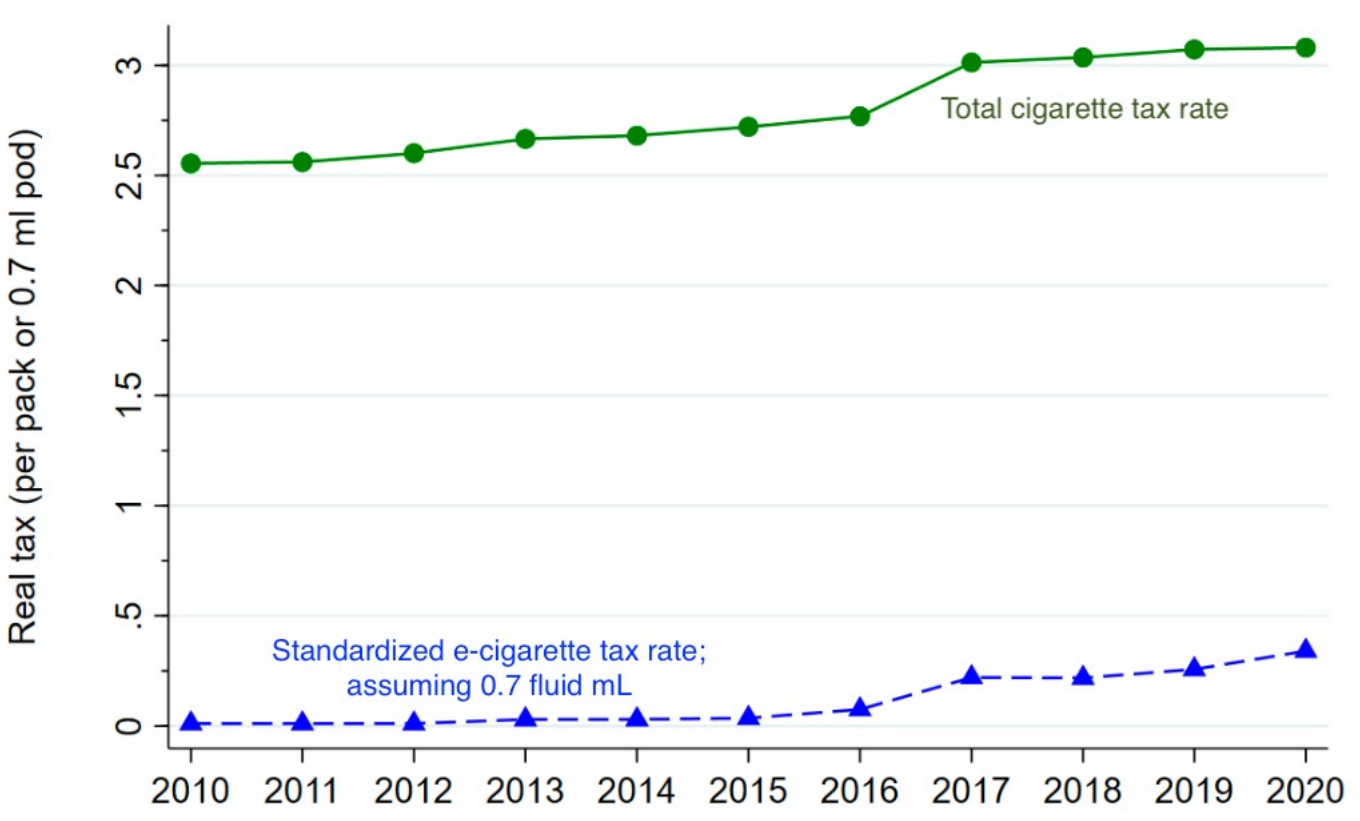
$$Tax\ per\ mL_{loc,t} = tax\ per\ container_{loc,t} \times container\ per\ mL_{t=2013}$$

    - » Calculate the sales-weighted avg. container per fluid mL across jurisdictions NOT adopting e-cig tax by the end of 2020 in year 2013
    - » Use only 2013 to reduce the influence of other time-varying factors
- We merge the standardized e-cig tax rate to birth records data at the level of *state-county-conception(year)-conception(quarter)*

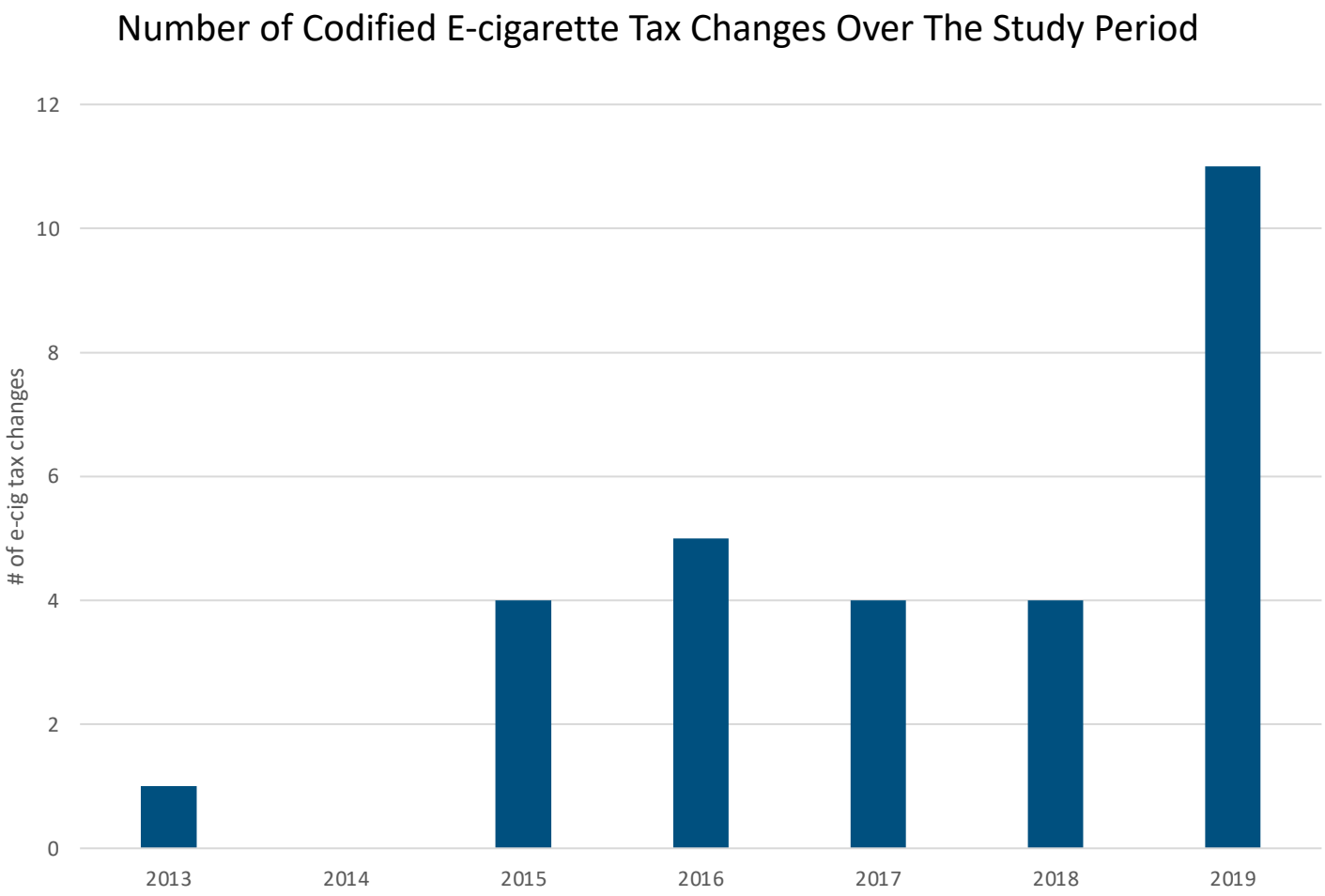
Main Regressor (Standardized E-cig Tax Rate)

Comparison of standardized e-cig tax rate to the total (federal + state + local) cig tax rate over time

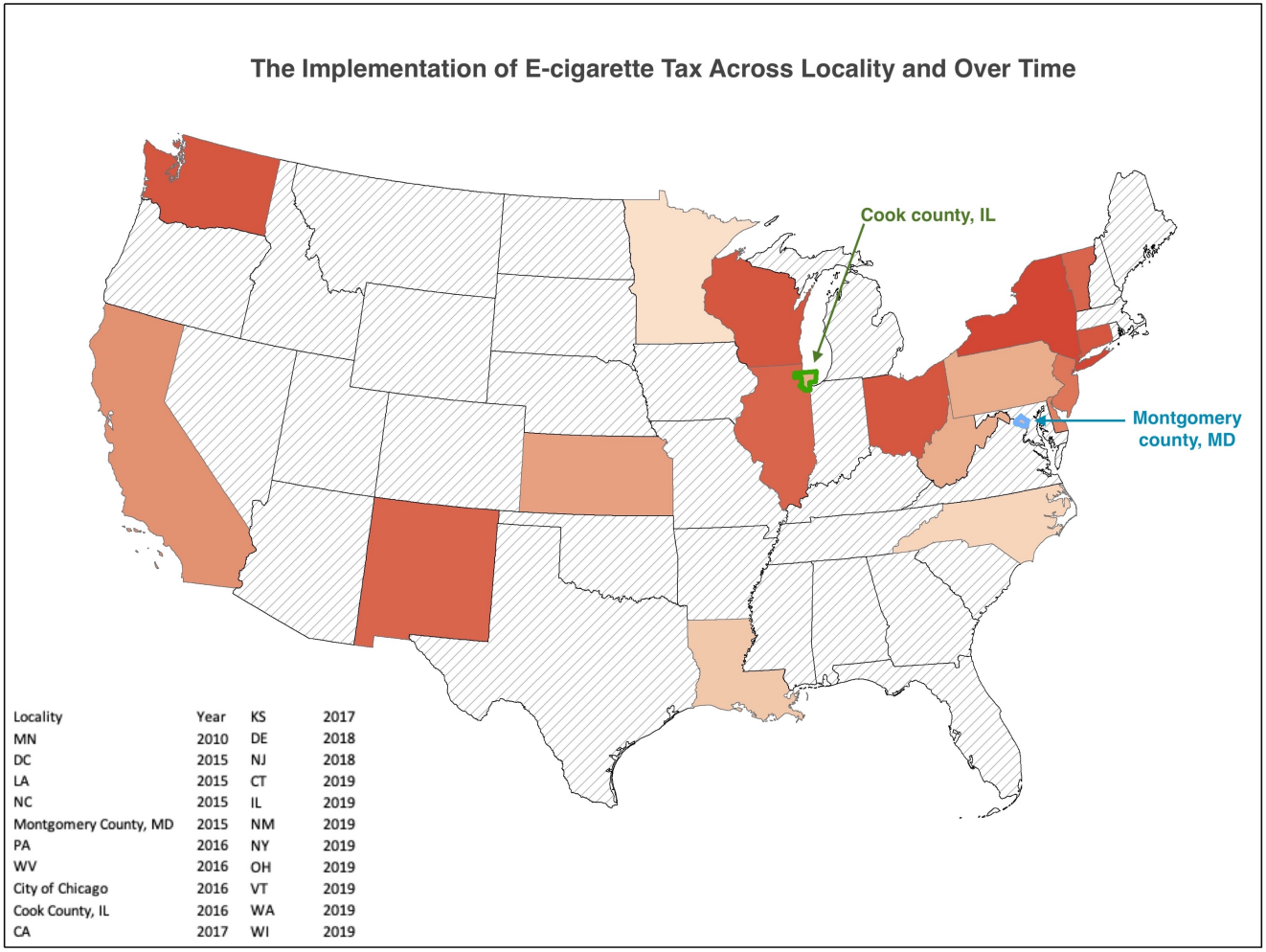
Population-weighted national avg; Qtr4 of each year



Main Regressor (Standardized E-cig Tax Rate)



Localities W/ E-cig Tax By The End of Study Period



Locality	Year	KS	2017
MN	2010	DE	2018
DC	2015	NJ	2018
LA	2015	CT	2019
NC	2015	IL	2019
Montgomery County, MD	2015	NM	2019
PA	2016	NY	2019
WV	2016	OH	2019
City of Chicago	2016	VT	2019
Cook County, IL	2016	WA	2019
CA	2017	WI	2019

Add'l Policy Controls

- Cigarette tax rate (federal + state + local)
  - » Source: CDC STATE System + American Non-Smokers Rights Foundation
- Index of indoor smoking restrictions (private workplaces, bars, and restaurants)
  - » Pct. of population in a given county/year/quarter subject to the comprehensive ban
  - » Source: American Non-Smokers Rights Foundation
- Index of indoor vaping restrictions (similar to the above)
- Any e-cigarette minimum legal sales age law
  - » Source: CDC STATE System + American Non-Smokers Rights Foundation
- Index of Tobacco 21 Law
  - » Source: Tobacco21.org
- Fraction of quarter over year for a given state with temporary e-cig sales ban
  - » Source: Authors' review of public information
- Fraction of quarter over year for a given state with ACA Medicaid expansion
  - » Source: Kaiser Family Foundation + Maclean, Pesko, and Hill (2019) – Economic Inquiry (link)

Mother's Demographics

All demographic variables are categorized and their missing values are included as a separate category

- Age at the time of delivery
- Race
- Primary source of payment (e.g., Medicaid, Private insurance, Self-pay, etc.)
- Marital status
- Education status
- Mother's total birth counts (living and dead)

Empirical Methods – Cross-sectional

$$Outcome = \boldsymbol{\beta_1} Tax + \Theta \cdot Dmgrphcs + \Phi \cdot \text{Policy\_Cntrls} + \text{FEs} + \varepsilon$$

- What's the level of these variables?
  - » ① each record in the birth records data denotes a birth delivery for a women residing in a given state, county, year, and month.
    - Recall, we est. conception year and month for every birth
    - Outcome vars and demographics are at this level
  - » ② Standardized e-cig tax rates are at the level of state, county, conception(year), and conception(quarter)
    - Recall, we merged e-cig taxes to each row in birth data using the geocode info (residence) and est. conception year and conception quarter.

Empirical Methods – Cross-sectional

$$Outcome = \boldsymbol{\beta_1} Tax + \Theta \cdot Dmgrphcs + \Phi \cdot \text{Policy\_Cntrls} + \text{FEs} + \varepsilon$$

- What's the level of these variables?
  - » ③ some policy variables are at the same level as standardized e-cig tax rate, and they are:
    - Total cig tax rate, index of indoor smoking (vaping) restrictions, any e-cig MLSA law, any tobacco 21 law
  - » ④ some policy variables are at the level of state, conception year, and conception quarter, and they are:
    - Fraction of quarter over year with temporary vape ban and with ACA Medicaid expansion

Empirical Methods – Cross-sectional

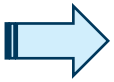
$$Outcome = \boldsymbol{\beta_1} Tax + \Theta \cdot Dmgrphcs + \Phi \cdot \text{Policy\_Cntrls} + \text{FEs} + \varepsilon$$

- What are the fixed effects (FEs)?
  - » ① FEs = dummy variables (each category is controlled for by itself)
  - » ② County FEs
  - » ③ Time FEs = conception year × conception month (e.g, 2015-Jan)
  - » ④ Mixed FEs = state of residence × conception year (e.g., MD-2015)
- How we handle standard errors?
  - » Cluster them at the level of state with a small tweak: we treat Cook County, IL and Montgomery County, MD as if they were states

Empirical Methods – Panel Analysis

- How did we reshape the original birth records data

Birth_ID	CIG_0	CIG_1	CIG_2	CIG_3
1001	0	0	1	1

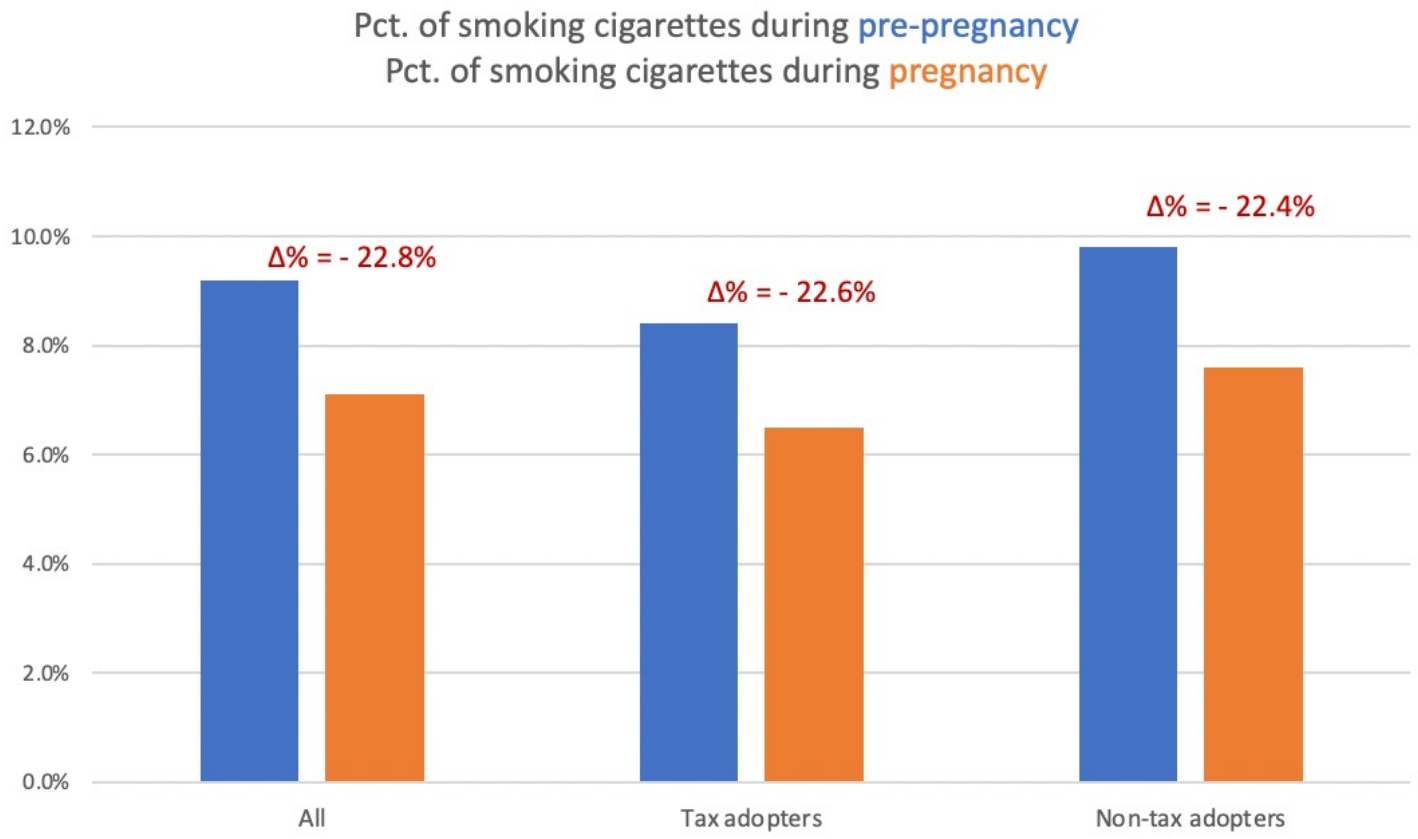


Birth_ID	Trimester	CIG
1001	0	0
1001	1	0
1001	2	1
1001	3	1

$$Outcome = \boldsymbol{\beta_1} Tax + \Theta \cdot Dmgrphcs + \Phi \cdot \text{Policy\_Cntrls} + \text{FEs} + \varepsilon$$

- How policies get merged into this long-fmtd dataset?
  - » Geo-location + Year of trimester (0,1,2,3) start + Qtr of trimester (0,1,2,3) start
- What are the fixed effects (FEs)?
  - » Birth FEs + Trimester FEs
- No need for demographics
- Cluster std.errs in the same fashion

Summary Statistics (Selected Few)



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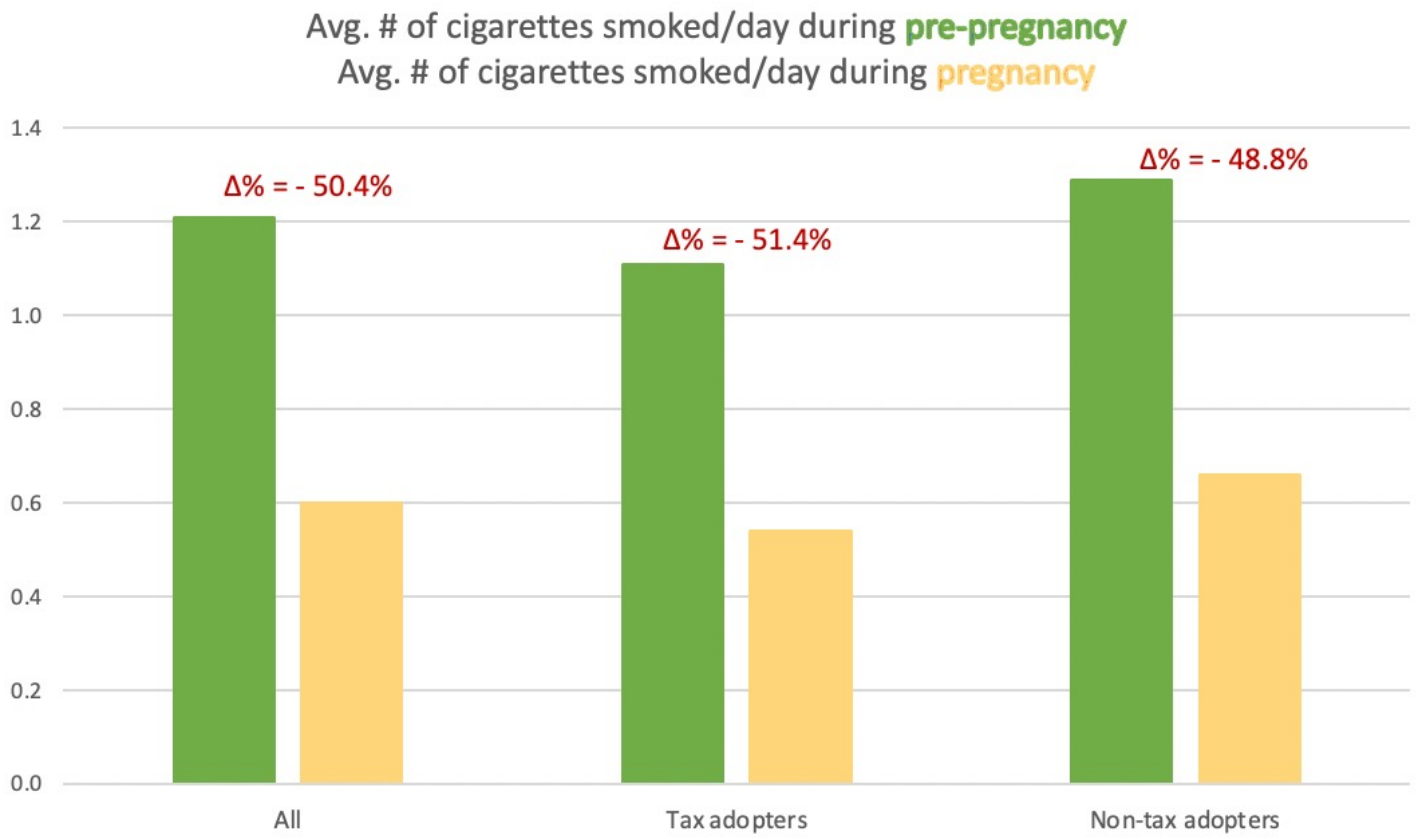

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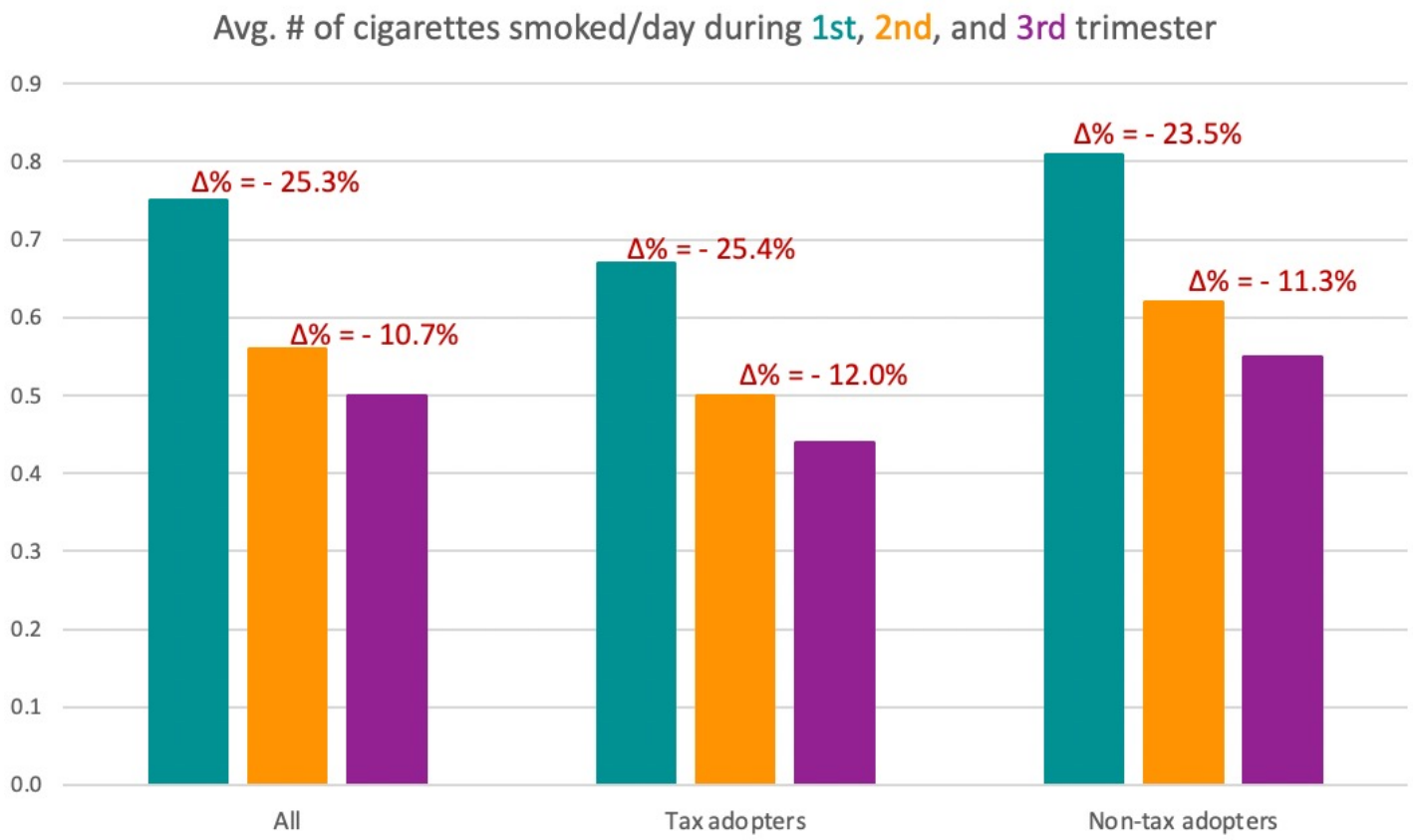
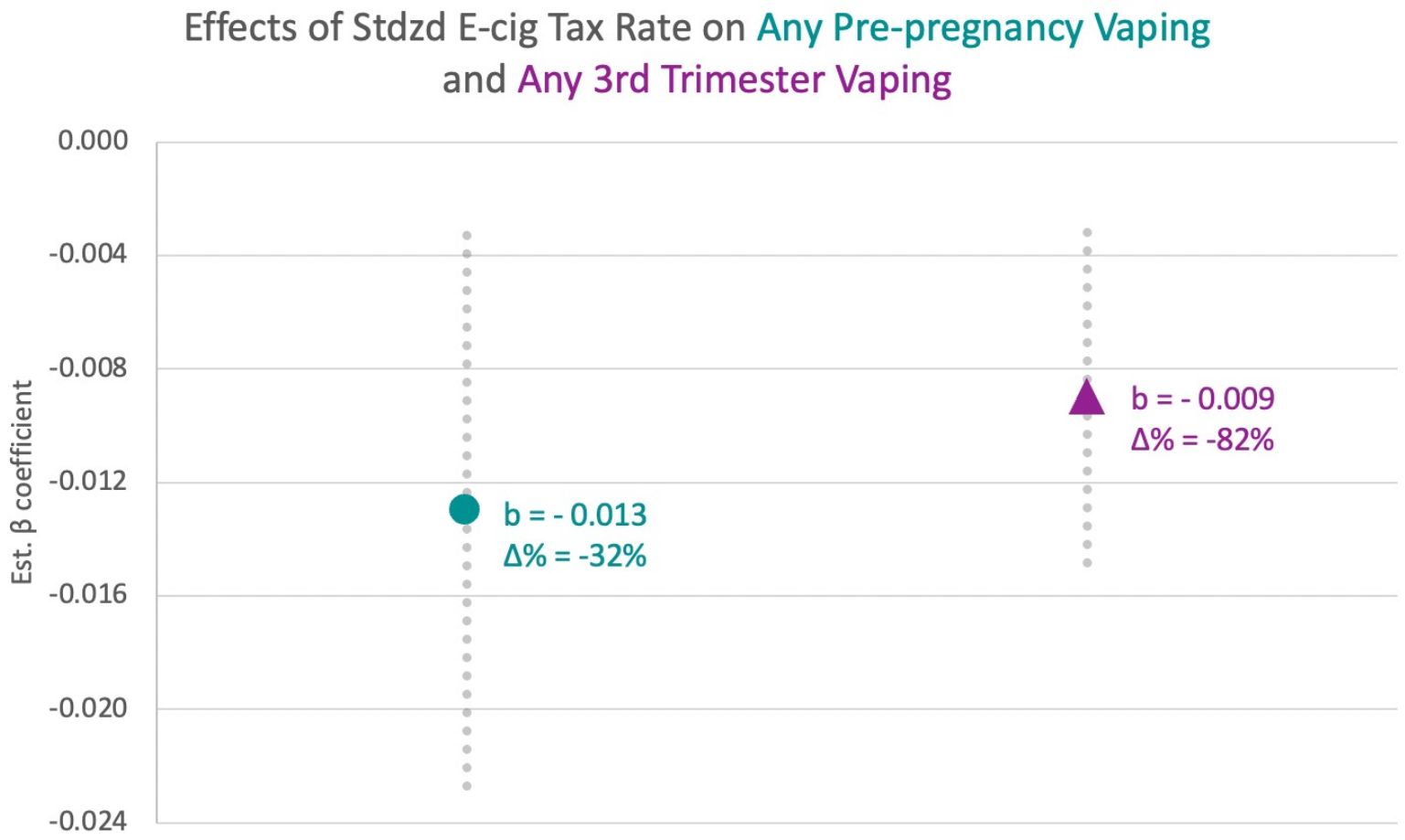
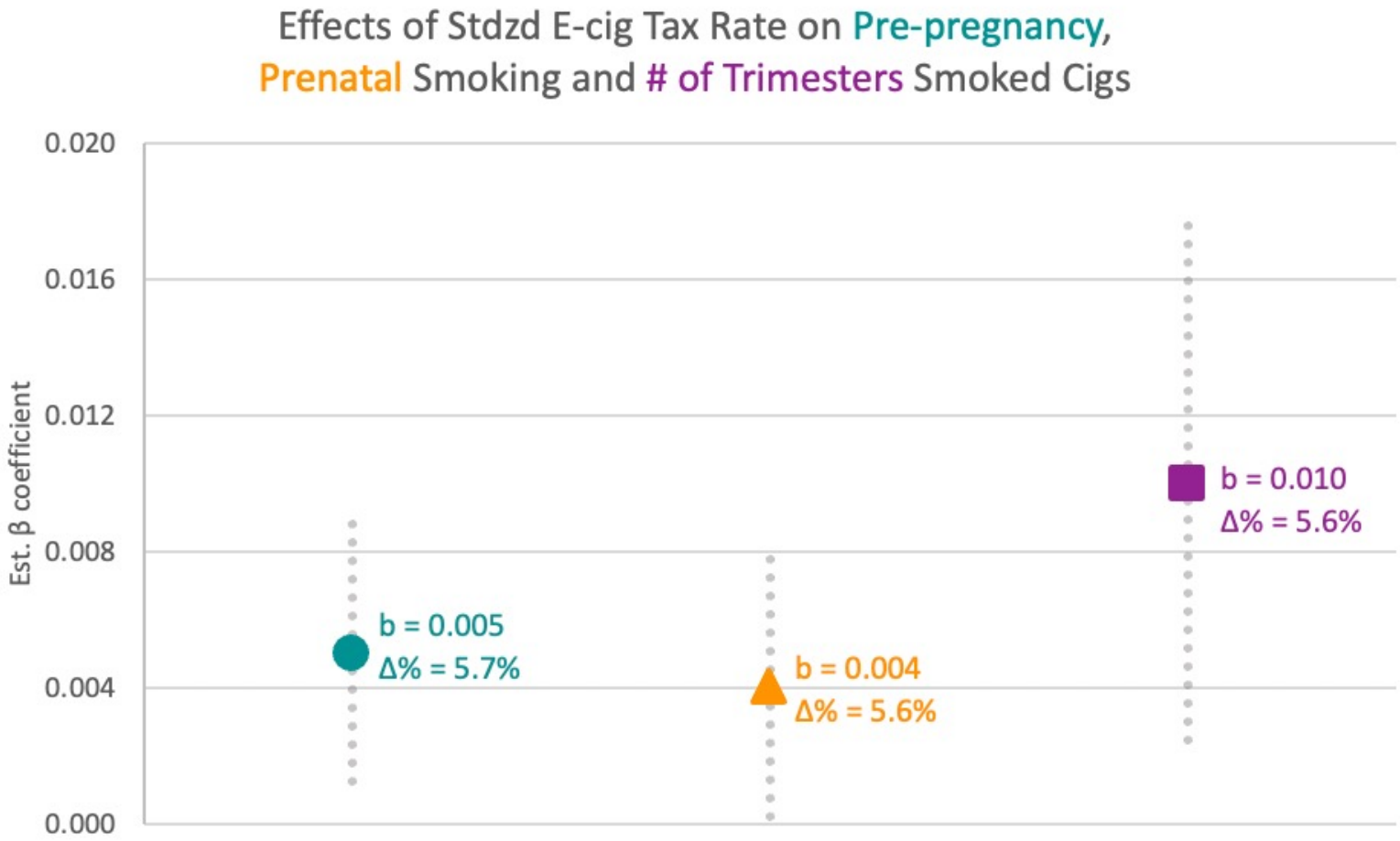


Summary Regression Results (selected few)



Note: each shape-color combination denotes a separate regression
PRAMS data; Full set of controls (demographics + policies) is included in regressions

Summary Regression Results (selected few)



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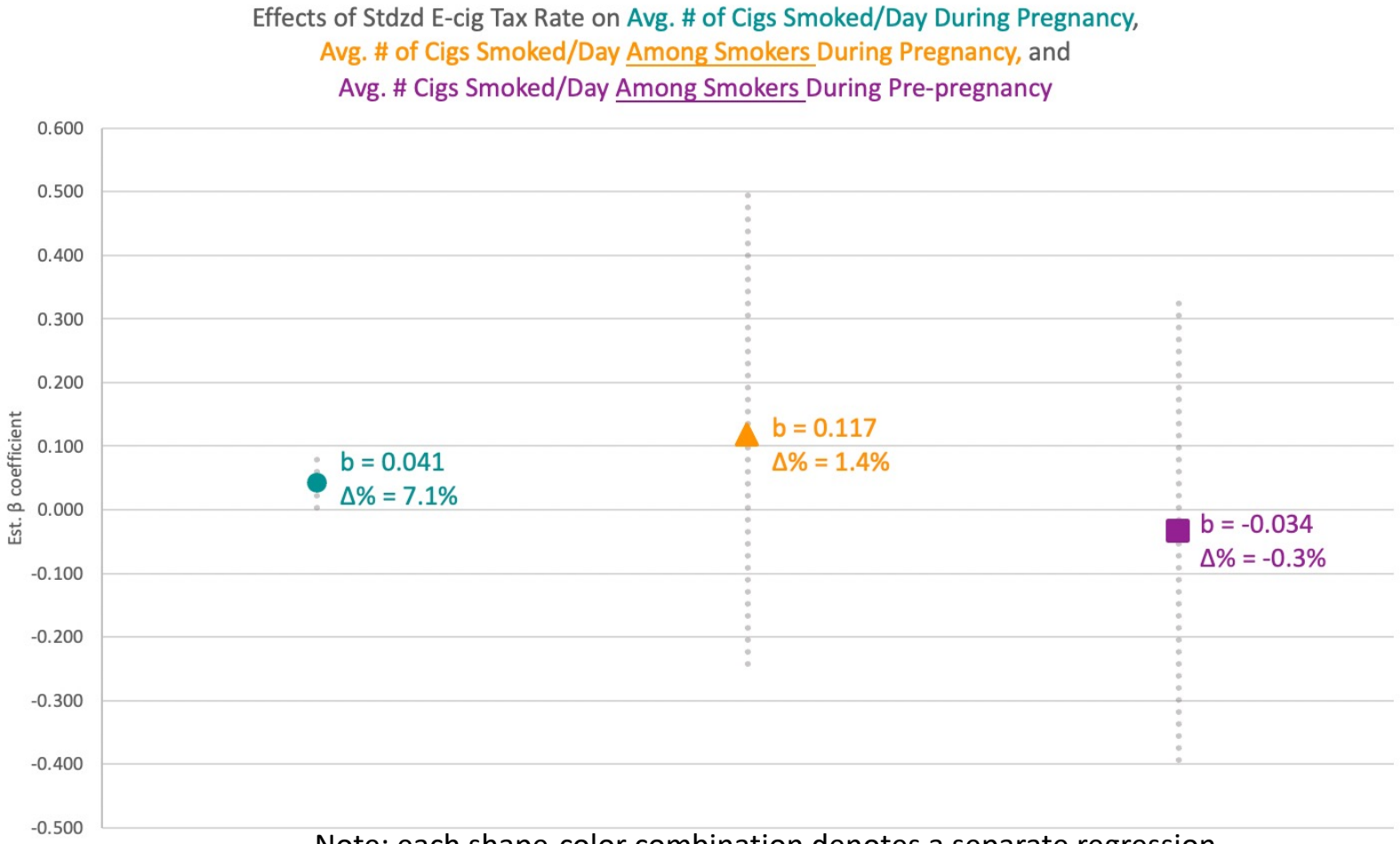
Summary Regression Results (selected few)



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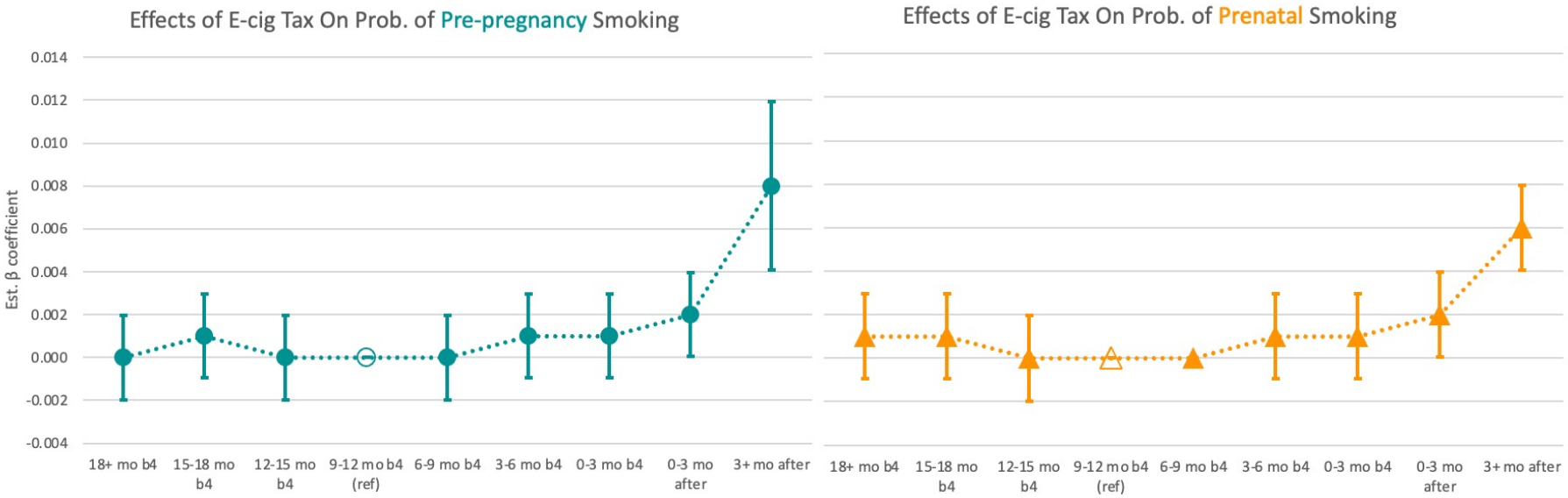
Full set of controls (demographics + policies) is included in regressions

Summary Regression Results (Event-Study, ES)

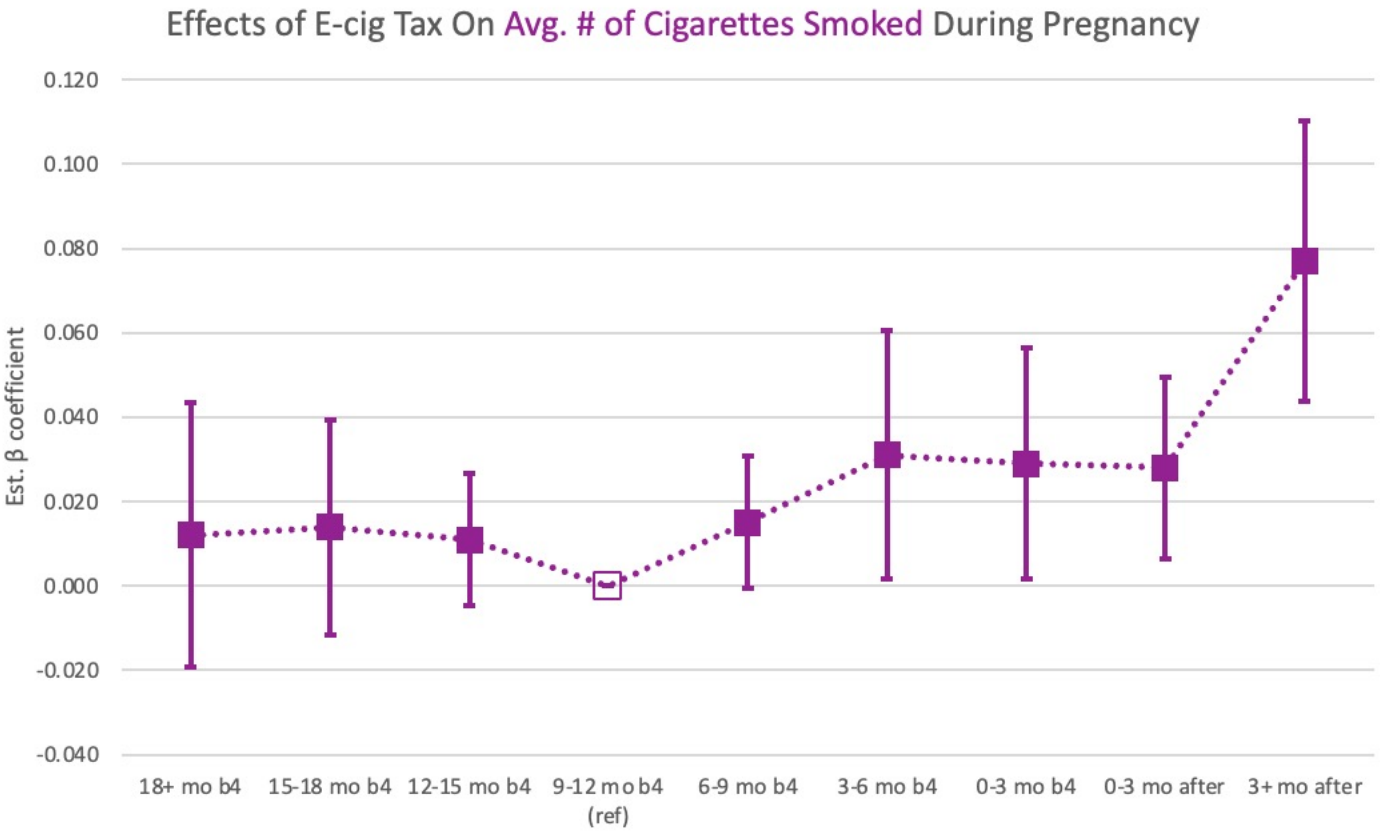


Note: Leads and lags denote the relative difference in months between mom's pregnancy and the time e-cigarette taxes went into effect.

Reference group: moms whose pregnancy precedes e-cigarette tax implementation by 9 to 12 months

Full set of controls (demographics + policies) is included in regressions

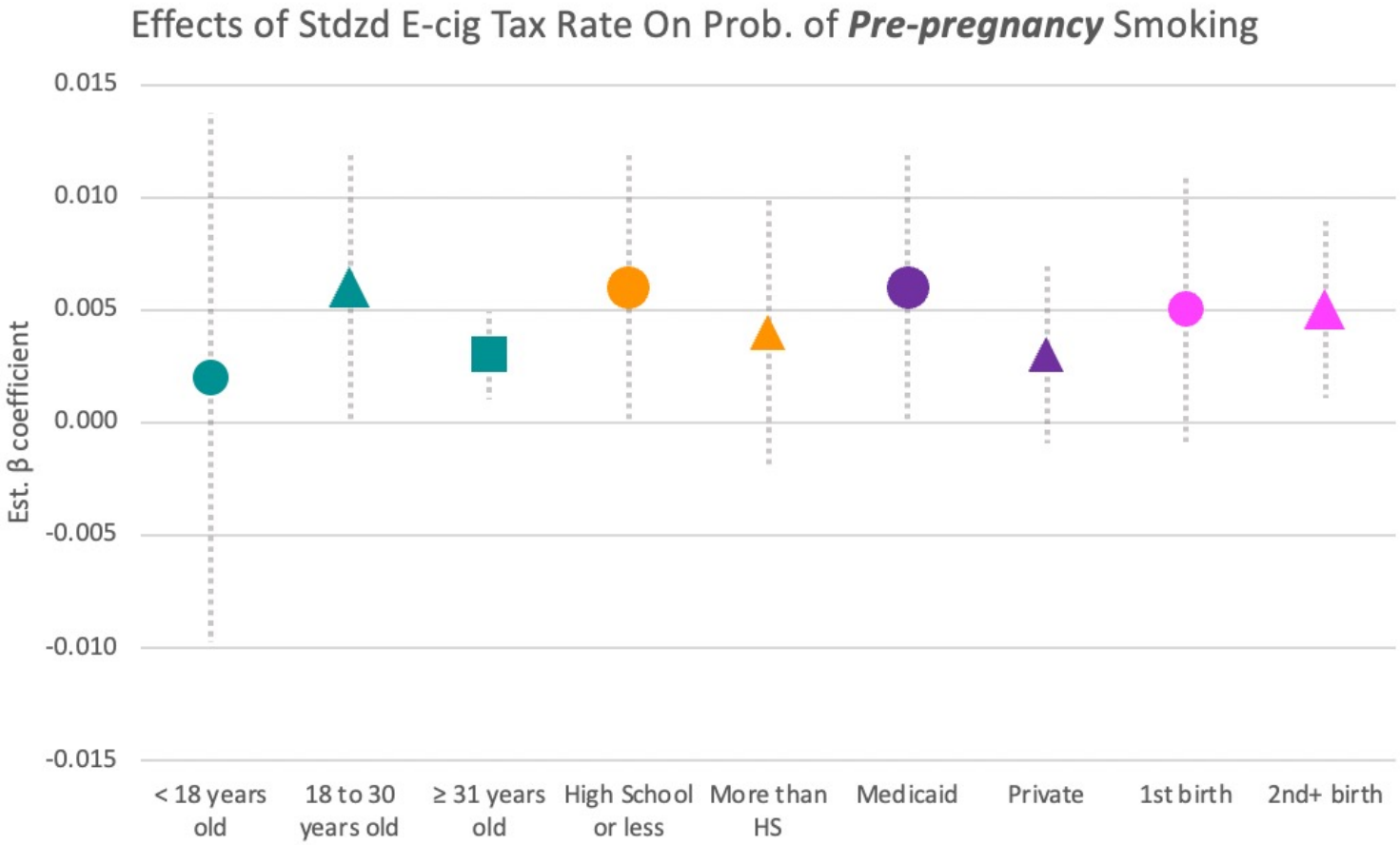
Summary Regression Results (ES)



Note: Leads and lags denote the relative difference in months between mom's pregnancy and the time e-cigarette taxes went into effect.

Full set of controls (demographics + policies) is included in regressions

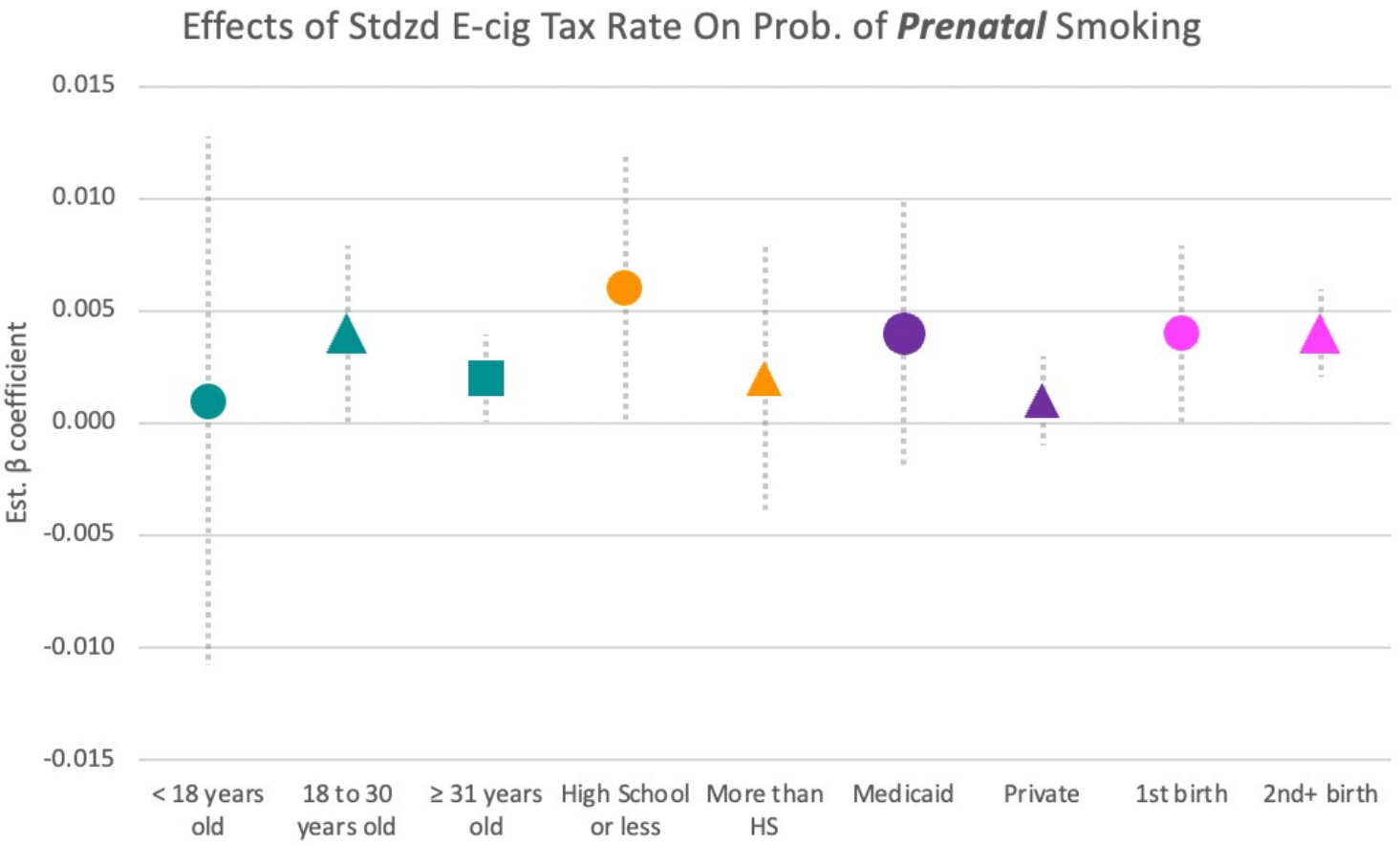
Summary Regression Results (Tax Effect Het.)



Note: Each shape-color combination denotes a separate (sub-sample) regression.

Full set of controls (demographics + policies) is included in regressions

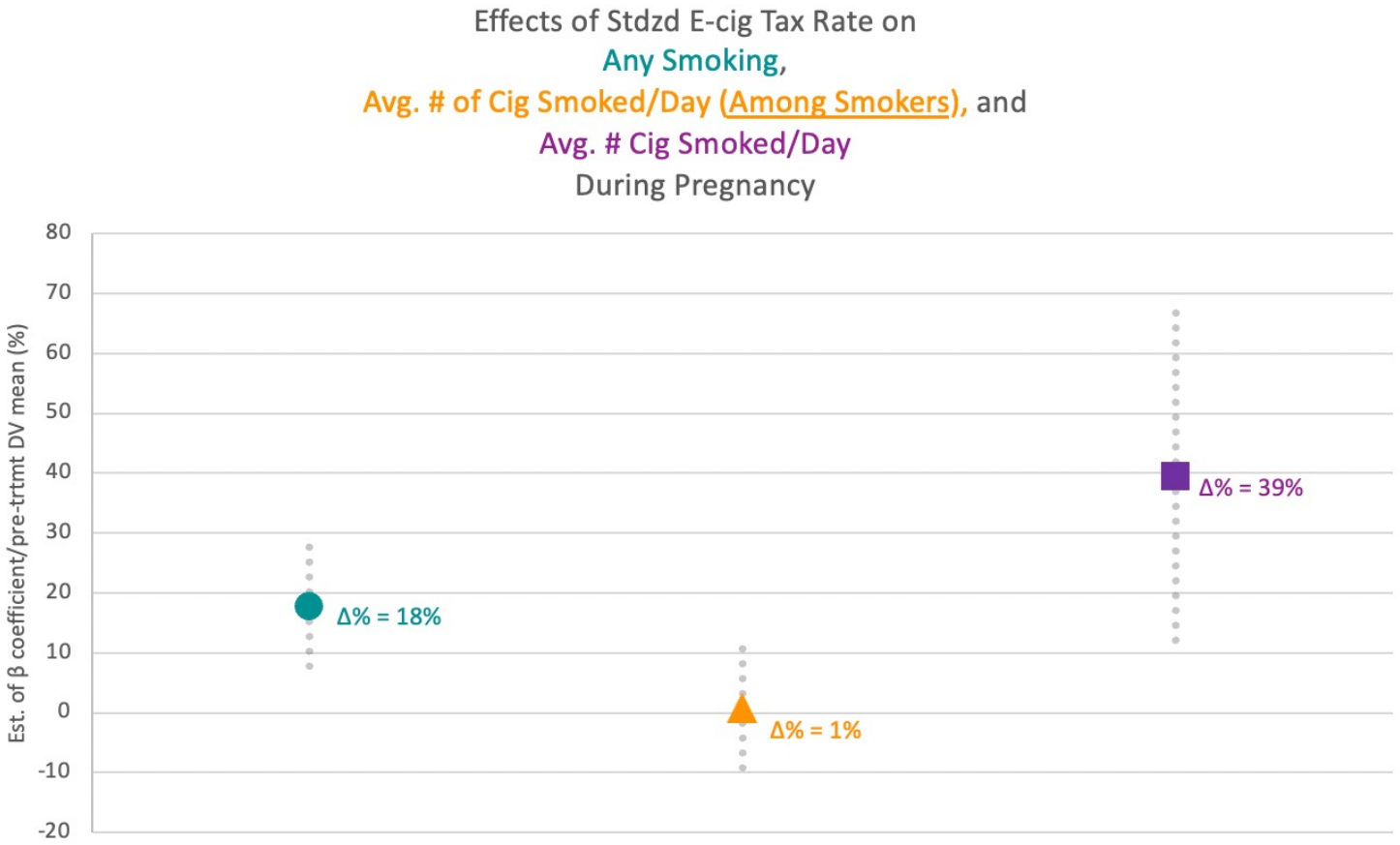
Summary Regression Results (Tax Effect Het.)



Note: Each shape-color combination denotes a separate (sub-sample) regression.

Full set of controls (demographics + policies) is included in regressions

Summary Regression Results (Panel Analysis)



Note: Each shape-color combination denotes a separate regression.
Policy variables, Birth FEs, and Trimester FEs are controlled for in regressions.

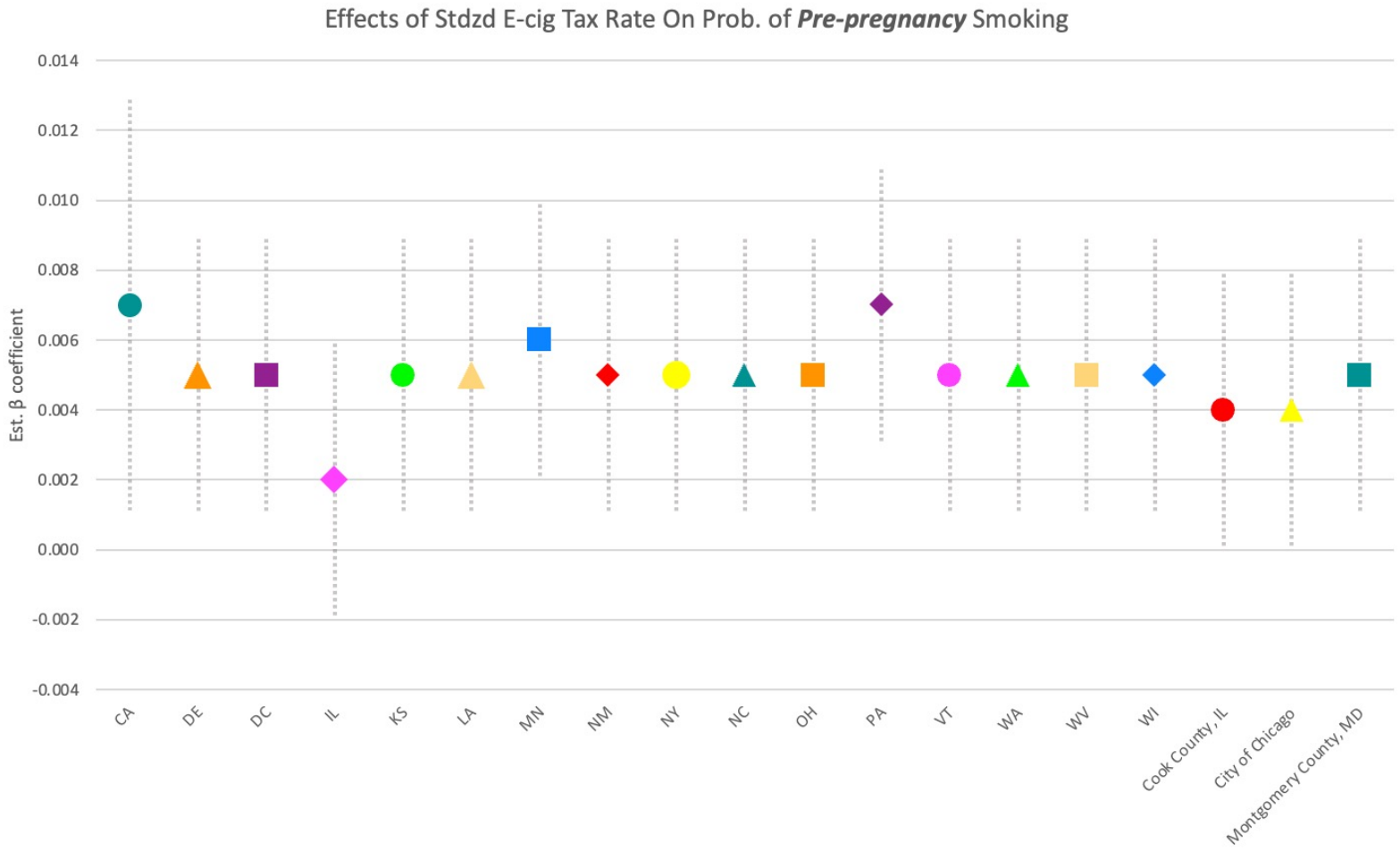
Summary Regression Results (Birth Outcomes)

Note: Each shape-color combination denotes a separate regression.
The full set of controls (demographics + policies + FEs) is controlled for in regressions

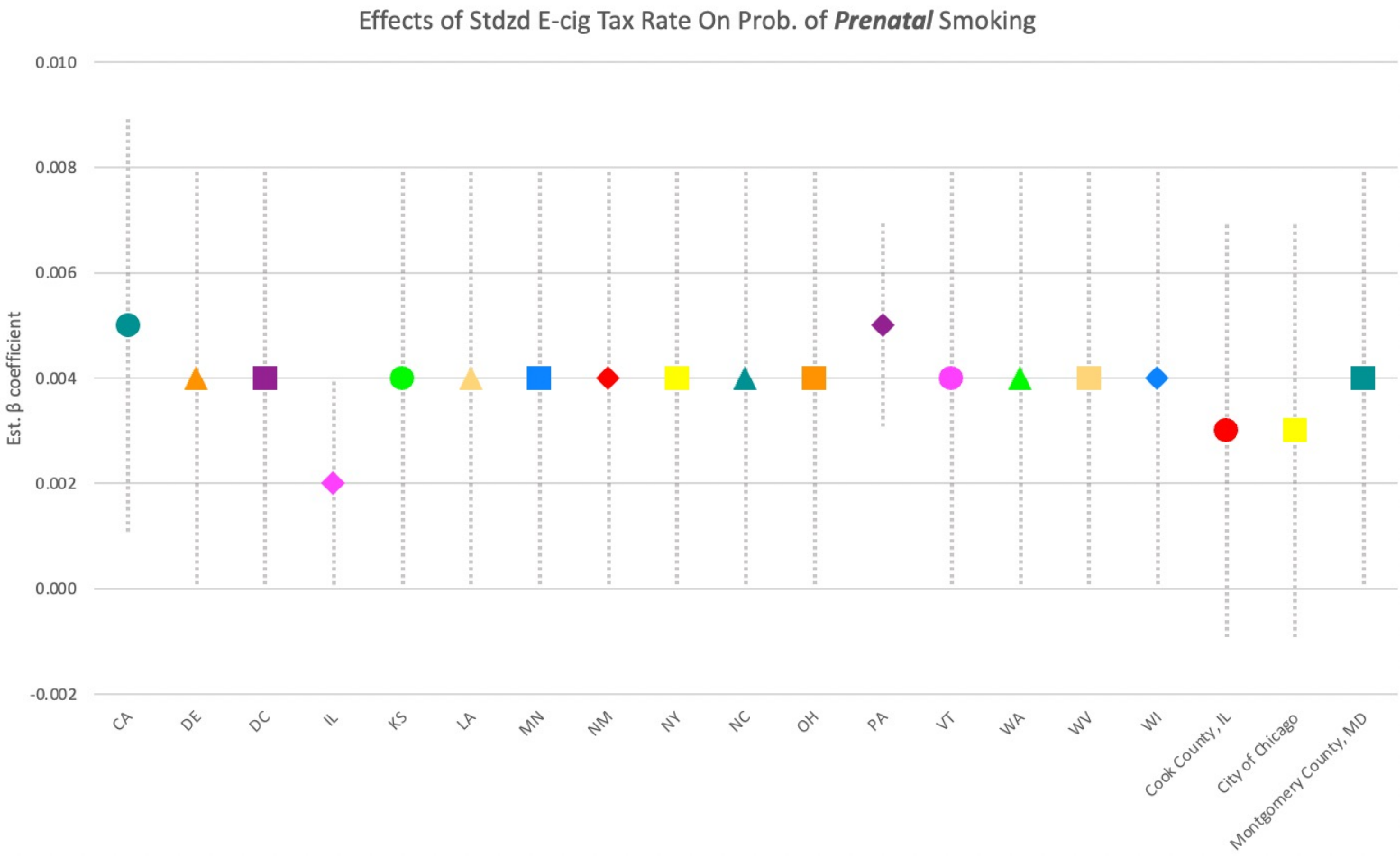
Extension – Robustness Checks

1. Replace standardized e-cig tax rate with its dichotomized version (0-1)
   - » Address concerns raised in recent literature on the conventional DD setup
   - » Execute Goodman-Bacon decomposition
2. Compare βs across models that a) without demographic nor policy controls; b) with demographics only; c) with both demographics and policy controls
   - » Note, FEs are always in
3. Shift the reference group used in ES-style regression to a different point
4. Examine the extent to which e-cig tax effect is correlated with composition of births (i.e., is pregnancy itself affected by e-cig taxes)
5. Check balance of data (or correlates of e-cigarette taxes and demographics and policy controls)
6. Start the analysis sample in 2011
7. Cluster standard errors at a different level
8. Check sensitivity of results to using a different retailer markup rate
9. And many more …

Extension – (Leave-One-Out Analysis)



Extension – (Leave-One-Out Analysis)



Summary of Findings

1. What we investigated?
   - » Impact of e-cigarette taxes (in particular, the standardized e-cig tax rate) on pre-pregnancy and prenatal smoking and vaping, and birth outcomes
2. What we found?
   - » E-cig taxes led to higher pre-pregnancy and prenatal smoking
   - » The increased prenatal smoking is likely not due to e-cig taxes alone
     - ◦ Some portion of the increase may be carry-over from the increased pre-pregnancy smoking
   - » Smoking declines monotonically as the birth date nears, and increased prenatal smoking attributable to e-cig taxes is concerning ⇢ discouraged smoking cessation
   - » Combine the first-stage effect from PRAMS: for every 3 moms who didn't use e-cigs due to higher e-cig taxes, one of them used cigarettes instead
   - » No stat. sig impact on birth outcomes (nicotine is harmful for fetal dev. regardless of tobacco products + small effects on cigarette smoking to have meaningful birth impacts)

Discussion (Brief)

While no stat. sig. effect on birth outcomes, increased smoking during pregnancy is concerning from a public health standpoint:

- Pre-pregnancy smoking carried over to prenatal smoking, which may carry over to post-pregnancy smoking: Negative childhood development issues due to second-hand smoke exposure
- Missed opportunity for smoking cessation for the mother, with potentially harmful consequences for her own health

Discussion (Brief)

Current literature on smoking during pregnancy and the health of newborn

- Smoking during pregnancy is the number one risk factor for having a low birth weight infant (Almond et al., 2005)
- In-utero exposure to cigarette smoke has been shown to directly impact the developing brain and impair early health and human capital development (Breslau et al., 1994; Bublitz and Stroud, 2011; Basten et al., 2015; Banderali et al., 2015; Akshoomoff et al., 2017)
- Reduced prenatal smoking improves children's human capital development, especially for low socioeconomic status children (Settele and Van Ewijk, 2018)

E-cigarettes continue to alter the tobacco marketplace. Active policy area across the country.

Link To Study (https://www.nber.org/papers/w26126)

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Jan/2022