Yale SCHOOL OF PUBLIC HEALTH

Two Methods to Estimate Parameters: Flavor Bans in E-cigarettes and Cigarettes

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Two methods for estimating parameters of policy impact of flavor bans: e-cigarettes and cigarettes

Discrete Choice Experiments (DCE)- examples from our work

- Useful especially when
  - policies have not been implemented and/or
  - there are no real-world data,

Quasi-experimental studies examine real-world policy change and data: ongoing

- Examine population response to policies implemented:

  Collect own data or use publicly available (we published on Tobacco 21)

Series of our publications on regulations of smoking and vaping and related

- Strombotne K, Buckell J, Sindelar JL. Who me? Optimism bias about US teenagers' ability to quit vaping. *Addiction.* 2021.
- Maclean JC, Buckell J. Information and sin goods: Experimental evidence on cigarettes. *Health Economics.* 2021 Feb;30(2):289-310.
- Buckell J, Hensher DA, Hess S. Kicking the habit is hard: A hybrid choice model investigation into the role of addiction in smoking behavior. *Health Economics.* 2021 Jan;30(1):3-19.
- Sindelar JL. Regulating Vaping: Policies, Possibilities and Perils. *New England Journal of Medicine.* May 2020.
- Strombotne K, Buckell J, Sindelar JL Strombotne K, Buckell J, Sindelar JL. Do JUUL and e-cigarette flavors change risk perceptions of adolescents? Evidence from a national survey. *Tobacco Control.* 2020.
- Friedman AS, Buckell J, Sindelar JL. Tobacco-21 laws and young adult smoking: quasi-experimental evidence. *Addiction.* 2019 Oct;114(10):1816-1823.
- Buckell J, Sindelar JL. The impact of flavors, health risks, secondhand smoke and prices on young adults' cigarette and e-cigarette choices: a discrete choice experiment. *Addiction.* 2019 Aug:114(8):1427-1435.
- Friedman AS, Buckell J, Sindelar JL. Patterns of Youth Cigarette Experimentation and Onset of Habitual Smoking. *American Journal of Preventive Medicine.* 2019 Jun;56(6):803-810.
- Buckell J, Hess S. Stubbing out hypothetical bias: improving tobacco market predictions by combining stated and revealed preference data. *Journal of Health Economics.* 2019 May;65:93-102.
- Marti J, Buckell J, Maclean JC, Sindelar JL. To 'vape' or smoke? Experimental evidence on adult smokers. *Economic Inquiry.* 2019 Jan;57(1):705-725.
- Buckell J, Marti J, Sindelar JL. Should flavours be banned in cigarettes and e-cigarettes? Evidence on adult smokers and recent quitters from a discrete choice experiment. *Tobacco Control.* 2018 May 28.
- Maclean JC, Oney M, Marti J, Sindelar JL. What factors predict the passage of state-level e-cigarette regulations? *Health Economics.* 2018 May;27(5):897-907.

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Background: Regulation – Federal (and State)

- **Food and Drug Administration**
  - FDA has regulatory power over tobacco products (2006) and now includes authority over ecigs 2016 (and other tobacco products).
  - FDA is required to regulate to improve public health. Needs to consider substitution of products in response to policies.
  - FDA has begun to use its 'premarket approval' to take some flavored ecigs off the market.
- **States and localities** can ban indoors, tax, Tob21 and regulate flavors**.**

(Sindelar JL, Regulating Vaping: Policies, Possibilities and Perils. *N Engl J Med.* May 2020.)

DCE paper and example of methods: How will different flavor bans impact public health?

Buckell J, Marti J, Sindelar JL. Should flavours be banned in cigarettes and e-cigarettes? Evidence on adult smokers and recent quitters from a discrete choice experiment. *Tobacco Control.* 2018 May 28.

- What are the best set of flavor bans on ecigs? Consider impact on smoking and vaping.
  - Ban menthol? all flavors? Maintain status quo?
  - Ban similarly or optimally different across ccigs and ecigs?
  - Heterogenous impact by demographics and types of smokers/vapers?
  - What are priorities? Reduce smoking overall, minimize use of cigs and ecigs

Discrete Choice Experiment (DCE) Methods

Overall: respondents make choices of **products** across **attributes** (e.g., flavor) at different **levels** (e.g., menthol, fruit)

- Researcher:
  - Selects attributes and 'levels'
  - Determine products to select among
  - Develop DCE and survey to accompany DCE
  - Pilot – use data to select the most impactful set of choices; Improve survey
  - Randomize to groups to sets of questions to reduce response burden (optimize)
  - Choices = data to analyze
  - Analyze data

Experimental Design – Pick 1st, 2nd Choices (best/best DCE)

- Products:
  - Combustible cigarettes, e-cigarettes, opt out
- Attributes:
  - Flavors, health, nicotine level, price
- Levels:
  - E.g., Flavors: tobacco, menthol, fruit, sweet
  - Nicotine: used, qualitative
- Price

	E-cigarette	Combustible cigarette
Flavor	Plain tobacco Menthol Fruit Sweet	Plain tobacco Menthol
Life years lost by average user	10 5 2 Unknown	10
Level of nicotine	High Medium Low None	High Medium Low
Price	$4.99 $7.99 $10.99 $13.99	$4.99 $7.99 $10.99 $13.99

Choice Tasks: top 2 choices (best-best). Online

- Best-best DCE:
  - Two choices per scenario
  - Two opt outs
- 12 scenarios per individual-Can't ask all possibilities. 3 sets to randomize
- 'Observations'= 24,372 (2 choices for each 2031 respondents, 12 choice scenarios)

Choices are the data to analyze

Option 1: Tobacco Cigarette	Option 2: Tobacco Cigarette
 • Flavor: **Tobacco** • Nicotine level: **High** • Die earlier: **10 years**	 • Flavor: **Tobacco** • Nicotine level: **Low** • Die earlier: **10 years**
$13.99	$7.99
Option 3: E-cigarette	Option 4: E-cigarette
 • Flavor: **Menthol** • Nicotine level: **High** • Die earlier: **5 Years**	 • Flavor: **Fruit** • Nicotine level: **Medium** • Die earlier: **2 years**
$13.99	$10.99

First preference		Second preference
○	Option 1: Tobacco Cigarette	○
●	Option 2: Tobacco Cigarette	○
○	Option 3: E-cigarette	○
○	Option 4: E-cigarette	●
○	None of these	○
○	None of these	○

Accompanying Survey Alongside DCE

- Ask about:
  - Socio-econ and demographics
  - Smoking, vaping history, and current habit
  - State and city of residence
  - Knowledge, beliefs, and perceptions re vaping
  - Specifics developed for each study
  - Else
- Use these data/variables as control variables, e.g., vaping history, gender, state
- Examine heterogeneity in response by control variables

Methods: Choice Model and Utility Function

- Build a utility function (i=individual; j=product in c=choice set):

$$U_{ijc}(flavored\ cigarette) =$$

$$= Men\_Ccig + Tob\_Ecig + Men\_Ecig + Fru\_Ecig + None - of - these$$

$$+ \beta_{price}.Price_{jc} + \beta_{nicotine}.Nicotine_{jc} + \beta_{Health\ risk}.Health\ Risk_{jc}$$

$$+ \varepsilon_{ijc}$$

- Yields choice probabilities – higher utility, more likely choice
  - (omitted tobacco-ccig)
- Product-flavor constants (interact product constant with flavor preference e.g., menthol-ccig)

Results: Cigarette Choice Model and Cigarette Choice Model Without Interaction

Main Results:

- Coefficients on constant terms are measures of the preferences.
- Thus, sample prefers omitted category of tobacco cigs (negative coefficients on else)
- Sample: adult current and recent smokers

Also prefers:

- Lower price
- Medium level of nicotine
- Healthier product

Parameters	Coef. (s.e.)	Sig.
Constant: menthol combustible cigarette	−0.38 (0.035)	***
Constant: tobacco e-cigarette	−0.55 (0.037)	***
Constant: menthol e-cigarette	−0.88 (0.058)	***
Constant: fruit/sweet e-cigarette	−0.71 (0.040)	***
Constant: none of these *(omitted tob cig)*	−1.87 (0.049)	***
Price	−0.08 (0.002)	***
Nicotine: none *(omitted medium)*	−0.15 (0.024)	***
Nicotine: low	−0.04 (0.019)	*
Nicotine: high	−0.06 (0.015)	***
Health: unknown *(omitted 10 years lost)*	0.30 (0.033)	***
Health: 2 life years lost	0.37 (0.036)	***
Health: 5 life years lost	0.18 (0.027)	***

Examine Heterogeneity

- Interact flavor-product-constant with sociodemographic variables to examine heterogeneity
- Use these results to predict impacts: better predictions than assuming all have same preferences

Simulations: Generating Preferences

- Predict % of the population that selects each cig type or none. These ‘choice probabilities’ sum to 1 in each scenario (are not quantities).
- These ‘choice probabilities’ are ‘choice shares’ (% of times ecig selected); are used to make predictions under alternative regulatory bans.
- Compare the ‘status quo’ (current regulations) to alternative regulations.

Potential flavor bans policy options: Predict impact; compare current to alternatives

	Permitted flavors by cigarette type.			
	Combustible cigarettes		E-cigarettes	
Policy	**Menthol**	**Fruit/sweet**	**Menthol**	**Fruit/sweet**
• Current US Policy: ban fruit/sweet in ccig	Allowed	Banned	Allowed	Allowed
• Alternative 1: ban all flavors	Ban	Ban	Ban	Ban
• Alternative 2: only allow menthol ecig	Ban	Ban	Allow	Ban
• Alternative 3: ban all ccig flavors	Ban	Ban	Allow	Allow
• Alternative 4: only allow fruit/sweet ecig	Ban	Ban	Ban	Allow
• Alternative 5: ban all ecig flavors	Allow	Ban	Ban	Ban

Results: Model Predictions (subset)
Goals? Reduce smoking, use of any tobacco?

Maximize	% change predicted market share compared to 'current'		
	Ccig	Ecig	none
Ban e-cigarette flavors	8.3	-11.1	3
Ban menthol in combustible cigarettes	-5.2	3.8	1.6
Ban all non-tobacco flavors	2.7	-7.9	5.2

Approach 2: Quasi-experimental Approach – Estimate Impact of State-level Flavor Bans (UMich/Yale TCORS)

- State flavor bans – can now analyze real-world bans
  - States with bans & Tob21 vs. Tob21 only vs. neither
- Aim to establish cause-and-effect impact of flavor ban policy on smoking/ vaping
  - Pre-post ban outcomes
  - Policy change is exogenous to the smoker/vaper
- Survey smokers and vapers and compare change in use (11- 2019 vs current) in states withvs without ban.
- Can't examine impact of flavor bans at Federal level – no ban on menthol in cigs and difficult to assess the pre-authority approval approach; use impact of states to suggest impact of Federal policies

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How to identify and measure pre-post change through survey question?

- State flavor bans occur mainly prior to Thanksgiving 2019. We use this as a prompt to help sample report how much was smoking/vaping then. Ask how much using now.
- Ask respondent if they have noticed an inability to buy flavored products.
  - (date of policy implementation may not be when noticed, e.g., not vaping then).
- If they noticed, ask how they changed and why (Tob21 vs ban)
- Outcome- change pre–post the date of law passed/when they noticed
  - Vs change across same dates for those in non-ban states.
- Take advantage of the exogenous to users passage of policies

Two National Online Surveys of users ages 18-32, 2000 respondents each

- **Survey 1:** regular vapers, vaped daily or some days; as of Thanksgiving 2019 (prior to the implementation of state flavor restrictions).
- **Survey 2:** ever smokers, smoked at least 100 cigarettes in life and smoked daily or some days as of Thanksgiving 2019.(have info on duals)
- **Questions in both surveys:** past/current tobacco use; socio-econ-demo; state of residence; and more.
- Also, perceptions and hypothetical responses,

By comparing smoking pre-post across state groups, we can ID the impact of flavor bans on smoking and vaping

Groups/ States	States (names or number of)	Cigarette Menthol Ban	E-cigarette Flavors Ban	Tobacco-21 Laws	Vapers (N obs.)	Smokers (N obs.)
MA	MA	X	X	X		1000 from MA 500 from NJ, NY, RI
Group 1	MA, NJ, NY, RI		X	X	1000	
Group 2	13+DC			X	500	500 from Groups 2 & 3 Combined
Group 3	33				500	

- In regressions, control for policies/grouping and interactions; in essence, compare to states with flavor e-cig bans/Tobacco-21 vs. states with only Tobacco-21.
- Similarly, we can ID impact of menthol cig ban on smoking/vaping by comparing across states. Only MA passed a cigarettes menthol ban.
- **Note:** Use survey data at individual level in these states.

Outcomes: in assessing impact of flavor bans

User Behavioral Responses to Tobacco Flavors Restriction Policies

Behavioral responses	State or local bans on flavored e-cigarettes (real-world)	Real-world MA ban or federal ban on menthol cigarettes
1) Quit…	• Vaping flavored e-cigarettes; quit all vaping	• Quit smoking menthol, quit smoking
2) If continue to vape any kind of ecig, reduce use	• Vape less frequently/intensely	• Smoke less frequently/intensely
3) Switch to or continue to use…	• Unflavored e-cigarettes • Different tobacco product (e.g. cigarettes)	• Non-menthol cigarettes • Menthol e-cigarettes • Unflavored e-cigarettes • Different tobacco product (e.g., cigars) • (hypothetical- flavored ecigs)
Also ask about: Efforts to circumvent bans/ change in perceptions/ response to hypothetical ban		

Regression analyses (also simple t-tests)

- Separate analyses for the sample of smokers and vapers, Control for dual use.
- Use logit, ordinal logit of MNL , depending on the outcome (binary, multivariate).
- Will estimate linear regression models such as:

$$Y_i = \beta_x X + \delta_z Z + \varepsilon_i$$

- Y_i is pre/post vaping/ smoking (risk perceptions, hypothetical).
- Xi is set of 1) individual socio-economic/demographic characteristics & history of smoking vaping: 2) state fixed effects (sensitivity analyses), 3) COVID-19. β_x, is set of estimated impact of each control variable.
- Z is the set of policy variables / groups of states; δ_z is the set of estimated impacts.
- ε_i is an error term assumed to be normally distributed.

Control Variables

- **Smoking and vaping histories**
- **Socio-economic and demographic measures as control variables.** socio-economic and demographic status e.g., age, gender, race, ethnicity, education and income.
- **Other state tobacco policies and characteristics.** composite score of other tobacco control state policies (may consider other state characteristics e.g. unemployment/poverty/ % Hispanic Black population, else)
- **COVID-19**

Thank you for your interest

Questions, comments, ideas?

Surveys and sampling details

- Use Qualtrics platform – Most take on smartphones
- Use quotas, based on vaping/smoking status, age, gender, state-group, and education from the TUS-CPS 2018-2019. Nationally representative.
- Have developed methods to enhance quality of data,
  e.g., must move slider before preceding (prevent straight-lining), delete those who rushed through, truth pledge before, ask if careful after

Summary of Findings – cont.

- Smokers and recent quitters prefer cigs and menthol cigs over ecigs with flavors
- Older adults prefer tobacco only
- Younger adults prefer flavors in cigs and ecigs (including tobacco)

Method 2: Quasi-experimental Approach – Estimate impact in states with/without flavor bans

Aims: Examine impacts of state ecig and cig flavor bans on smoking and vaping; apply to FDA bans.

Surveys: Ages 18-32 – one of vapers (2000) and one of smokers (2000); have data on dual; use quotas for representativeness across states that did vs. did not pass bans; gathering data now.

Approach: Compare outcomes in states that banned flavors in ecigs vs. states that did not (control states) or cigs (only MA) to assess 'causality'; some states have bans and Tobacco-21; some have Tobacco-21 only,

Measures: Changes pre/post

1. Pre/post state law smoking/vaping; self-report with memory prompts; key.
2. Perceptions of risks change relating to passage of bans (real-world changes).
3. Hypothetical changes in states without changes.

Analyze:

- Regressions of change in vaping and smoking of those affected or not by the bans.
- Control for the impact due to Tob21 laws at state (first) then Federal level (1.20.21)
- Policy not randomly passed, control for characteristics of state & population in the state.

Our DCE Studies: Analyze impacts of alternative, future Federal regulations & provide findings in advance of selection of policies

- Many advantages of method when real world data not available. Collect own, purposeful data
  - Rigorous, well-documented methods, e.g., Hauber, et al. 2016; Johnson et al. 2013; Bridges et al. 2011; ISPOR
  - Timely findings and designed for specific policy and population
  - Focus on & estimate trade-offs across policy options and cig types
  - Use estimates to predict/simulate impact under alternative policies
  - Examine heterogeneity in responses to regulation; define types of smokers and vapers