The Long-term Impact of Early-Life Cigarette Taxes on Adult Pre-Pregnancy and Prenatal Smoking

Lauren Hoehn-Velasco
Michael F. Pesko
Serena Phillips
Georgia State University

February 2021

*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: Pesko). The views expressed herein are those of the authors and do not necessarily reflect the views of the National Institutes of Health.

Disclosures

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- I have no other tobacco-related conflicts over the last 10 years.

Introduction

Motivation

- Do early-life public policies impact long-term health behaviors?
  - Literature has shown–prenatal and early-childhood environment crucial for human capital development*
  - If early-life influences also impact on long-run health behaviors (such as smoking)–provides another potential avenue for early-childhood health to persist into adulthood

*See Behrman and Rosenzweig (2004); Almond (2006); Bleakley (2007); Case et al. (2008); Case and Paxson (2009); Currie (2009); Bozzoli et al. (2009); Maluccio et al. (2009); Currie and Almond (2011); Almond et al. (2011); Beach et al. (2016); Hoynes et al. (2016); Hjort et al. (2017); Bhalotra et al. (2017); Butikofer et al. (2019); Hoehn-Velasco (2021).

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Main Question

- Do higher early-life cigarette taxes have long-term *intergenerational* links to adult smoking behavior?
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- Prenatal smoking remains an ongoing public health threat
  - Raises the likelihood of pregnancy complications such as low birth weight *(Almond et al.; 2005)*
  - Prenatal smoking during gestation may also have long-term implications for health and human capital development *(Simon, 2016; Settele and Van Ewijk, 2018)*
  - Birth Certificates provide well-reported administrative record of prenatal smoking & include the mother's own birth state
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Methods and Data

- Prenatal smoking from U.S. Birth Certificate records
- Early-life taxes: taxes in place during the mother's own gestation (1965-2000)
- Use a fixed effects model:
  - Month-year of the current pregnancy's conception & mother's conception year
  - Mother's birth state & current residence state
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Preview of Findings

- **Findings:** ↑ state-level in-utero cigarette taxes ↓ prenatal smoking in adulthood (for first-time mothers)
    - 1% increase in early-life cigarette tax is associated with a reduction in the probability of prenatal smoking by 0.24 percent and pre-pregnancy smoking by 0.21 percent
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- *Human capital formation* and adult *socioeconomic status*
    1. Higher cigarette tax in the years leading up to the mother's in-utero exposure changes the likelihood of:
    2. SES/human capital also linked to lower prenatal smoking

- *Multigenerational effects* on health and health behaviors
    - Infant health:
        1. ↓ very premature
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Is this a Cohort Effect?

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- Two notable *cohort effects* appear in the data:
    1. Contemporary and teenage cigarette taxes: influential for older cohorts, those with first child during the late 1990s and early 2000s
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Literature

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  - Impairs early health and human capital development (*Settele and Van Ewijk (2018)*
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- **Reason 2:** In-utero and childhood exposure to nicotine may affect the individual's general proclivity towards nicotine-containing products
  - Nicotine exposure has been shown to affect rodent brain development; which may be generalizable to humans *(Lv et al., 2008; England et al., 2015; HHS, 2016, 2018; Romoli et al., 2019)*
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- **Reason 3:** Higher cigarette taxes will affect smoking in the home environment
  - Children who grow up in households with smoking parents more likely to smoke in adulthood (*Bantle and Haisken-DeNew, 2002; Gohlmann et al., 2010*)
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- **Reason 4:** Higher cigarette taxes shape the state-level cultural environment
  - Mother's beliefs about smoking shaped by parents, peers, and acquaintances
  - Cultural transmission of smoking behaviors (*Christopoulou and Lillard, 2015; Rodriguez-Planas and Sanz-de Galdeano, 2019; Kleinjans and Gill, 2020; Catalano and Gilleskie, 2021*)
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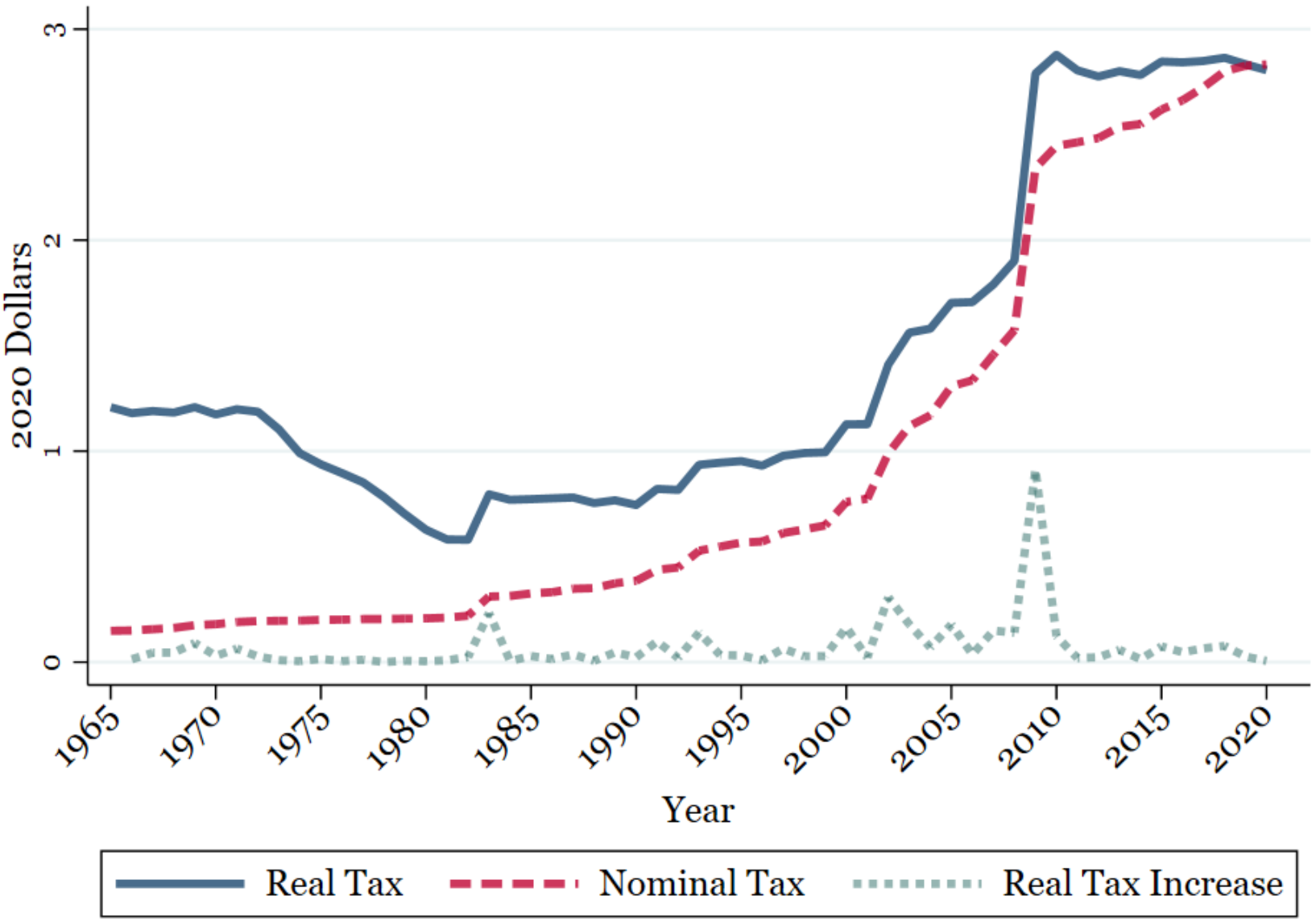
1. In-utero exposure and human capital formation
2. Nicotine receptors in the developing brain
3. Smoking culture at home
4. Smoking culture in state
5. Earmarked expenditures

Background

Cigarette Taxes over Time

Average State-level Cigarette Taxes, 1965-2020



Data

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    - Natality Detail File from the CDC and NVSS
    - Revised version has information on smoking at three points in time (2009+)
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    - Use cigarette taxes in place at the conception of mother, during teen years (age 13), and at the conception of the newborn
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Revised Records for 2009-2020

- **Main outcomes:**
  1. Prenatal Smoking
     - Any smoking during the three trimesters of pregnancy
  2. Smoking pre-pregnancy
  3. Quantity of Cigarettes
     - Number of cigarettes smoked during the three trimesters of pregnancy

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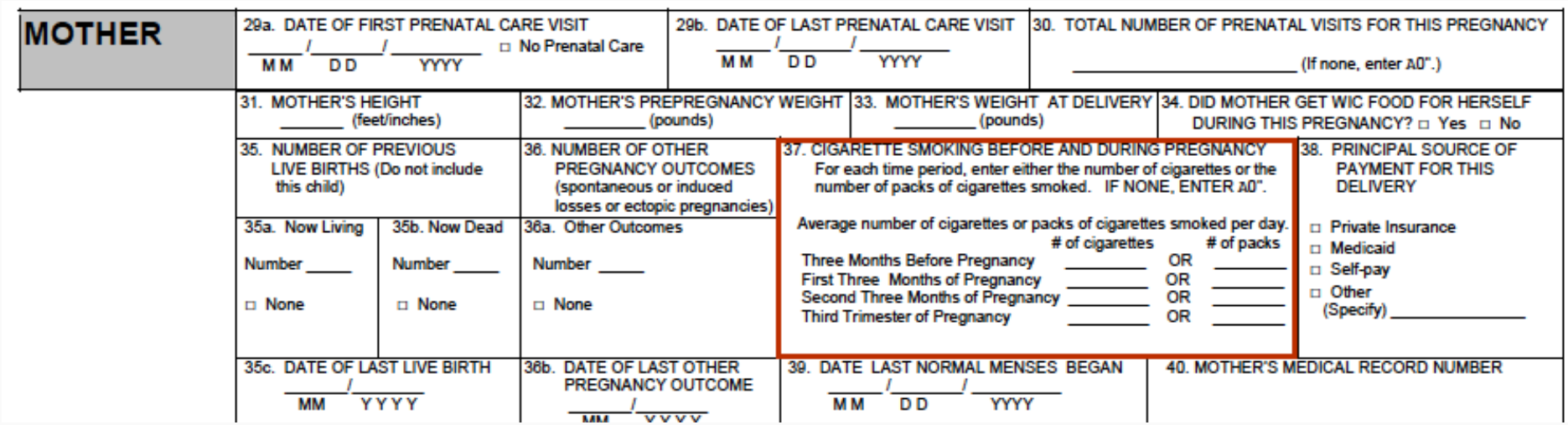
- **Main Sample:** first deliveries to adults (18-49) occurring over 2009-2020

2003 Birth Certificate Revision



MOTHER

29a. DATE OF FIRST PRENATAL CARE VISIT ____/____/____ (MM DD YYYY) ☐ No Prenatal Care

29b. DATE OF LAST PRENATAL CARE VISIT ____/____/____ (MM DD YYYY)

30. TOTAL NUMBER OF PRENATAL VISITS FOR THIS PREGNANCY ____ (If none, enter "0".)

31. MOTHER'S HEIGHT ____ (feet/inches)

32. MOTHER'S PREPREGNANCY WEIGHT ____ (pounds)

33. MOTHER'S WEIGHT AT DELIVERY ____ (pounds)

34. DID MOTHER GET WIC FOOD FOR HERSELF DURING THIS PREGNANCY? ☐ Yes ☐ No

35. NUMBER OF PREVIOUS LIVE BIRTHS (Do not include this child)

35a. Now Living Number ____ ☐ None

35b. Now Dead Number ____ ☐ None

36. NUMBER OF OTHER PREGNANCY OUTCOMES (spontaneous or induced losses or ectopic pregnancies)

36a. Other Outcomes Number ____ ☐ None

37. CIGARETTE SMOKING BEFORE AND DURING PREGNANCY
For each time period, enter either the number of cigarettes or the number of packs of cigarettes smoked. IF NONE, ENTER "0".

Average number of cigarettes or packs of cigarettes smoked per day.

	# of cigarettes		# of packs
Three Months Before Pregnancy	____	OR	____
First Three Months of Pregnancy	____	OR	____
Second Three Months of Pregnancy	____	OR	____
Third Trimester of Pregnancy	____	OR	____

38. PRINCIPAL SOURCE OF PAYMENT FOR THIS DELIVERY

☐ Private Insurance
☐ Medicaid
☐ Self-pay
☐ Other (Specify) ____

35c. DATE OF LAST LIVE BIRTH ____/____ (MM YYYY)

36b. DATE OF LAST OTHER PREGNANCY OUTCOME ____/____ (MM YYYY)

39. DATE LAST NORMAL MENSES BEGAN ____/____/____ (MM DD YYYY)

40. MOTHER'S MEDICAL RECORD NUMBER

Source: U.S. Standard Certificate of Live Birth, 2003 (`https://www.cdc.gov/nchs/data/dvs/birth11-03final-ACC.pdf`)

Empirical Strategy

For individual i residing in county j and state s_c at time t who was born in state s_b this specification appears as:

$$\begin{aligned}\text{Smoking}_{i,j,s_c,s_b,t} = \alpha + \beta\ \text{Early-life Tax}_{s_b(t-age-1)} + \mathbf{X}'_{i,j,s_c,s_b,t}\gamma + a_{s_c} + \delta_{s_b} \\ + \eta_{(t-g)} + \nu_{(t-age-1)} + \phi_{s_b}(t - age - 1) + \epsilon_{i,j,s_c,s_b,t}\end{aligned} \tag{1}$$

- $\text{Smoking}_{i,j,s_c,s_b,t}$–smoking behavior for for individual i
- $\text{Early-life Tax}_{s_b(t-age-1)}$–real cigarette tax in the mother's birth state s_b & conception year $(t - age - 1)$
- $\mathbf{X}'_{i,j,s_c,s_b,t}\gamma$ are demographic and policy controls
- Fixed effects and trends
- $\epsilon_{i,j,s_c,s_b,t}$ is the standard error (clustered at the birth state level)

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- $\mathbf{X}'_{i,j,s_c,s_b,t}\gamma$ are demographic and policy controls
    1. Demographic controls: race/ethnicity
    2. Tobacco control: contemporary state-level cigarette tax, county-level Tobacco 21 laws, share of the population covered by indoor vaping and smoking restrictions, standardized ecigarette tax, and e-cigarette minimum purchasing age indicator
    3. General policy: ACA Medicaid expansion, state-level minimum wage and beer tax, county-level unemployment rate, median income, poverty rate, binary variables for state-level recreational & medical marijuana legalization and opioid PDMP

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  1. Current state a_{s_c} and birth state δ_{s_b}
  2. Infant month-year of conception $\eta_{(t-g)}$, mother's conception year, $\nu_{(t-age-1)}$ and $\phi_{s_b}(t - age - 1)$ linear time trends
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Main Results

Effect of Early-life Taxes on Smoking

	1(Any Pre-Pregnancy Smoking)			1(Any Prenatal Smoking)			Prenatal Per Day Cigarettes		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
At-Conception Cigarette Tax	-0.3115**	-0.3050**	-0.2126***	-0.3681**	-0.3583**	-0.2403***	-0.4170***	-0.4135**	-0.2506***
	(0.1414)	(0.1471)	(0.0707)	(0.1693)	(0.1766)	(0.0856)	(0.1578)	(0.1702)	(0.0848)
Observations	9,466,192	9,466,192	9,466,192	9,470,171	9,470,171	9,470,171	9,456,678	9,456,678	9,456,678
Adjusted R-squared	0.053	0.069	0.071	0.040	0.053	0.055	0.026	0.035	0.036
Mean Dependent	0.104	0.104	0.104	0.072	0.072	0.072	0.521	0.521	0.521
Baseline FE	X	X	X	X	X	X	X	X	X
Controls		X	X		X	X		X	X
Maternal Birth State Trends			X			X			X

Notes: Elasticities reported. Robust standard errors clustered at the level of the mother's birth state. ***, **, * represent statistical significance at 1, 5 and 10 percent levels.

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Maternal Birth State Trends			X			X			X

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Baseline FE	X	X	X	X	X	X	X	X	X
Controls		X	X		X	X		X	X
Maternal Birth State Trends			X			X			X

Notes: Elasticities reported. Robust standard errors clustered at the level of the mother's birth state. ***, **, * represent statistical significance at 1, 5 and 10 percent levels.

Robustness

Contemporary, Teenage, and Early-life Cigarette Taxes

	1(Any Pre-Pregnancy Smoking)			1(Any Prenatal Smoking)			Prenatal Per Day Cigarettes		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Main Sample, Adding Teenage and Contemporary Taxes									
At-Conception Cigarette Tax	-0.3403**	-0.3163**	-0.2092***	-0.4001**	-0.3713**	-0.2353**	-0.4472**	-0.4256**	-0.2423***
	(0.1444)	(0.1425)	(0.0686)	(0.1713)	(0.1710)	(0.0834)	(0.1600)	(0.1657)	(0.0831)
Teenage (Age 13) Cigarette Tax	0.0997*	0.0895	0.0153	0.1151*	0.1023	0.0223	0.1086*	0.0952	0.0365
	(0.0603)	(0.0640)	(0.0348)	(0.0649)	(0.0688)	(0.0352)	(0.0628)	(0.0660)	(0.0386)
Present-Day Cigarette Tax	0.2316**	0.1433**	0.1621*	0.2493**	0.1336**	0.1585	0.2362**	0.0549	0.0784
	(0.1002)	(0.0639)	(0.0881)	(0.1111)	(0.0681)	(0.1008)	(0.1156)	(0.0728)	(0.1027)
Observations	9,466,192	9,466,192	9,466,192	9,470,171	9,470,171	9,470,171	9,456,678	9,456,678	9,456,678
Adjusted R-squared	0.053	0.069	0.071	0.040	0.053	0.055	0.026	0.035	0.036
Mean Dependent	0.104	0.104	0.104	0.072	0.072	0.072	0.521	0.521	0.521
Baseline FE	X	X	X	X	X	X	X	X	X
Controls		X	X		X	X		X	X
Maternal Birth State Trends			X			X			X

Notes: Elasticities reported. Robust standard errors clustered at the level of the mother's birth state. ***, **, * represent statistical significance at 1, 5 and 10 percent levels.

Contemporary, Teenage, and Early-life Cigarette Taxes

	1(Any Pre-Pregnancy Smoking)			1(Any Prenatal Smoking)			Prenatal Per Day Cigarettes		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel B: Never Movers, Adding Teenage and Contemporary Taxes									
At-Conception Cigarette Tax	-0.3414**	-0.3336**	-0.2253**	-0.3923**	-0.3869*	-0.2499**	-0.4110**	-0.4222**	-0.2471**
	(0.1607)	(0.1684)	(0.0798)	(0.1906)	(0.2025)	(0.0953)	(0.1743)	(0.1930)	(0.1027)
Teenage (Age 13) Cigarette Tax	0.1361**	0.1208*	0.0206	0.1634***	0.1433**	0.0289	0.1564***	0.1339*	0.0415
	(0.0565)	(0.0665)	(0.0384)	(0.0610)	(0.0716)	(0.0403)	(0.0591)	(0.0686)	(0.0443)
Present-Day Cigarette Tax	0.2498*	0.1367	0.1696	0.2725*	0.1336	0.1759	0.2529*	0.0335	0.0708
	(0.1304)	(0.0893)	(0.1373)	(0.1441)	(0.1002)	(0.1615)	(0.1528)	(0.1074)	(0.1608)
Observations	6,500,087	6,500,087	6,500,087	6,502,930	6,502,930	6,502,930	6,493,287	6,493,287	6,493,287
Adjusted R-squared	0.054	0.071	0.073	0.041	0.055	0.057	0.026	0.036	0.037
Mean Dependent	0.111	0.111	0.111	0.077	0.077	0.077	0.567	0.567	0.567
Baseline FE	X	X	X	X	X	X	X	X	X
Controls		X	X		X	X		X	X
Maternal Birth State Trends			X			X			X

Notes: Elasticities reported. Robust standard errors clustered at the level of the mother's birth state. ***, **, * represent statistical significance at 1, 5 and 10 percent levels.

Contemporary, Teenage, and Early-life Cigarette Taxes

	1(Any Pre-Pregnancy Smoking)			1(Any Prenatal Smoking)			Prenatal Per Day Cigarettes		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel C: Main Sample, Only Adding Teenage Taxes									
At-Conception Cigarette Tax	-0.3243**	-0.3150**	-0.2099**	-0.3830**	-0.3701**	-0.2359**	-0.4310**	-0.4251**	-0.2426***
	(0.1343)	(0.1427)	(0.0681)	(0.1609)	(0.1712)	(0.0829)	(0.1503)	(0.1659)	(0.0828)
Teenage (Age 13) Cigarette Tax	0.0943*	0.0887	0.0123	0.1092*	0.1016	0.0194	0.1031*	0.0949	0.0351
	(0.0570)	(0.0639)	(0.0356)	(0.0618)	(0.0687)	(0.0360)	(0.0606)	(0.0660)	(0.0390)
Observations	9,466,192	9,466,192	9,466,192	9,470,171	9,470,171	9,470,171	9,456,678	9,456,678	9,456,678
Adjusted R-squared	0.053	0.069	0.071	0.040	0.053	0.055	0.026	0.035	0.036
Mean Dependent	0.104	0.104	0.104	0.072	0.072	0.072	0.521	0.521	0.521
Baseline FE	X	X	X	X	X	X	X	X	X
Controls		X	X		X	X		X	X
Maternal Birth State Trends			X			X			X

Notes: Elasticities reported. Robust standard errors clustered at the level of the mother's birth state. ***, **, * represent statistical significance at 1, 5 and 10 percent levels.

Contemporary, Teenage, and Early-life Cigarette Taxes

	1(Any Pre-Pregnancy Smoking)			1(Any Prenatal Smoking)			Prenatal Per Day Cigarettes		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel D: Main Sample, Adding Each Cigarette Tax Alone									
At-Conception Cigarette Tax	-0.2127***			-0.2403***			–0.2506***		
	(0.0704)			(0.0853)			(0.0847)		
Teenage (Age 13) Cigarette Tax		0.0304			0.0397			0.0560	
		(0.0411)			(0.0417)			(0.0439)	
Present-Day Cigarette Tax			0.1608*			0.1566			0.0753
			(0.0889)			(0.1018)			(0.1039)
Observations	9,466,192	9,466,192	9,466,192	9,470,171	9,470,171	9,470,171	9,456,678	9,456,678	9,456,678
Adjusted R-squared	0.071	0.071	0.071	0.055	0.055	0.055	0.036	0.036	0.036
Mean Dependent	0.104	0.104	0.104	0.072	0.072	0.072	0.521	0.521	0.521
Baseline FE	X	X	X	X	X	X	X	X	X
Controls	X	X	X	X	X	X	X	X	X
Maternal Birth State Trends	X	X	X	X	X	X	X	X	X

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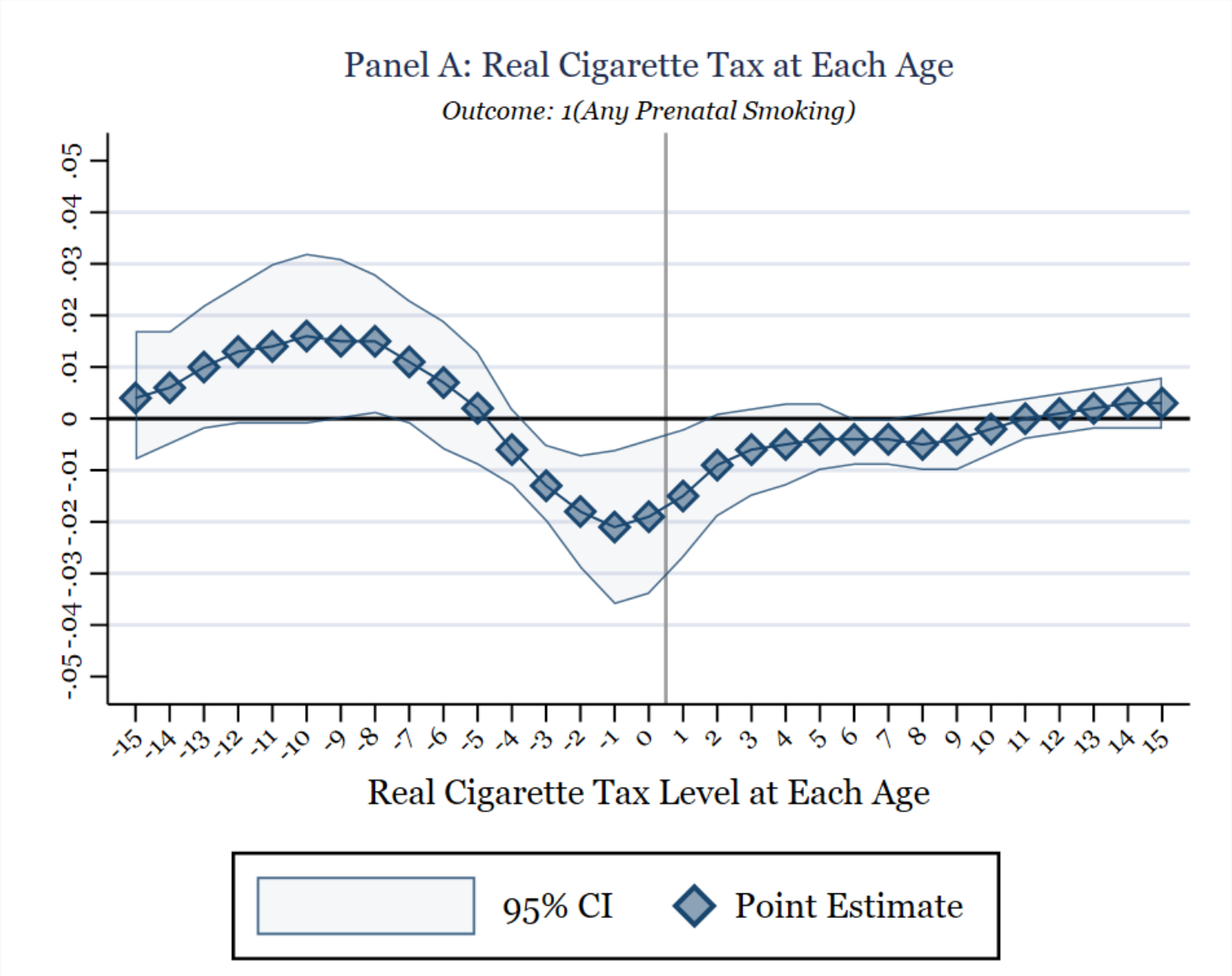
Tax Levels at Each Age



Other Notable Robustness Checks

1. Real taxes increases at each age (separately considered)
2. Event study of tax increases relative to mother's birth year
3. Effect over trimester
4. Balanced panels
5. Alternative clustering of standard errors

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Mechanisms for the Main Effect

Mechanisms

1. Human Capital and Socioeconomic Status
2. Earmarked Expenditure
3. Related State-level Tobacco Control Policies
4. Biological impacts: mother and infant health
5. *Unable to test: Intergenerational effects*

Mechanisms

- Early-life cigarette taxes influence *human capital formation* and adult *socioeconomic status*
  1. Higher cigarette tax in the years leading up to the mother's in-utero exposure changes the likelihood of:
     - 1.1 ↑ college degree attainment
     - 1.2 ↑ married at first delivery
     - 1.3 ↓ WIC receipt
  2. Also show that SES/human capital is linked to lower prenatal smoking

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Mechanisms

- *Multigenerational effects* on health and health behaviors.
- Mother health:
  1. ↓ pre-pregnancy BMI
  2. ↓ diabetes
  3. ↑ breastfeeding
- Infant health:
  1. ↓ very premature
  2. ↓ very low birth weight

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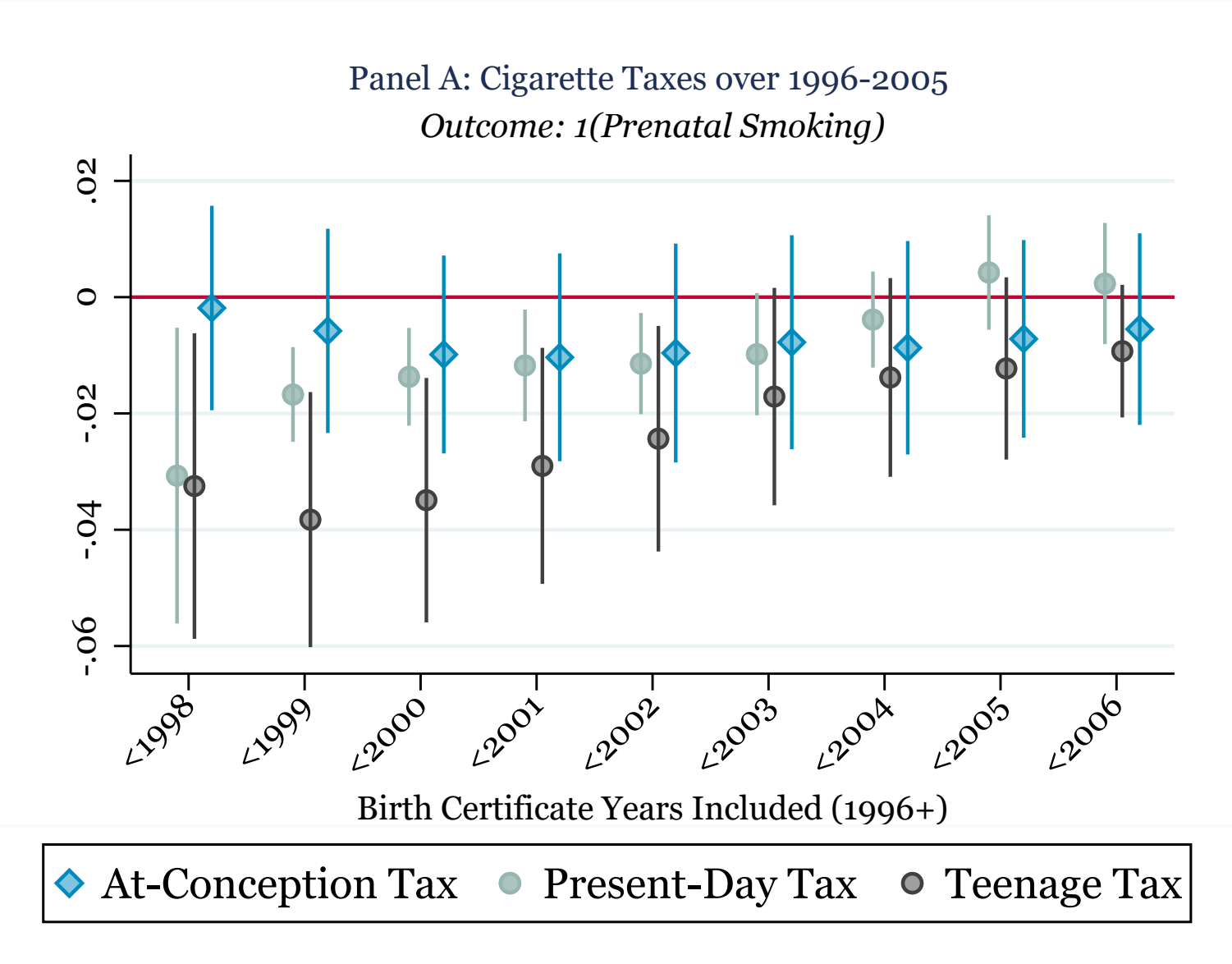
Extensions–Is this a Cohort Effect?

Remaining Questions

- Remaining questions:
  1. When did early-life taxes become important?
  2. Why do contemporary and teen taxes fail to affect smoking behavior? Have these cigarette taxes lost their bite? (Hansen et al. (2017); DeCicca et al. (2020))

- Add earlier delivery years, using the unrevised birth certificate data:
  - Consider 1996-2005 and 2002-2020
  - Ideally want to show when contemporary/teen taxes became less important and when early-life taxes arose as important

The Changing Importance of Life-Course Cigarette Taxes



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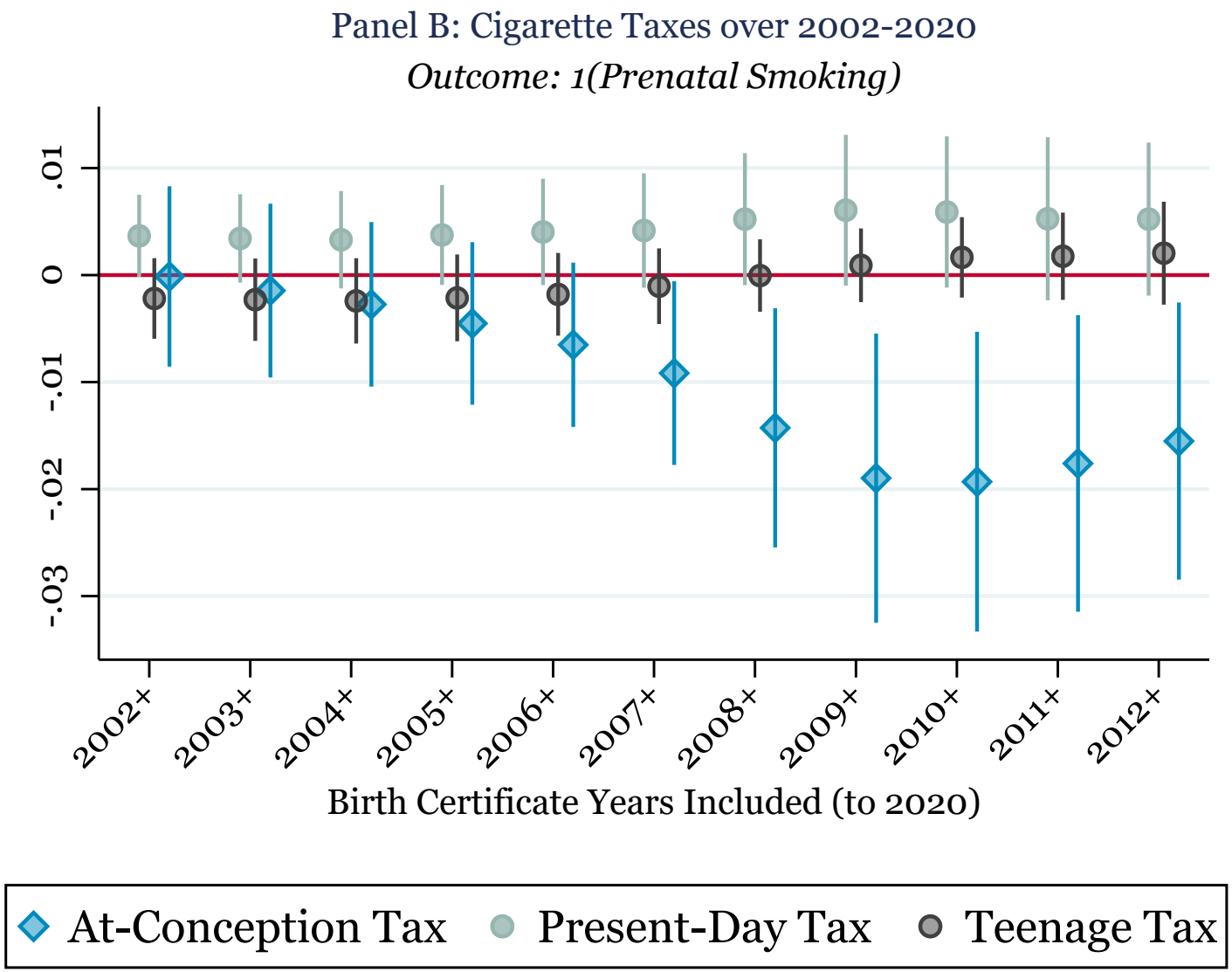

Conclusions

Conclusions

- **Primary Findings:** long-term link between mother's exposure to *higher in-utero (early-life) cigarette taxes* and *later-life* adult prenatal smoking
    1. The importance of early-life taxes holds over various specifications, notably:
        - Controlling for present-day and teenage cigarette taxes.
        - Event study
        - Considering taxes at all ages
    2. Most plausible mechanisms:
        - 2.1 *Human capital formation* and adult *socioeconomic status*
        - 2.2 *Multigenerational effects* on health and health behaviors

Conclusions

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        - Considering taxes at all ages
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