Intended and Unintended Effects of E-cigarette Taxes on Youth Tobacco Use

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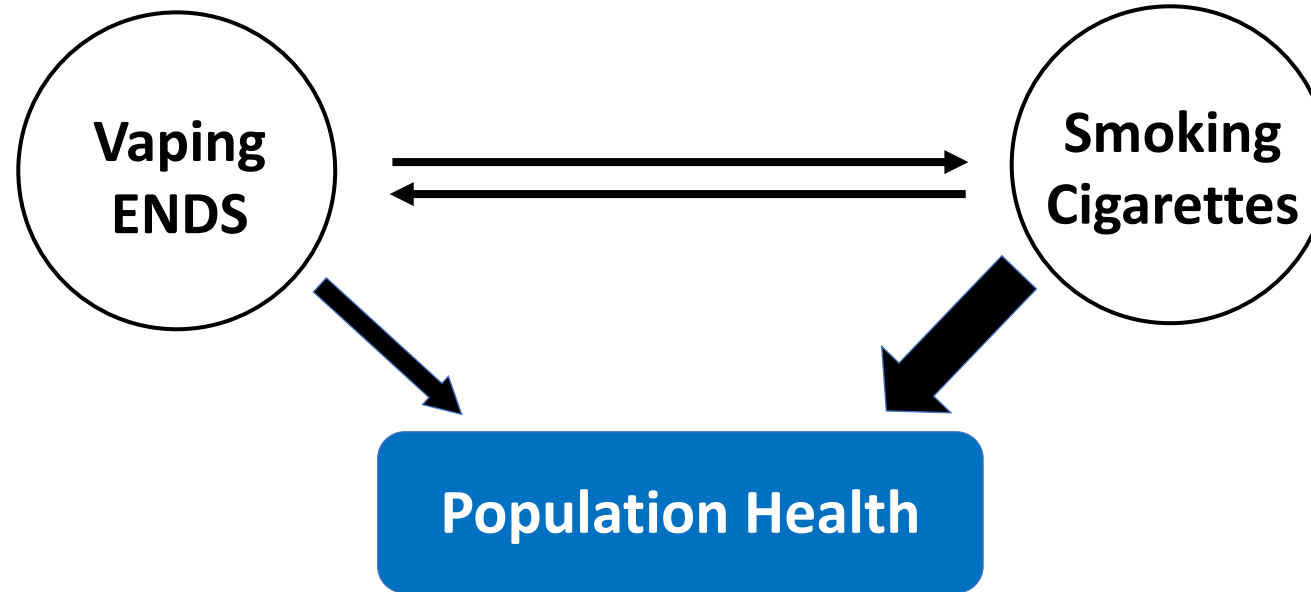
Disclosure: No Conflicts of Interest

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Acknowledgments and Disclaimers

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Agenda

- Context and Background
  - ENDS Policies & Public Health
  - Overview of Prior Research
- Research Questions
- Data & Methods
- Results
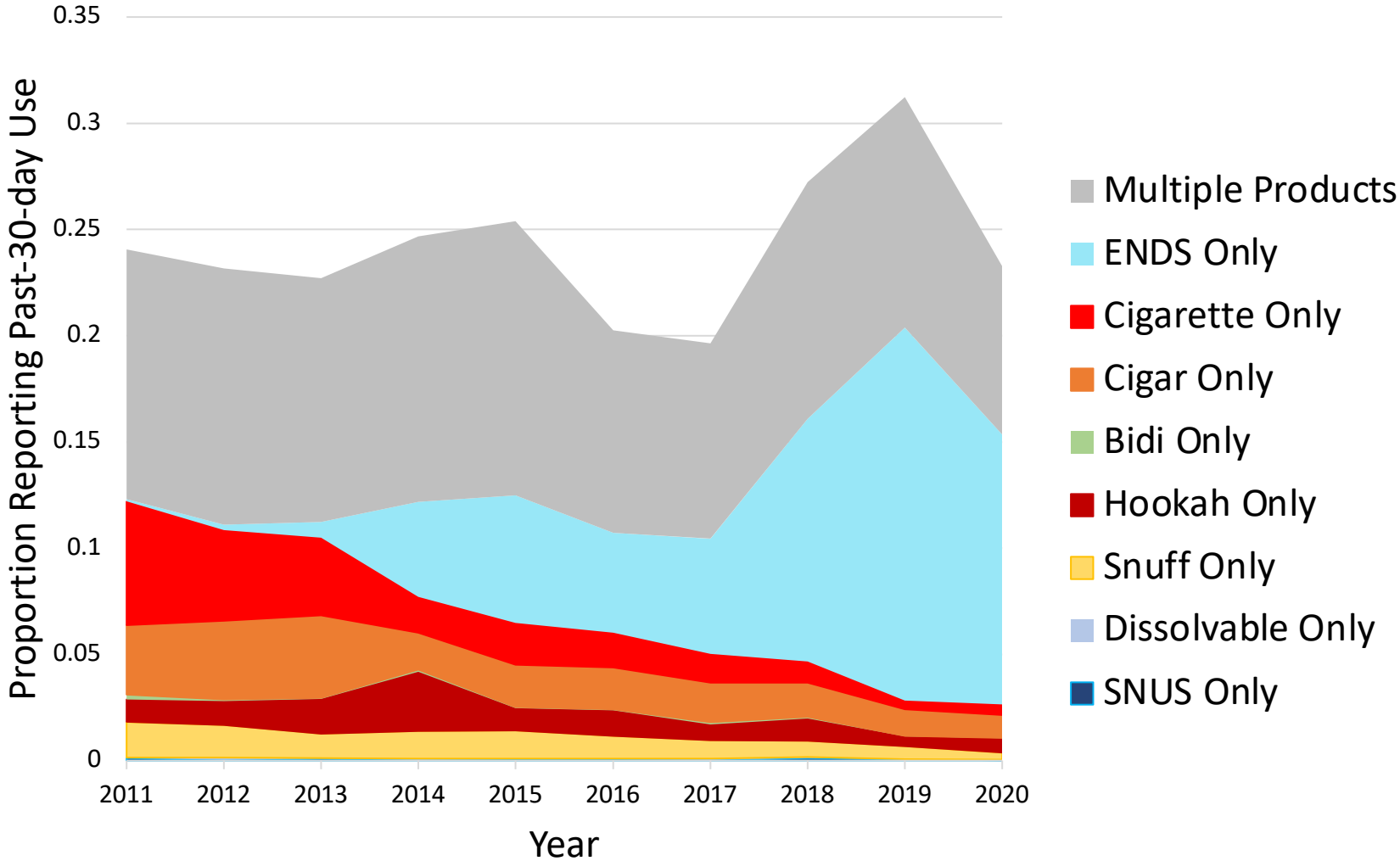- Limitations
- Implications for Policy & Research

*ENDS – "Electronic Nicotine Delivery Systems"

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Context: Electronic Nicotine Delivery Systems & Health

- Allcott and Rafkin 2021: average expert believed vaping ENDS' effect on quality-adjusted life expectancy was 37% that of smoking (2020 survey of 137 tobacco scholars)
- Wilson et al (2020) review biomarker studies in exclusive vapers vs. exclusive smokers ➔ suggests vaping is 33% as harmful as smoking.
- Smokers who switch to ENDS show 40% lower odds of respiratory outcomes (syst. review, Goniewicz et al 2020), improved vascular function a month after switching (RCT, George et al 2019), & significant decreases in carcinogen and toxicant exposure (longitudinal observational study, Goniewicz et al 2017)
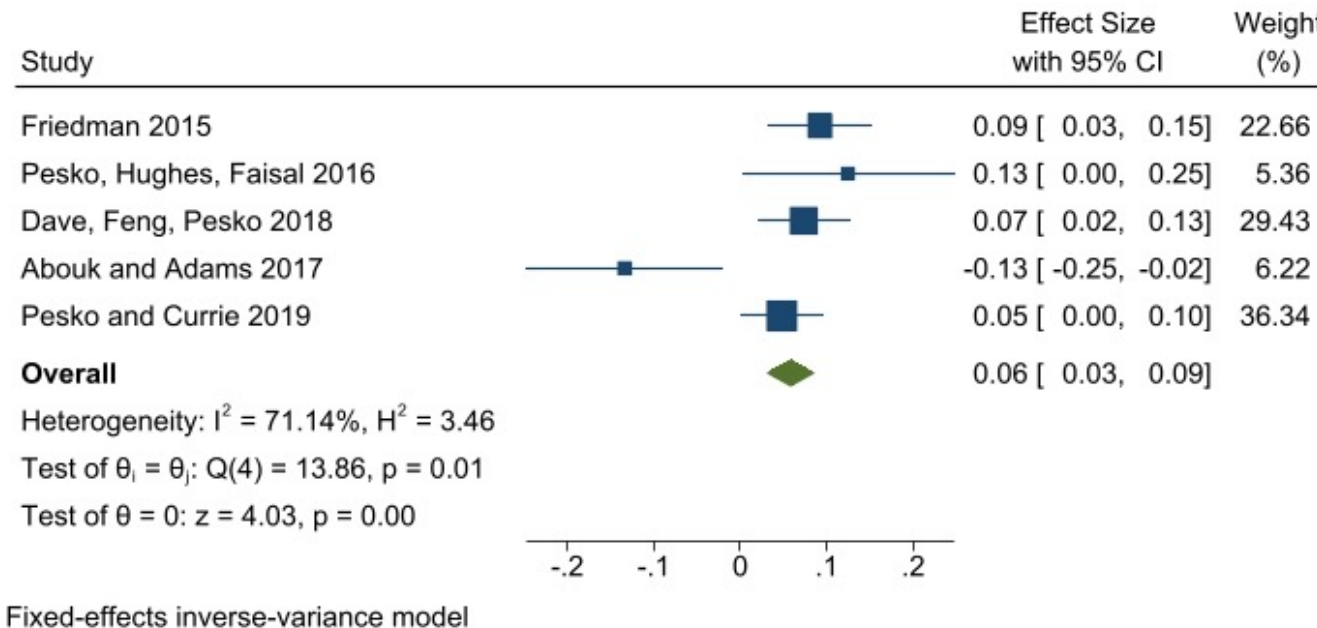
Recent Tobacco Use: US High School Students

Source: Author's calculations, unpublished. Data: National Youth Tobacco Survey.

Smoking and Vaping: Complements or Substitutes?

- Minimum legal sales ages for ENDS ➜ Increased youth smoking
  - Friedman 2015; Pesko, Hughes, & Faisal, 2016; Dave, Feng, & Pesko, 2019; Pesko & Currie, 2019
  - Counter: Abouk & Adams (2017) find evidence of complementarity in 12th graders

Study		Effect Size with 95% CI	Weight (%)
Friedman 2015		0.09 [0.03, 0.15]	22.66
Pesko, Hughes, Faisal 2016		0.13 [0.00, 0.25]	5.36
Dave, Feng, Pesko 2018		0.07 [0.02, 0.13]	29.43
Abouk and Adams 2017		-0.13 [-0.25, -0.02]	6.22
Pesko and Currie 2019		0.05 [0.00, 0.10]	36.34
Overall		0.06 [0.03, 0.09]	

Heterogeneity: I^2 = 71.14%, H^2 = 3.46

Test of $\theta_i = \theta_j$: Q(4) = 13.86, p = 0.01

Test of $\theta = 0$: z = 4.03, p = 0.00

Fixed-effects inverse-variance model

Smoking and Vaping: Complements or Substitutes?

- Indoor ENDS vaping restrictions ➔ increased prenatal smoking (Cooper and Pesko, 2017)
  - Suggestive evidence linking vape-free worksite restrictions to increased smoking among 18-25 year-olds (Friedman, Oliver, Busch, 2021)

- ENDS advertising ➔ increased adult smoking cessation (Dave et al., 2019)

Complements or Substitutes? Evidence on Taxes & Adults

Synthetic Control
- Saffer et al. (2020) use TUS-CPS data to estimate effects of Minnesota's ENDS tax on adults ➔ Increased smoking & reduced smoking cessation

Nielsen Retail Scanner Data
- Cotti et al. (2021) use NRS 2011-2017 ➔ Negative own-price elasticities for ENDS (-1.3) & cigarettes (-0.4). Positive cross-price elasticities
  - ENDS cross-price elasticity on cigarette sales=0.5; Cigarette cross-price elasticity on ENDS sales =1.1
- Allcott and Rafkin (2021) use NRS 2013-2017 ➔ Evidence for substitution depends on whether time trends are controlled for

Individual-level Survey Data (Difference-in-Differences)
- Pesko et al. (2020): estimate ENDS taxes' effects on adult vaping and smoking (BRFSS & NHIS). ➔ Higher ENDS taxes reduce daily vaping and increase daily smoking, especially among <40 year-old adults. Symmetric effects for cigarette taxes.
- Abouk et al. (2019): estimate ENDS taxes' effects on prenatal smoking and vaping ➔Increases pre-pregnancy and prenatal smoking by ≈0.4 pp (7.5% of the mean).
  - ➤ About 1 in 3 pregnant women that stop using ENDS due to an ENDS tax smokes cigarettes instead (through less smoking cessation).

Complements or Substitutes? Evidence on Taxes & Youth

Binary ENDS tax indicators

- Anderson, Matsuzawa, & Sabia (2020): estimate effects of ENDS tax adoption in 3 states (2015 and 2017 YRBSS) ➔ ENDS tax adoption reduces current ENDS use by 3.4 pp and daily ENDS use by 0.8 pp, with imprecisely estimated effects on cigarette use.

Identifying Variation Based on Prices or a single state's ENDS Tax

- Pesko and Warman (2021) match 2011-2015 NYTS data to prices derived from the Nielsen Retail Scanner Data, with a sensitivity check assessing responses to Minnesota's ENDS tax ➔ A 100% ENDS ad valorem tax increases cigarettes smoked among youth smokers by approximately 3 packs monthly.

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Research Questions

How do ENDS taxes affect youths':

1. Cigarette smoking (any use and intensity),
2. ENDS vaping (any use and intensity),
3. Perceived likelihood of regular ENDS use being highly risky, and
4. Primary source for ENDS?

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Survey Data

- Monitoring the Future (MTF)
  - Covers a nationally representative sample of 8th-, 10th-, and 12th-grade students in middle and high schools in the contiguous US, interviewing about 45,000 youth from nearly 400 public and private schools each year.
  - Longstanding smoking questions, ENDS added in 2014, along with perceived risk questions ("Perceived likelihood of regular ENDS use being highly risky")

- Youth Risk Behavior Surveillance System (YRBSS)
  - The National and State YRBSS survey high school students in public and private schools across the US about their health behaviors biennially.
  - Longstanding smoking questions, ENDS added in 2015, along with source questions (e.g., retail, online, etc.)
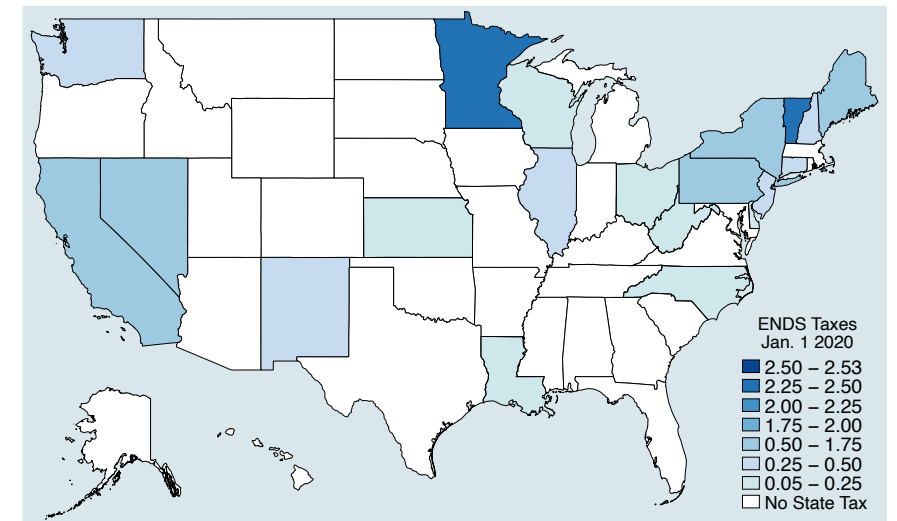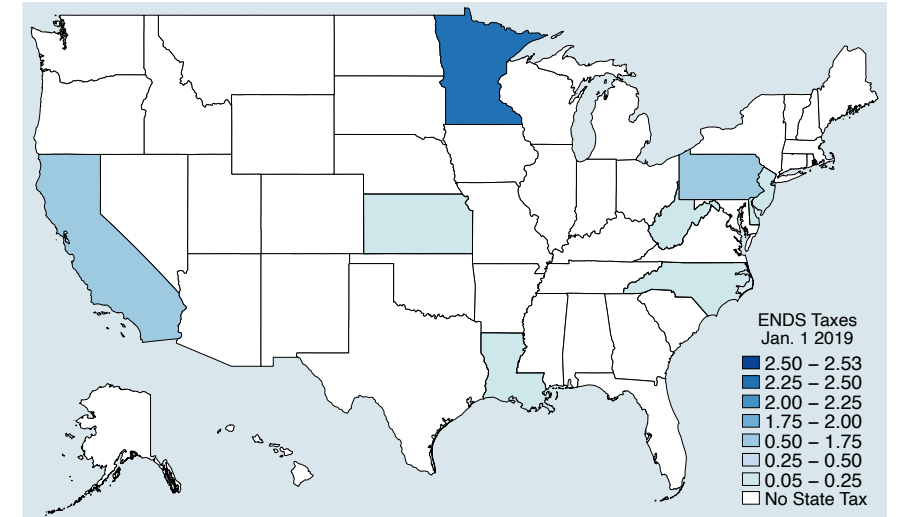
ENDS tax data

Problem: Localities vary in how they levy ENDS taxes: excise, ad valorem, sales, or two-tier. ➜ Solution: standardized ENDS taxes as in Cotti et al (2021)

Cotti C, Nesson E, Pesko MF, et al (2021). Standardising the measurement of e-cigarette taxes in the USA, 2010–2020. *Tob Control*. doi: 10.1136/tobaccocontrol-2021-056865

Basic Approach

- Match Nielsen Retail Scanner data with UPCs to identify fluid mLs.

- Use data for no-tax states and estimated mark-up based on purchasing documents to identify wholesale and retail prices per ml in states without e-cigarette taxes.

- Confirm minimal geographic variation in ENDS pricing.

    ➜ Back out tax/mL equivalent of observed ENDS taxes

ENDS taxes through mid-2019

Locality	Effective Date	Unit Taxed	Tax Amount	Tax per mL, Q1-2 2015 ($)	Tax per mL, Q1-2 2017 ($)	Tax per mL, Q1-2 2019 ($)
Table 1: ENDS Tax Changes Through 2nd Quarter of 2019						
District/State						
California	4/2017, 7/2017, 7/2018	Wholesale price	27.3%, 65.1%, 62.8%	$0	$0.72	$1.65
Delaware	1/2018	Per fluid milliliter	$0.05	$0	$0	$0.05
Kansas	1/2017, 7/2017	Per fluid milliliter	$0.20, $0.05	$0	$0.20	$0.05
Louisiana	7/2015	Per fluid milliliter	$0.05	$0	$0.05	$0.05
Minnesota	8/2010, 7/2013	Wholesale price	35.0%, 95.0%	$2.49	$2.49	$2.49
North Carolina	6/2015	Per fluid milliliter	$0.05	$0.02	$0.05	$0.05
New Jersey	10/2018	Per fluid milliliter	$0.10	$0	$0	$0.10
Pennsylvania	7/2016	Wholesale price	40.0%	$0	$1.05	$1.05
Washington, DC	10/2015, 10/2016, 10/2017, 10/2018	Wholesale price	67.0%, 65.0%, 60%, 96%	$0	$1.70	$2.52
West Virginia	7/2016	Per fluid milliliter	$0.08	$0	$0.08	$0.08
County/City						
Chicago, Illinois	1/2016, 1/2019	Per container / per fluid milliliter[1]	$0.80 / $0.55, $1.50 / $1.20			
Cook County, IL	5/2016	Per fluid milliliter	$0.20	$0	$0.94	$1.50
Montgomery County, MD	8/2015	Wholesale price	30.00%	$0	$0.79	$0.79

Note: Please see the online data appendix for further details. [1] The Chicago tax is added to the Cook County tax based on the share of the population residing in Chicago.

Estimation

$$Y_{ilt} = \alpha + \gamma_l + \delta_t + \beta_1 Ecig\ tax_{lt} + X_{it}\beta_2 + Z_{ct}\beta_3 + \varepsilon_{ilt}$$

- Two-way fixed effects
  - MTF: locality by year-quarter
  - YRBSS: state-by-year
- Z_{ct} controls for policies affecting tobacco and other substances (including marijuana) and economic climate
  - By county for MTF data & state for YRBSS (based on population-weighted county variables).
  - Some data only available at the state level.
- X_{it} adjusts for respondent sociodemographics: sex, age, race/ethnicity, & grade.
- Standard errors are clustered by state.

Table 3: Effects of ENDS Tax on ENDS Use

Outcome	Current ENDS User	Regular ENDS User	ENDS Initiation	Ever Use ENDS	Current ENDS User
ENDS Tax Rate (2019 $)	-0.019+	-0.013+	-0.008	-0.052***	-0.071**
	(0.010)	(0.007)	(0.014)	(0.010)	(0.025)
	[-0.040,0.002]	[-0.028,0.001]	[-0.036,0.021]	[-0.072,-0.031]	[-0.120, -0.022]
	<0.071>	<0.073>	<0.581>	<0.000>	<0.006>
Cigarette Tax Rate (2019 $)	-0.005	0.009+	-0.003	0.012	0.041
	(0.008)	(0.005)	(0.013)	(0.008)	(0.026)
	[-0.021,0.012]	[-0.001,0.019]	[-0.029,0.022]	[-0.004,0.028]	[-0.012, 0.094]
	<0.552>	<0.065>	<0.789>	<0.135>	<0.129>
Data	MTF	MTF	MTF	MTF	YRBSS
Years	2014-2019	2014-2019	2015-2019	2015-2019	2015-2019
N	126,306	126,306	66,124	85,541	538,992
Dependent Variable Mean	0.152	0.038	0.104	0.287	0.213
ENDS Elasticity	-0.075	-0.212	-0.059	-0.146	-0.164
Cigarette Elasticity	-0.095	0.712	-0.097	0.127	0.568

+ $p<0.10$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Notes: All MTF models include tax jurisdiction fixed-effects, year-by-quarter fixed-effects, and each of the individual controls and policy/economic covariates listed in Table 2. All YRBSS models include state fixed-effects, year fixed-effects, and each of the individual controls and policy/economic covariates listed in Table 2. Regressions are weighted, standard errors are corrected for clustering at the state level, 95% confidence intervals are shown in [ ] and p-values are shown in < >.
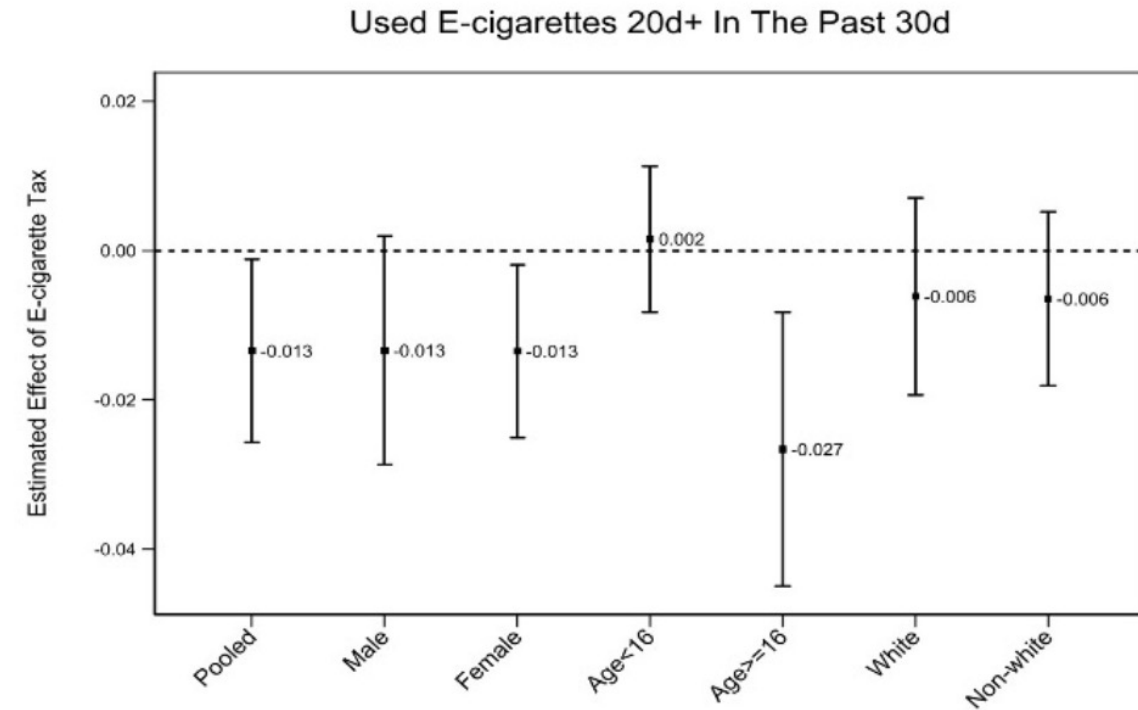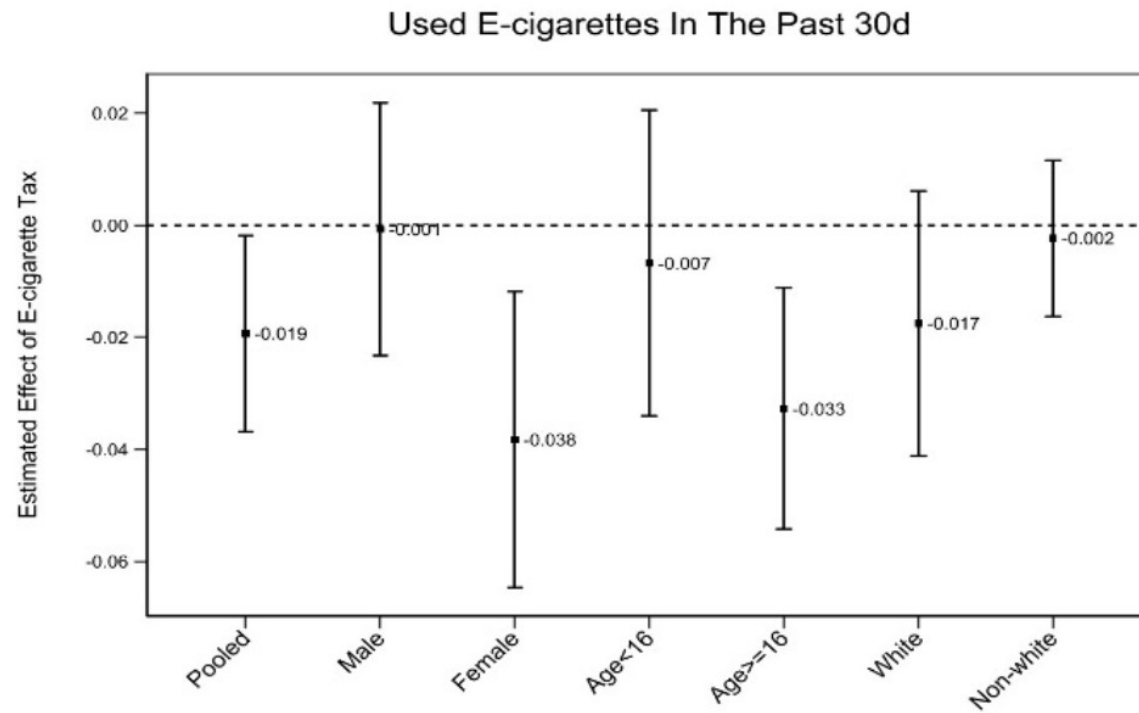
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Heterogeneity in Vaping-Response (MTF)

Table 4: Effects of ENDS Tax on ENDS Perceived Risk and Sources

Outcome	ENDS Perceived Risk	Retail Source	Social Source	Internet Source	Other Source
ENDS Tax Rate (2019 $)	0.029*	-0.076*	0.101*	0.019	-0.044*
	(0.014)	(0.034)	(0.046)	(0.015)	(0.021)
	[0.001, 0.057]	[-0.143, -0.008]	[0.008, 0.194]	[-0.012, 0.049]	[-0.086, -0.002]
	<0.041>	<0.029>	<0.034>	<0.220>	<0.040>
Cigarette Tax Rate (2019 $)	-0.003	0.086**	-0.105*	0.006	0.014
	(0.007)	(0.031)	(0.049)	(0.019)	(0.021)
	[-0.017, 0.011]	[0.023, 0.148]	[-0.204, -0.006]	[-0.032, 0.044]	[-0.029, 0.056]
	<0.671>	<0.009>	<0.038>	<0.747>	<0.522>
Data	MTF	YRBSS	YRBSS	YRBSS	YRBSS
Years	2014-2018	2017-2019	2017-2019	2017-2019	2017-2019
N	86,486	55,902	55,902	55,902	55,902
Dependent Variable Mean	0.192	0.185	0.627	0.042	0.145

$+ p<0.10$, $* p<0.05$, $** p<0.01$, $*** p<0.001$

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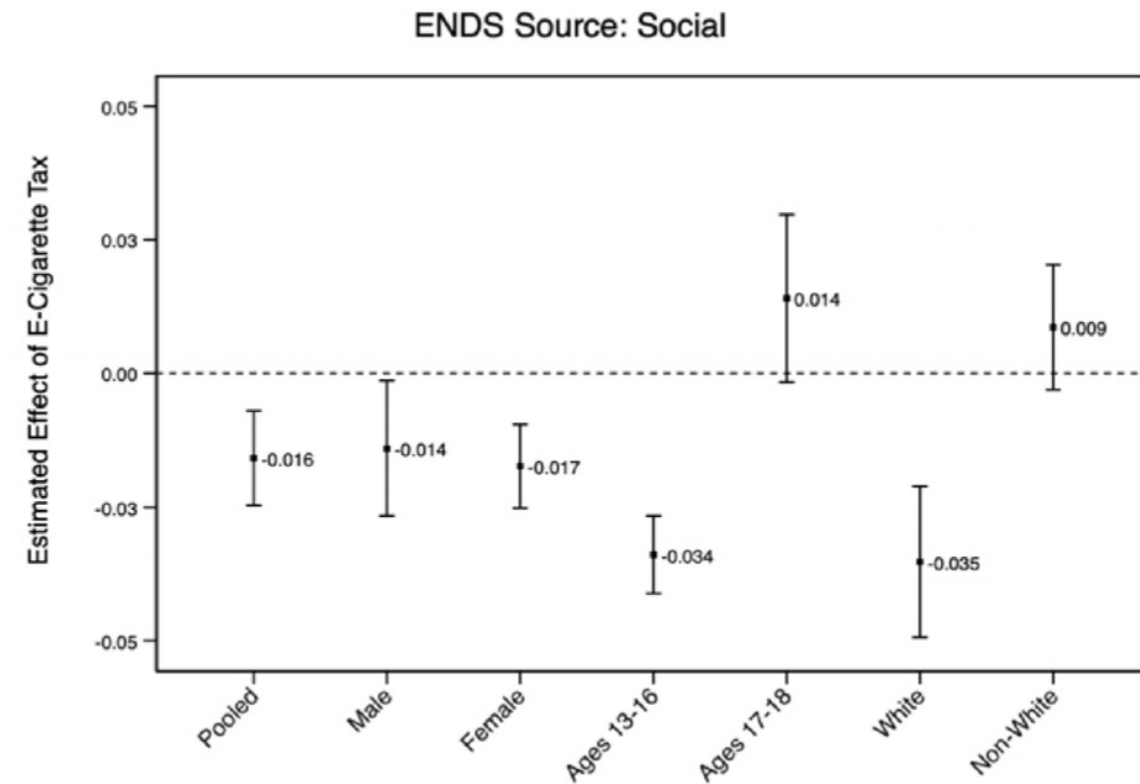
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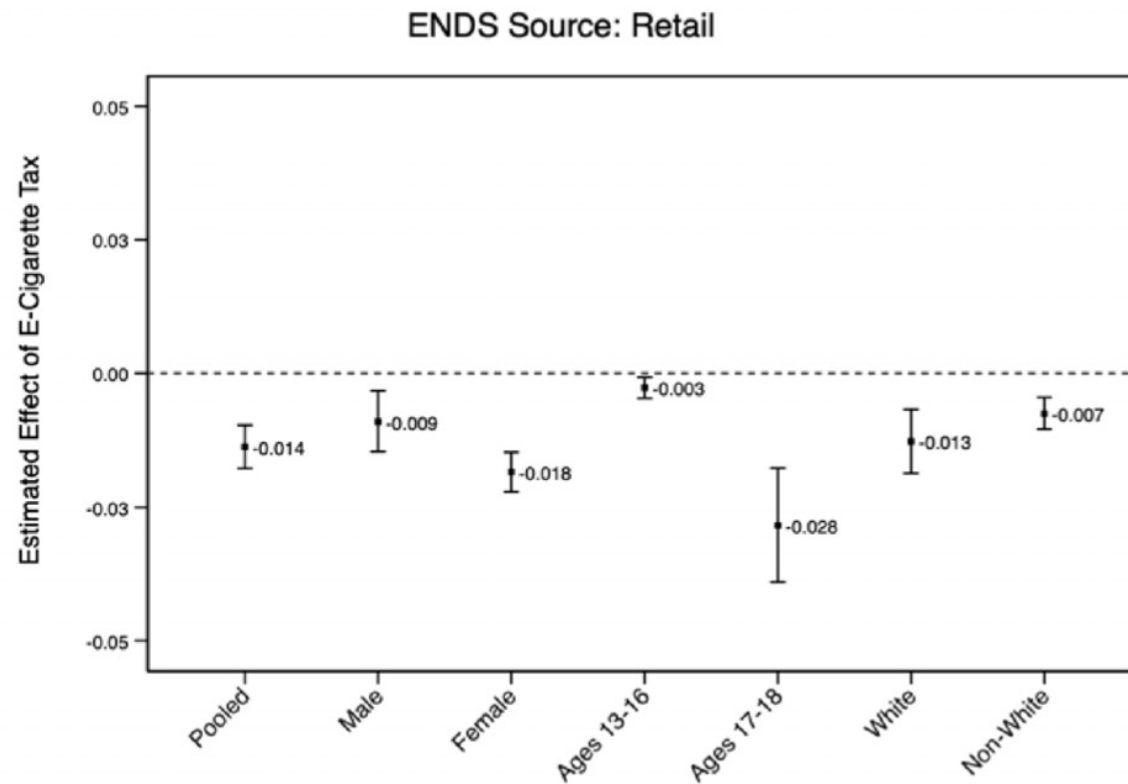
Heterogeneity in Sourcing-Response (YRBSS)

Table 5: Effects of ENDS Tax on Combustible Tobacco Product Use

Outcome	Current Cigarette Use	Current Cigarette Use (half pack a day)	Current Cigarette or Cigar Use	Current Cigarette Use	Regular Cigarette Use	Daily Cigarette Use	Current Cigarette or Cigar Use
ENDS Tax Rate (2019 $)	0.013*	0.006**	0.012+	0.008	0.016	0.014	0.007
	(0.006)	(0.002)	(0.006)	(0.013)	(0.014)	(0.012)	(0.016)
	[0.001,0.026]	[0.002,0.010]	[-0.001,0.024]	[-0.019, 0.035]	[-0.011, 0.043]	[-0.011, 0.039]	[-0.024, 0.038]
	<0.041>	<0.008>	<0.069>	<0.544>	<0.244>	<0.257>	<0.658>
Cigarette Tax Rate (2019 $)	-0.001	-0.002	-0.002	-0.010	-0.012	-0.008	-0.011
	(0.005)	(0.002)	(0.007)	(0.013)	(0.014)	(0.012)	(0.017)
	[-0.011,0.010]	[-0.005,0.001]	[-0.015,0.012]	[-0.035, 0.016]	[-0.039, 0.016]	[-0.033, 0.016]	[-0.045, 0.023]
	<0.892>	<0.227>	<0.819>	<0.544>	<0.398>	<0.491>	<0.502>
Data	MTF	MTF	MTF	YRBSS	YRBSS	YRBSS	YRBSS
Years	2014-2019	2014-2019	2014-2019	2015-2019	2015-2019	2015-2019	2015-2019
N	244,360	244,360	246,192	580,788	580,788	580,788	504,639
Dependent Variable Mean	0.066	0.012	0.080	0.080	0.019	0.014	0.107
ENDS Elasticity	0.123	0.341	0.089	0.041	0.336	0.412	0.031
Cigarette Elasticity	-0.032	-0.530	-0.056	-0.355	-1.792	-1.784	-0.321

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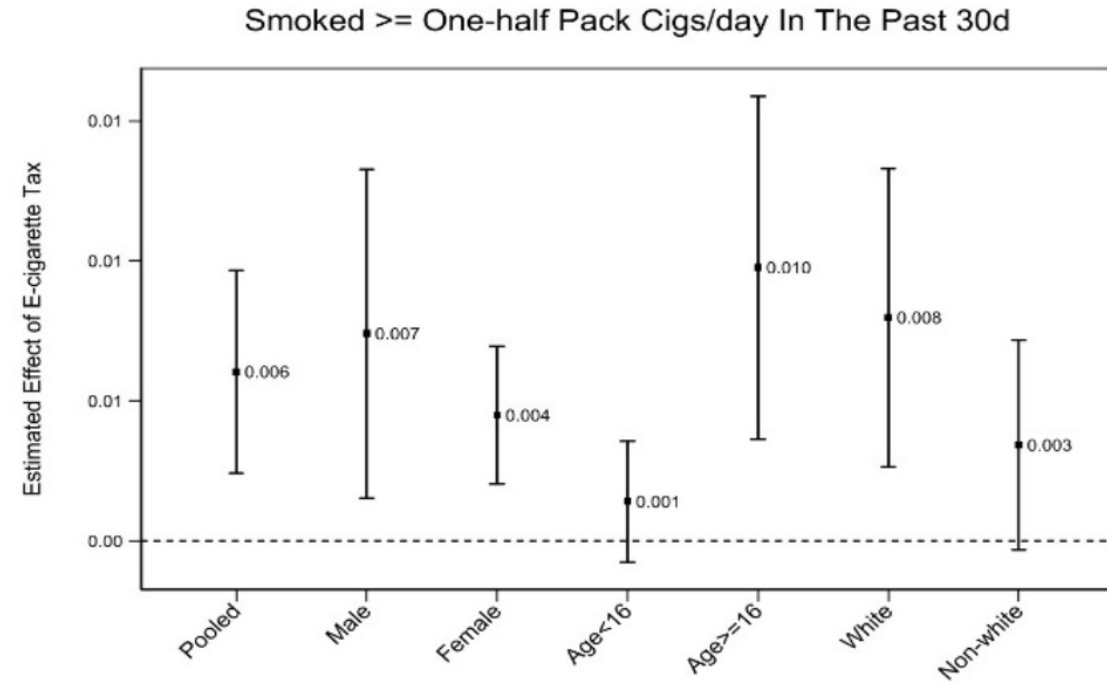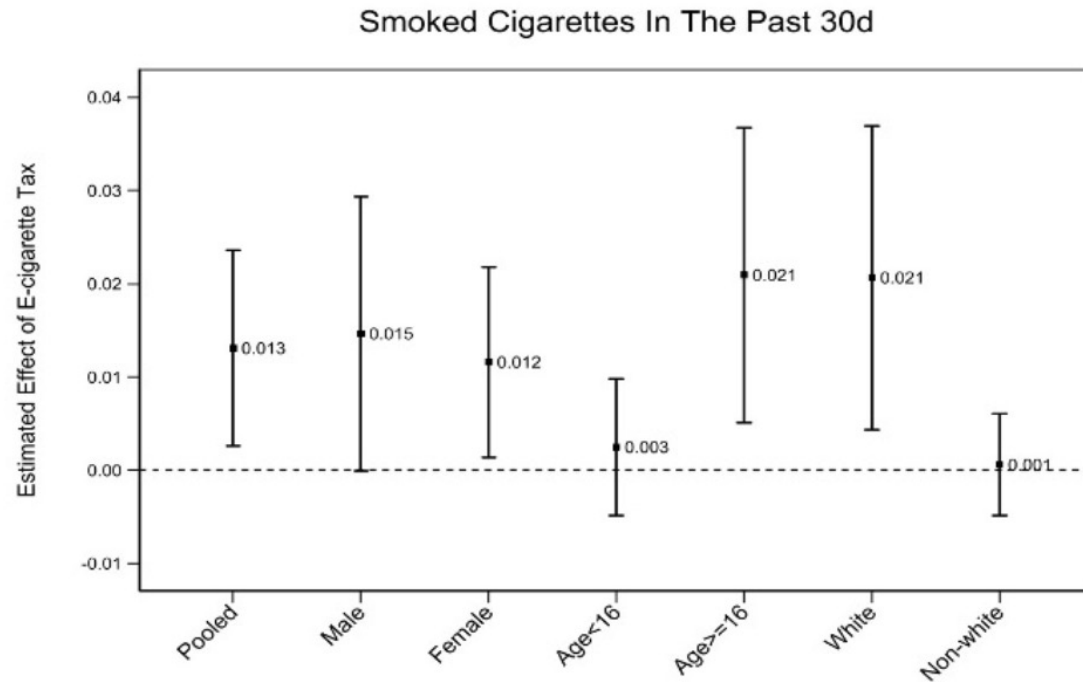
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	(0.005)	(0.002)	(0.007)	(0.013)	(0.014)	(0.012)	(0.017)
	[-0.011,0.010]	[-0.005,0.001]	[-0.015,0.012]	[-0.035, 0.016]	[-0.039, 0.016]	[-0.033, 0.016]	[-0.045, 0.023]
	<0.892>	<0.227>	<0.819>	<0.544>	<0.398>	<0.491>	<0.502>
Data	MTF	MTF	MTF	YRBSS	YRBSS	YRBSS	YRBSS
Years	2014-2019	2014-2019	2014-2019	2015-2019	2015-2019	2015-2019	2015-2019
N	244,360	244,360	246,192	580,788	580,788	580,788	504,639
Dependent Variable Mean	0.066	0.012	0.080	0.080	0.019	0.014	0.107
ENDS Elasticity	0.123	0.341	0.089	0.041	0.336	0.412	0.031
Cigarette Elasticity	-0.032	-0.530	-0.056	-0.355	-1.792	-1.784	-0.321

+ $p<0.10$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Notes: All MTF models include tax jurisdiction fixed-effects, year-by-quarter fixed-effects, and each of the individual controls and policy/economic covariates listed in Table 2. All YRBSS models include state fixed-effects, year fixed-effects, and each of the individual controls and policy/economic covariates listed in Table 2. Regressions are weighted, standard errors are corrected for clustering at the state level, 95% confidence intervals are shown in [ ] and p-values are shown in <>.

Heterogeneity in Smoking-Response (MTF)

Summary of Main Results

- A $1 rise in ENDS taxes:
  - Decreases current ENDS use
    - 2 pp in MTF data, which includes 8th graders (p<0.10)
    - 7 pp in YRBSS data (p<0.01)
  - Decreases ever-use of ENDS by 5 pp (MTF data, p<0.001)
  - Increases current cigarette use by ≈1 pp
    - Larger as a percent of the mean in higher intensity forms of cigarette use.
  - Increases perceptions of risk of e-cigarettes being highly risky by 3 pp.
  - Shifts ENDS sources away from retail and "other," towards social.

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Identification Checks

1. Concern: Policy Exogeneity Assumption

   ➢ Check: Add one-period ENDS-tax-adoption leads ➔ Lead coefficients small and insignificant, with no effect on contemporaneous tax variable.

2. Concern: Identification issues in two-way fixed effects with staggered treatments

   ➢ Check 1: Goodman-Bacon Decomposition (2021) ➔ using earlier-treated or already-treated states as a counterfactual for later-treated states (the problematic comparison) drives less than 6% of our average treatment effect.

   ➢ Check 2: Extending the MTF sample back to 2011 for combustible tobacco outcomes, use a "stacked" difference-in-difference estimator to rule out bias from heterogenous treatment effects, and dropping MN (Cengiz et al. 2019). ➔ Similar results.

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Sensitivity Checks

- Estimating an IV model in which the standardized tax is instrumented with tax components (e.g., excise tax rate for containers and liquid, ad valorem rate).

- Controlling for cigar taxes

- Using Probit model

- Not using weights

- Adjusting standard errors using Wild cluster bootstrap procedure

- MTF specific:
  - Using an unbalanced panel
  - Adding extra controls for parental education and location
  - Using "any vaping" when available instead of nicotine-only vaping.

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Limitations

- Data Limitations
  - Samples limited to students attending middle/high school ➔ May not generalize to those who drop out
  - Potential reporting bias
  - Lack of detailed information on intensity of ENDS use

- Implications of Evolving ENDS Products

Policy Implications

- Congress is currently considering an e-cigarette-only tax roughly proportionate to the federal cigarette tax of $1.01 per pack.
  - Our MTF results suggest that 2 in 3 teens that do not use ENDS due to the tax would use cigarettes instead.
  - Our YRBSS results suggest even larger reductions in youths' current ENDS use, but still a sizable increase in youth cigarette use.
  - Problem: Sizable increases in smoking as a result of a federal ENDS tax will considerably undercut or even outweigh any public health gains of reduced youth ENDS use.

Policy Implications

- The FDA is currently assessing whether specific ENDS products are appropriate for public health for them to be approved as new tobacco products and remain on the market.
  - Natural experiment research is particularly well-suited to answering what effect does reducing accessibility or appeal of ENDS have on combustible tobacco product use, a more dangerous product.
  - This study provides evidence of one public health benefit of allowing ENDS to be legally sold: reduced cigarette use among youth.
  - This benefit should be used alongside other estimates of public health benefits and harms of ENDS as the FDA continues to evaluate whether these products will be approved for legal sale or not.

Research Implications/Challenges Going Forward

- Ongoing analysis needed as products (& potential substitutes) evolve. Including supply-side analyses.

- Allow for age-varying responses

- Reject over-simplifications
  - Health effects of tobacco use vary across products
  - Addictiveness/nicotine delivery vary across products (even within ENDS)

$$\downarrow$$

1. **Be careful about homogeneity assumptions.**
2. **Classic models may need to be updated to allow for close substitutes.**
3. **More-nuanced analyses call for more nuanced data (and larger datasets)**

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Thank you!

Questions/Comments?

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