Impact of Tobacco-21 Laws on Maternal Smoking Behavior

Tim Bersak, Makayla Lavender, Lyudmyla Sonchak

Disclosures

- This work had no funding sources.
- I have never had any tobacco-related financial support

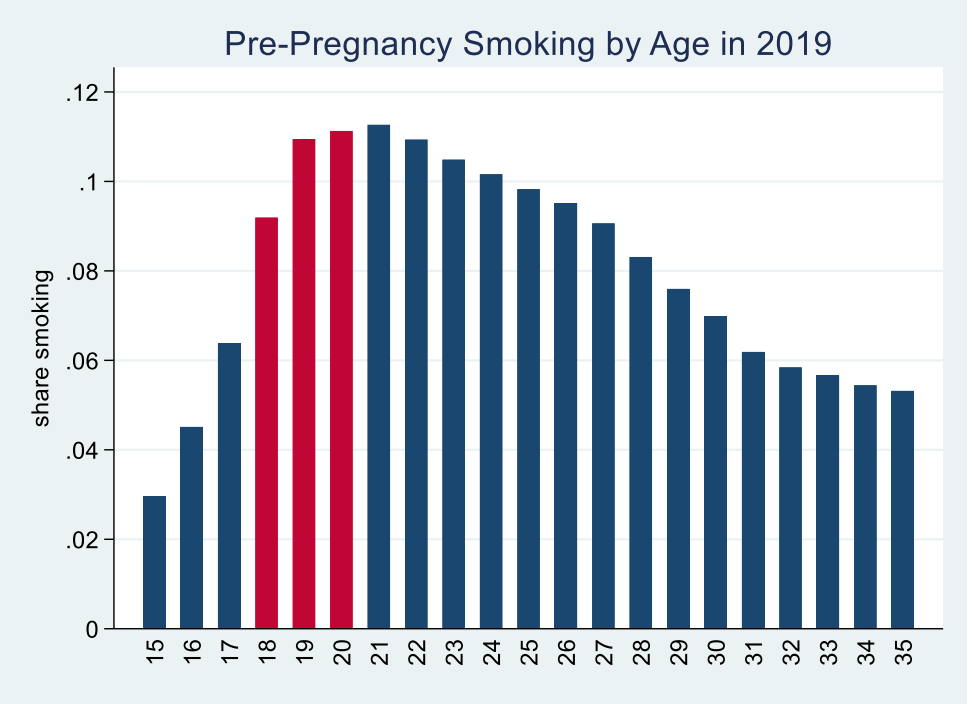
Overview

- How did county and state level T-21 policies impact maternal smoking for pregnant women 18-20?
- Use Vital Statistics data from 2012-2019
  - Logit difference-in-difference model that accounts for staggered adoption
  - In NYC and CA, also use an age-based difference-in-difference model for both locations separately.
- We find significant reductions in smoking pre-pregnancy and during pregnancy, driven mostly by CA and to some degree NYC.
  - Magnitude is smaller than other T-21 studies
  - Not large enough to go on to examine impact on infant health.

Motivation

Well established negative impact of prenatal smoking on infant health

- Increased risks of stillbirth, premature birth, low birth weight, weaker lungs, SIDS
- Smoking is the most modifiable cause of poor infant health
- Maternal smoking is most common around 21 year of age



Can raising the tobacco purchasing age to 21 reduce smoking during pregnancy and potential improve infant health?

Tobacco-21 background

- Needham, MA was the first locality to implement tobacco-21 policy in 2005.
- In 2014, NYC raised tobacco sales age to 21
- Hawaii and California were the first states to implement tobacco-21 policy statewide in 2016
- By the end of 2018, hundreds of localities in 19 states
- On December 20, 2019 federal government implemented tobacco-21 policy nationwide

Literature: T21 Significantly Reduced Reported Tobacco Use Among Teens

- **Schneider et al. (2016)** find a decline in smoking in Needham, MA relative to other communities after implementation of T-21 policy.
- **Friedman and Wu (2019)** using data from 2011-2016 BRFSS find that tobacco-21 policy reduces smoking by 18.7% among 18-20 year-olds
- **Friedman, Bucknell and Sinclair (2019)** using on-line survey data find a reduction in smoking of 39% in 18-20 year-olds relative to 21-22 year-olds.
- **Hansen et al. (2023)** reduced smoking between 19.7% and 31.5%
- **Abouk, De, Pesko (2024) and Cottie, DeCicca, and Nesson (2024)** found reductions using Monitoring the Future Survey

Literature: T21 Significantly Reduced Tobacco Sales

- **Ali et al. (2019) and Glover-Kudon et al. (2021)** find reduction in cigarette sales in Hawaii and California relative to other regional states.

- **Liber et al. (2022)** finds sales fell for brands favored by younger

- **Abouk, De, Pesko (2024)** Nielson Scanner show reduced cig sales by 12.4% in the counties with the highest quartile of under 21 people

Literature: T21 Limitations

- **Weak enforcement?**
  - **Silver et al. (2016)** Compliance in NYC fell around the same time as T21
  - **Schiff et al. (2021)** underage individuals did purchase tobacco
  - **Roberts et al (2021)** Compliance with age restrictions was 65.8% in Columbus, Ohio
  - **Agaku et al (2022)** Most youth who attempted buying cigarettes in 2020 were successful

- **Impacting self reporting more than smoking?**
  - **Cottie, DeCicca, and Nesson (2024)** Find reductions in self reported smoking, but no evidence of reductions in biomarkers from urine samples

Our paper

- Focus on T-21 policies at the county level and higher
- Sample of women 18-20 compare treated to untreated counties
- Women 24-26 as placebo group or control group

Location	**Expansion Date**	**Births to 18-20yos in our sample**
New York City, NY	May 2014	42,641
Suffolk, NY	January 2015	5,129
California (statewide)	June 2016	234,030
Albany, NY	June 2016	1,252
Schenectady, NY	September 2016	1,035
Cortland/Chautauqua, NY	October 2016	1,531
Cattaraugus, NY	November 2016	646
St. Louis, MO	December 2016	3,126
Orange, NY	January 2017	2,581
Washington, DC	February 2017	4,364
Lane, OR	April 2017	1,828
Tompkins, NY	July 2017	305
Sullivan, NY	September 2017	483
Onondaga, NY	January 2018	2,844
Oregon (statewide)	January 2018	20,960

Vital Statistics Data

- Restricted US Vital Statistics data from 2012-2019
- Data include basic demographic characteristics and detailed info on maternal and infant health at birth
- Data include number of cigarettes smoked in each trimester of pregnancy and pre-pregnancy
  - We only use indicators for any smoking in this analysis
- Some states were slow to adopt the 2003 revision of the birth certificate with the updated smoking questions
  - Drop 11 states with missing smoking data
- Infant health measures include birth weight

Vital Statistics Data

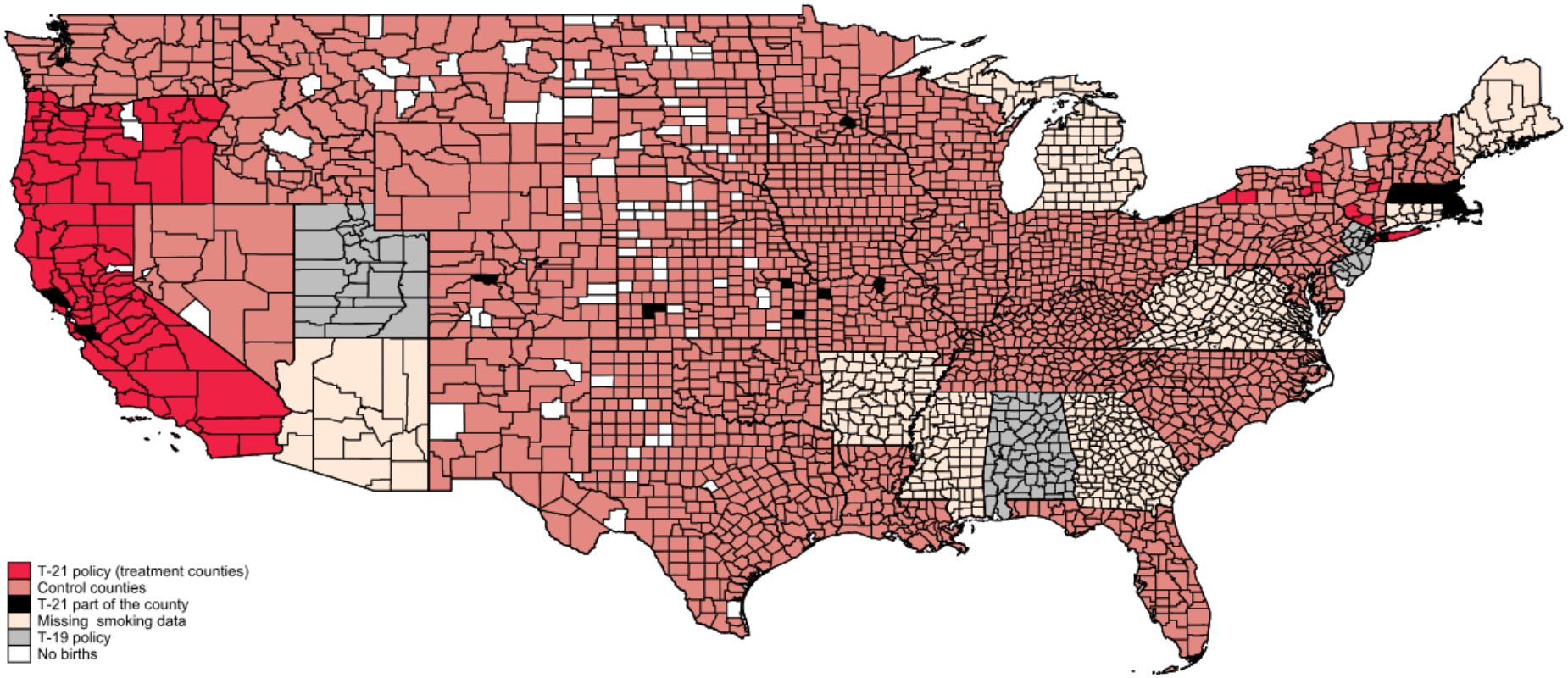
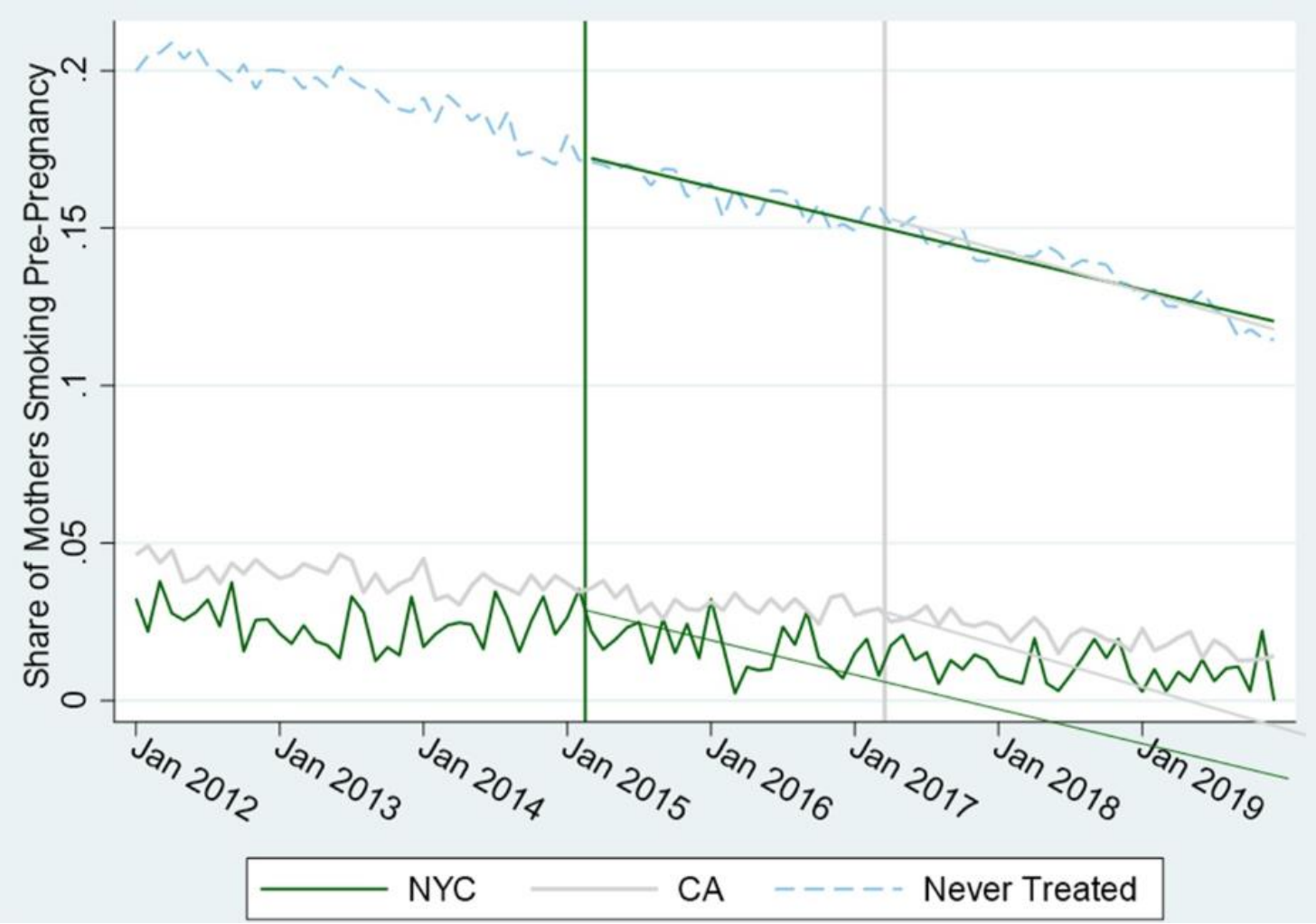


Figure 1: Treatment, control, and excluded locations. Not pictured on the map are Alaska and Hawaii. Alaska was not included due to T-19 policy and Hawaii was not included due to missing smoking data.

Pre-Pregnancy Smoking Over Time



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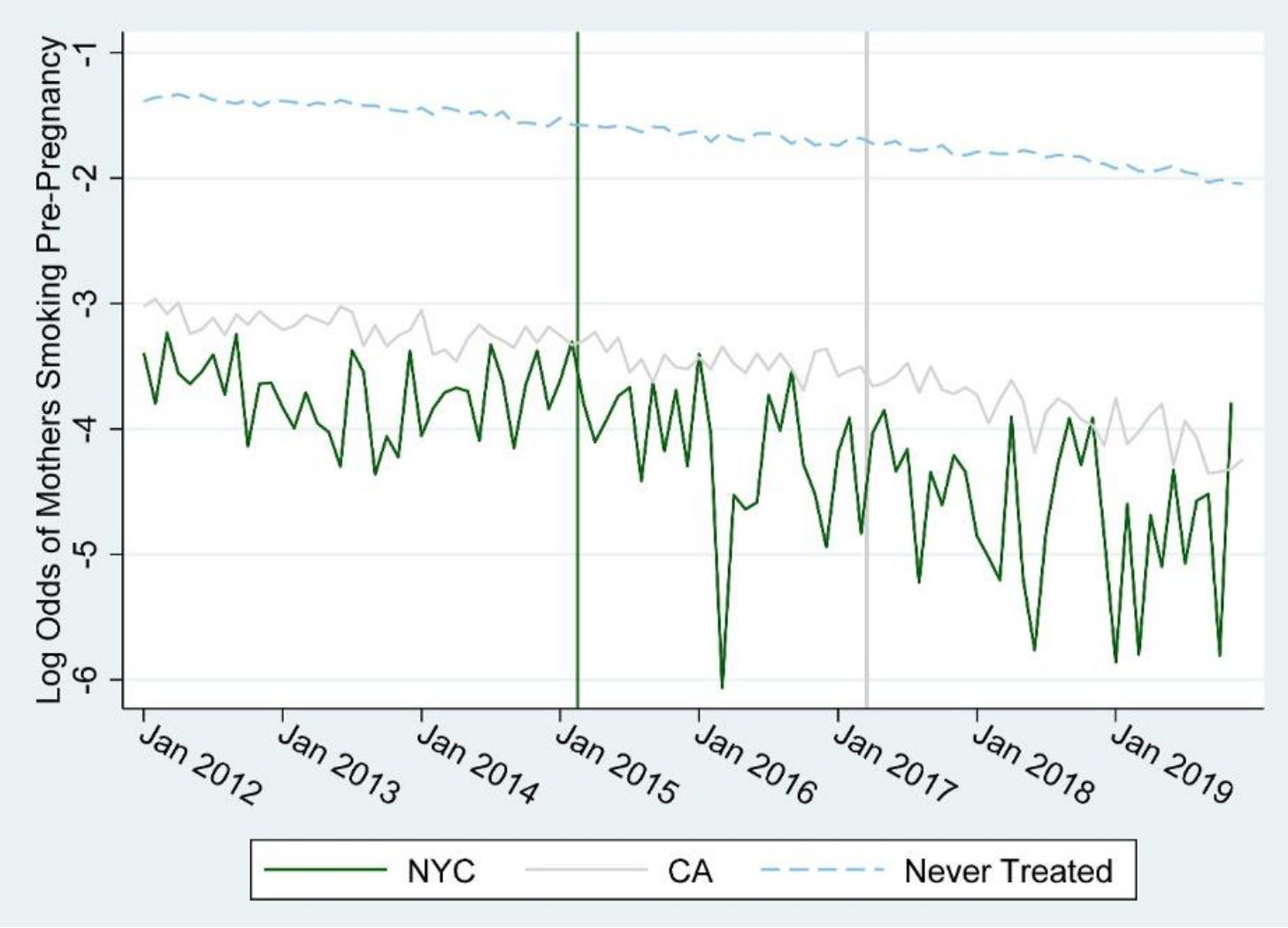
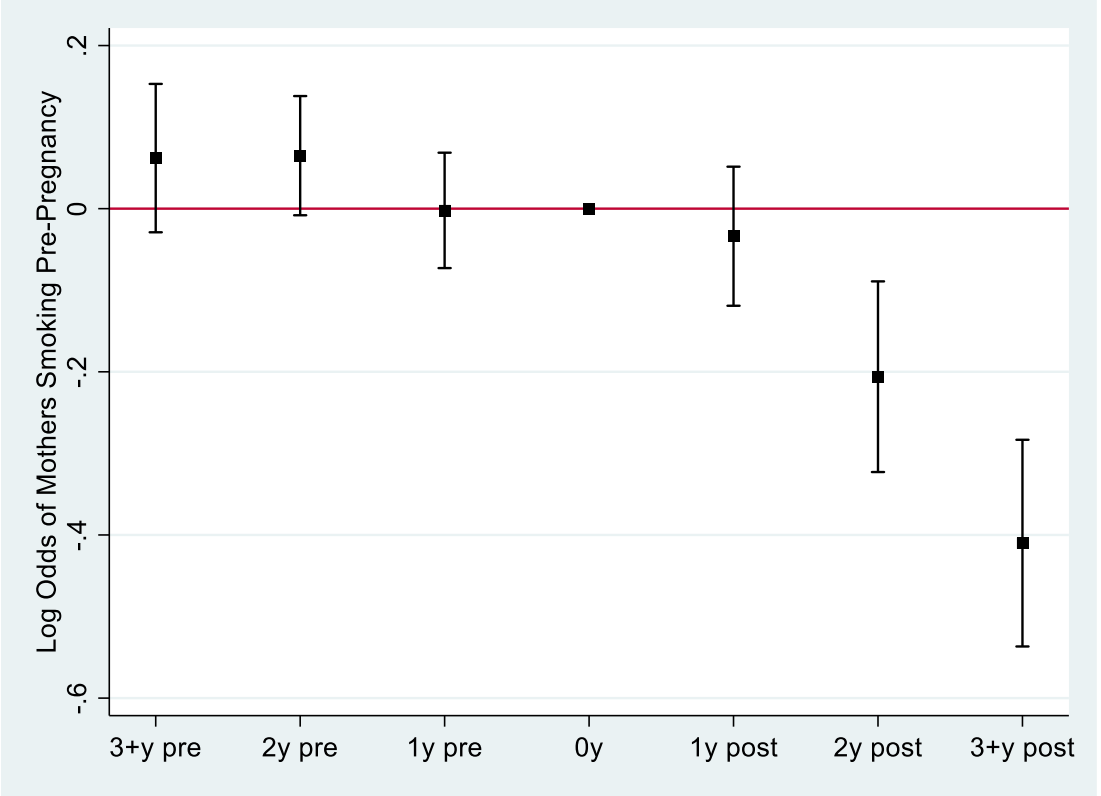


Pre-Pregnancy Event Study



$$\log\left[\frac{\mathrm{pr}(Y_{igt}=1|X_{i\beta})}{1-\mathrm{pr}(Y_{igt}=1|X_{i\beta})}\right]$$

$$= \sum_{k=-3}^{3} \delta_k I(t - T_g = K) * I(Ever\ Treated) + \sum_{k=-3}^{3} \eta_k I(t - T_j = K)$$

$$+ \sum_{g=1}^{G} \lambda_g D_{ig} + \boldsymbol{X_i \eta_i} + \varepsilon_{igt}$$

Methods

- Logit difference-in-difference model with staggered adoption

1. Logit DD effects→ Puhani (2012)
   - How do you interpret?

2. Staggered adoption → Wooldridge (2021)
   - Don’t want to measure newly treated groups relative to already treated ones.

Methods

- Puhani (2012)
  - Imagine a 2 group DD with treatment group G and post period T
  - Linear DD:
    - interaction coefficient
    - $\frac{\Delta^2 E(Y^0|T,G)}{\Delta T \Delta G}$
    - $E[Y^1|\text{T=1, G=1}]$ - $E[Y^0|\text{T=1, G=1}]$ are all the same
  - Logit DD: All three are different.
  - Puhani suggests that for non-linear DD, the differential potential outcomes framework is the correct approach:
    - $E[Y^1|\text{T=1, G=1}]$ - $E[Y^0|\text{T=1, G=1}]$
  - Computationally, this can be done by making the interaction of interest $w_{GT} d_G f_T$ and then looking at the marginal effect of w_{GT} in the subgroup where G==1 and T==1

Methods

Wooldridge (2021) Extended TWFE

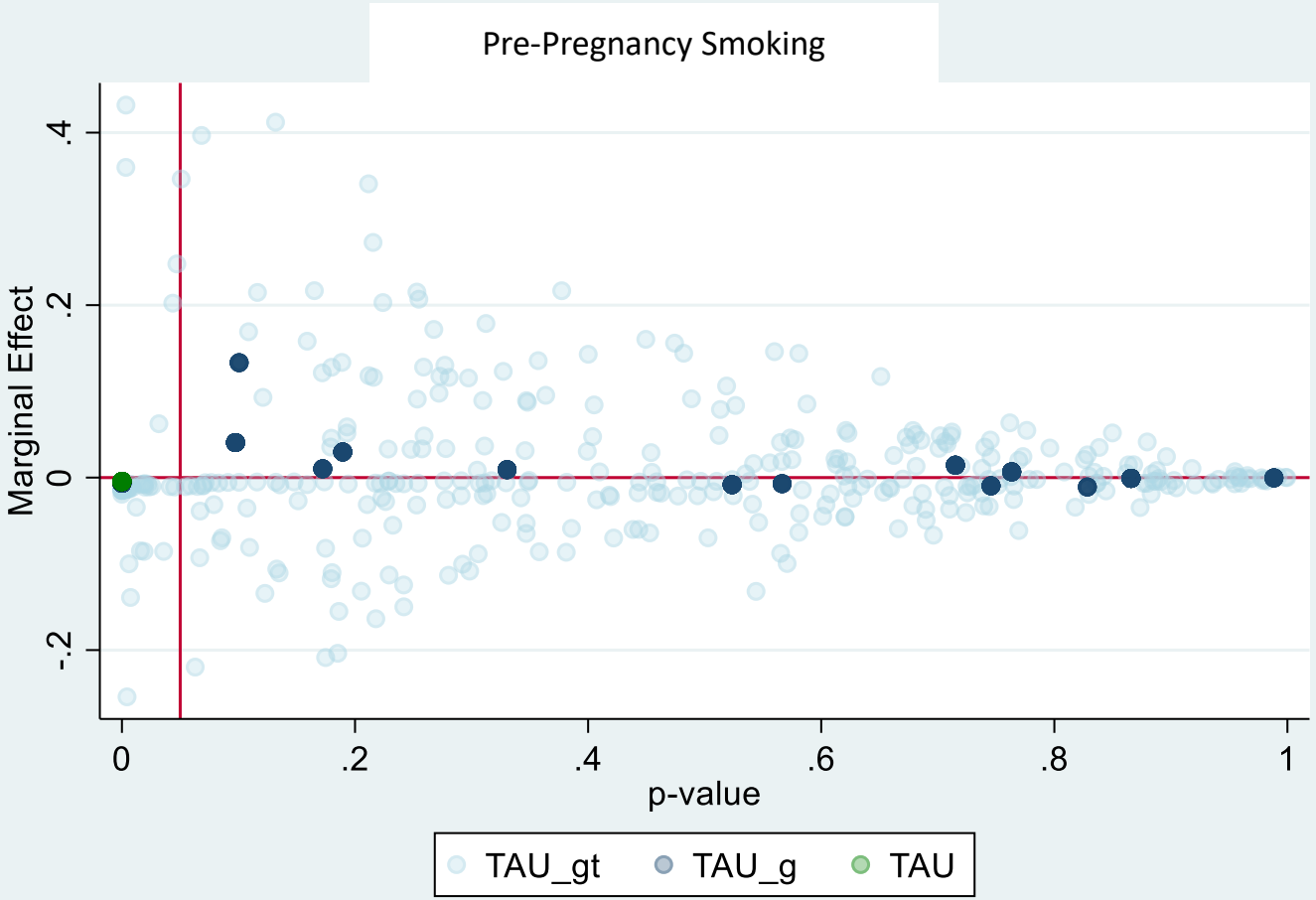
Multiple groups g treated at different times, first group treated in period q.

$$\log\left[\frac{\mathrm{pr}(Y_{igt}=1|X_{i\beta})}{1-\mathrm{pr}(Y_{igt}=1|X_{i\beta})}\right] = \sum_{g=1}^{G}\sum_{t=q_g}^{T}\tau_{gt}(W_{it}\cdot D_{ig}\cdot f_{it}) + \sum_{g=1}^{G}\lambda_g D_{ig} + \sum_{t=q_1}^{T}\theta_t f_{it} + \boldsymbol{X_i}\boldsymbol{\eta_i} + \varepsilon_{igt}$$

- Treatment effects are measured using observations in the *never-treated* and the *not-yet-treated* groups as controls
- After the regression, aggregations among treatment groups or post periods can be done using margins.
  - We need to use margins anyway because of the logit model, so this fits in nicely with Puhani's margins approach.
  - We will focus on treatment effects τ_g's and overall τ

Results

In light blue are all the disaggregated treatment effects for illustrative purposes, but we will focus on aggregated measures.



TAU overall = -0.0045 TAU_g for NYC= -0.0065 and TAU_g for CA = -0.0053

Results

Simplified code for example:

```
*Create global of treated groups-with -their-post interactions
foreach g of numlist $treatgroup_numlist{
    sum runningmonth if w==1 & group==`g'
    local firstpost=r(min)

    foreach t of numlist `firstpost'(1)96 {
            global treatcontrols $treatcontrols  i.w#c.g_`g'#c.rm_`t'
    }
}
******


*ETWFE-Logit
logit `out' $treatcontrols i.runningmonth#1.post i.group $controls  , vce(cluster countyfips)

    *overall
    margins, dydx(w) at () subpop(if treated==1 & w==1) noestimcheck  vce(uncond)

    *Group level
    margins, dydx(w) at () subpop(if group==`g' & w==1) noestimcheck  vce(uncond)

    *Post time
    margins, dydx(w) at () subpop(if treated==1 & t_post`t'==1) noestimcheck  vce(uncond)

    *By group and years post
    margins, dydx(w) at () subpop(if group==`g' & t_post`t'==1) noestimcheck  vce(uncond)
```

Results: ETWFE for 18–20-year-olds

Smoking Pre-Pregnancy			1st Trim. Persistence			Smoking During Pregnancy		
Obs.	Main	With tobacco controls	Obs.	Main	With tobacco controls	Obs.	Main	With tobacco controls
Overall								
1,781,644	-0.0045***	-0.0105***	260,786	-0.0023	0.0143	1,779,617	-0.0021**	-0.0053***
	(0.0013)	(0.0027)		(0.0178)	(0.02)		(0.001)	(0.0018)
	-7.75%	-18.08%		-0.33%	2.08%		-4.96%	-12.53%
New York City								
42,641	-0.0065***	-0.0045	781	0.0516	0.0179	40,774	-0.0016	0.0002
	(0.0024)	(0.0039)		(0.0407)	(0.0734)		(0.0014)	(0.0014)
	-26.41%	-18.29%		15.16%	5.26%		-16.22%	2.03%
California								
234,001	-0.0053***	-0.0026	7,619	0.0111	-0.0002	234,030	-0.0036**	-0.0019
	(0.0016)	(0.0018)		(0.0254)	(0.0223)		(0.0015)	(0.0012)
	-14.44%	-7.08%		1.73%	-0.03%		-14.45%	-7.63%

Notes: The marginal effect of T-21 from the ETWFE model for 18 to 20-year-old mothers are shown for all T-21 locations in Panel 1 and for NYC and CA specifically in Panel 2. The number of observations in the overall model is the full number of observations in the regression (treated and untreated), whereas the observations for NYC and CA are the number of observations from the regression in those locations. For each outcome, results are provided for two models: with and without controls for state cigarette tax, average cost per pack, and whether indoor clean air laws cover e-cigarettes. A version of these results with group-specific pre-trends can be found in Appendix Table 3. Standard errors are in parentheses and account for clustering at the county level. The percent changes from pre-period means are also reported in the bottom row of each cell. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Results: Impacts of T-21 Over Time in the Post Period

Smoking Pre-Pregnancy			1st Trim. Persistence			Smoking During Pregnancy		
1y post	2y post	3+y post	1y post	2y post	3+y post	1y post	2y post	3+y post
Overall								
-0.0015	-0.005***	-0.0077***	-0.0237	0.007	0.0477	-0.0011	-0.002	-0.0034***
(0.0013)	(-0.005)	(0.0014)	(0.0191)	(0.007)	(0.0321)	(0.0011)	(-0.002)	(0.0012)
-2.58%	-8.61%	-13.26%	-3.44%	1.02%	6.93%	-2.60%	-4.73%	-8.04%
NYC								
-0.0017	-0.0076**	-0.0083***	0.0312	0.0092	0.0998	-0.0012	-0.0022	-0.0016
(0.0027)	(0.0035)	(0.002)	(0.049)	(0.0411)	(0.0644)	(0.0011)	(0.0024)	(0.0014)
-6.91%	-30.88%	-33.73%	9.16%	2.70%	29.31%	-12.17%	-22.31%	-16.22%
California								
-0.003*	-0.0061***	-0.0076***	-0.0263	0.0428	0.047	-0.0028**	-0.0035**	-0.0051***
(0.0015)	(0.0018)	(0.0022)	(0.0318)	(0.0324)	(0.0389)	(0.0014)	(0.0017)	(0.0018)
-7.54%	-15.34%	-19.11%	-4.11%	6.69%	7.34%	-10.24%	-12.81%	-18.66%

Notes: The marginal effect of T-21 from the ETWFE model for 18- to 20-year-old mothers are shown for all T-21 locations in Panel 1 and for NYC and CA specifically below. These results are from our model without tobacco controls, but results for the model with tobacco controls can be found in Appendix Table 4 and results for models with group specific trends and tobacco controls can be found in Appendix Table 5. The underlying regression for these results is the same as those for the model without tobacco controls in Table 3, so the number of observations is not repeated. Standard errors are in parentheses and account for clustering at the county level. The percent changes from pre-period means are also reported in the bottom row of each cell. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Results: Placebo

	Women 24-26							Women 18-21		
	Smoking Pre-Pregnancy			1st Trim. Persistence		Smoking During Pregnancy			Prenatal Care	
	Obs.	Main	With tobacco controls	Obs.	Main	With tobacco controls	Obs.	Main	With tobacco controls	Obs.	Main	With tobacco controls
Overall												
	3,637,424	-0.0021**	-0.006***	468,838	-0.003	0.0006	3,637,817	-0.0014**	-0.0039***	1,740,765	-0.0025	-0.0097
		(0.0008)	(0.002)		(0.0123)	(0.0144)		(0.0007)	(0.0015)		(0.0044)	(0.0094)
		-3.95%	-11.30%		-0.42%	0.08%		-3.63%	-10.11%		-0.36%	-1.40%
New York City												
	120,643	-0.0028*	-0.0015	2,275	-0.0119	0.0708	120,643	-0.0017	0.0009	41,784	0.0061	0.029
		(0.0015)	(0.0031)		(0.0456)	(0.0501)		(0.0015)	(0.0014)		(0.0066)	(0.0462)
		-12.36%	-6.62%		-3.05%	18.15%		-17.33%	9.18%		1.03%	4.92%
California												
	502,657	-0.0022**	0.0004	16,466	0.01	-0.0054	502,679	-0.0014*	-0.0002	231,085	-0.0068	-0.0018
		(0.001)	(0.0012)		(0.0169)	(0.0165)		(0.0008)	(0.0008)		(0.0044)	(0.0052)
		-6.04%	1.10%		1.49%	-0.81%		-5.49%	-0.78%		-0.94%	-0.25%

Notes: The four sample and outcome combinations in this table are placebo tests. The marginal effects of T-21 from the ETWFE model are shown for all T-21 locations in Panel 1 and for NYC and CA specifically in Panel 2. For each outcome, results are provided for two models: with and without tobacco controls. Results for the models with group specific trends can be found in Appendix Table 6. Standard errors are in parentheses and account for clustering at the county level. The percent changes from pre-period means are also reported in the bottom row of each cell. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Results: Age-Based Logit Difference-in-differences models

Smoking Pre-Pregnancy			1st Trim. Persistence			Smoking During Pregnancy			Prenatal Care		
Obs.	Main	With tobacco controls	Obs.	Main	With tobacco controls	Obs.	Main	With tobacco controls	Obs.	Main	With tobacco controls
New York City											
163,646	-0.0034	-0.0034	3,093	0.0326	0.0343	163,646	<0.0001	<0.0001	160,184	-0.0041	-0.005
	(0.0029)	(0.0029)		(0.056)	(0.0543)		(0.002)	(0.002)		(0.0062)	(0.0065)
	-15.01%	-15.01%		9.58%	10.07%		0.00%	0.00%		-0.57%	-0.70%
California											
736,658	-0.005***	-0.0047***	24,085	-0.0166	-0.0167	736,709	-0.0037***	-0.0036***	728,621	0.0072	0.0061
	(0.0012)	(0.0012)		(0.0211)	(0.021)		(0.0011)	(0.001)		(0.0045)	(0.0046)
	-12.85%	-12.08%		-2.59%	-2.61%		-13.59%	-13.22%		0.88%	0.75%

Notes: The marginal effect of T-21 from the ETWFE model are shown, though here each model has two policy groups and a single implementation date which simplifies the model considerably. Mothers 18-20 are the treated age group and mothers 24-26 serve as a control group in the age-based model. For each outcome, results are provided for two models: with and without tobacco controls. Standard errors are in parentheses and account for clustering at the county level. The percent changes from pre-period means are also reported in the bottom row of each cell. *** p<0.01, ** p<0.05, * p<0.1.

Conclusion

- T21 reduced maternal smoking
  - Clearest case is in CA which drives the overall results (across all T21 areas)
    - Around -14.5% in smoking pre & during using ETWFE
    - -12.9% pre and -13.6% during using age-based DD.
  - Results are driven by less pre-pregnancy smoking rather than increased quitting
  - Magnitude of results is smaller than previous T21 papers found in the general teen population

Conclusion

- Smoking reductions were not strong enough to estimate a 2-stage regression to look at the impact on birth outcomes
  - Reduced form regression with LBW as outcome is insignificant
- Back-of-the-envelope calculations suggest similar impact to what Institute of Medicine 2015 report
  - IOM: T21 nationwide in 2015 would cause 5,200 fewer LBW infants a year for moms 15-49 in years 2040-2059
  - Our paper: Estimates similar impact for nationwide T21 in 2020
    - 12.2% of never-treated areas smoked in 2019, log odds reduction of 3+ years of smoking is 0.41, which corresponds to 5,677 fewer smoking moms in those areas.
    - Almond, Chay, Lee (2005) estimate smoking during pregnancy increases probability of LBW by 3.47%, so 5,677 fewer moms smoking corresponds to 197 fewer LBW infants
    - Our 18-20yos in non-treated areas are 4.1% of all 2019 births, so scaling up 197 fewer LBW would be 4,975 fewer LBW infants.