How US vapors choose among different e-cigarette (EC) models & cigarettes in response to prices

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Disclosure

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Summary of this study

- Employ a volumetric choice experiment (VCE) for adult EC users in the US to study own and cross elasticities among six different e-cigarettes (EC) types & cigarettes

- Different EC types substitute each other

- Higher prices and taxes on ECs & cigarettes will reduce consumptions among adult EC users

- Cross-price elasticities between ECs & CIGs for vapors were largely nonsignificant

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BACKGROUND
&
MOTIVATION

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Background

- Growing popularity of e-cigarettes (ECs) → state & local EC excise taxes in the US

- Increasing EC taxes reduces EC sales and use among both youth and adult populations. (Abouk et al (2023), Cotti et al (2022), Pesko et al (2020, 2022), Friedman et at (2022))

- Increasing EC taxes may increase smoking and cigarette sales, leading to unintended consequences. (i.e., ECs and cigarettes are likely economic substitutes)

- The current debate over EC taxes has also been focused on balancing the intended and unintended consequences of taxing ECs.

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Motivation – What is not known in the EC tax literature?

- Almost all conclusions are based on sales or repeated cross-sectional data. Therefore, those studies did not control for tobacco users' unobserved heterogeneity (e.g., beliefs in EC risks etc.) using individual fixed effects.

- Treat ECs as a homogeneous group while their characteristics and tax burdens significantly vary (Shang et al (2023)). E.g., most studies used past-30-day use as the sole outcome.

- The economic relationships (i.e., whether they are substitutes or not) among different types of ECs and between various EC types and cigarettes are unknown, despite their differential appeals and potentials to replace cigarettes.

Disposable   *Tank systems w/ e-liquids*   *E-liquids*   *Pod starter kit*   *Pod device w/ pods*   *Cigarettes*

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Motivation – What is not known in the EC tax literature?

- Dual use of e-cigarettes and cigarettes are not well addressed in existing data

    - Survey data often measure whether to use cigarettes or ECs instead of measuring quantities ⟶ The allocations between ECs and cigarettes among dual users are unknown.

- Unlike cigarettes, ECs are platform goods (device + refills) in marketing and economics research, similar to Keurig coffee machine + pods ⟶ The purchasing patterns of ECs could be very different from cigarettes due to the nature of platform goods and need to be further investigated

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This study conducts a volumetric choice experiment (VCE) to fill in evidence gaps, which has the following advantages

- Use within variation that addresses confounding issues (controlling for individual fixed effects in assessing price impacts)

- Allow for the estimation of cross- and own- price elasticity for different EC types, which observational survey data are not able to estimate due to the lack of reporting, confounding, and multicollinearity issues.

- Causal interpretation of results ~ widely used in medical decision-making and marketing

- Flexibility in modeling dual use behaviors compared to discrete choice experiments

- Flexibility in modeling platform goods (Expensive device for one-time purchase + relatively cheaper refills)

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Aims

- To study own & cross elasticities among six different EC types & cigarettes, we employed a volumetric choice experiment (VCE) for adult EC users in the US

    - We chose these ECs based on market shares and differences in configurations and product characteristics

Product type	Disposable	Tank device w/ e-liquid	E-liquid bottle	Pod device w/ pods	Pod starter kit	Pod refills	Cigarettes
Nicotine (per ml)	30mg	6mg		50mg			
Volume size	1ml	60ml		0.8ml			Pack of 20

METHODS

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Methods

Eligibility & Sample

- Online volumetric choice experiment (VCE) in May 2023

  - We pretested the survey and VCE design using 7 structured qualitative interviews and pretested the survey among 27 adult (18+) EC users

- A nationally-representative sample of 808 EC users (18+)

  - Recruited using the Knowledge Panel

  - Reported past-30-day EC

  - Lived in the US

  - Provided valid answers to VCE questions, total N = 700 persons

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Methods (continued)

Online volumetric choice experiment (VCEs) design

- Participants answer 9 choice questions. In each question, they report # of units they will purchase for monthly use among the following products. Participants were advised to make purchases within their monthly budget and respond to changing taxes and prices across choice questions.
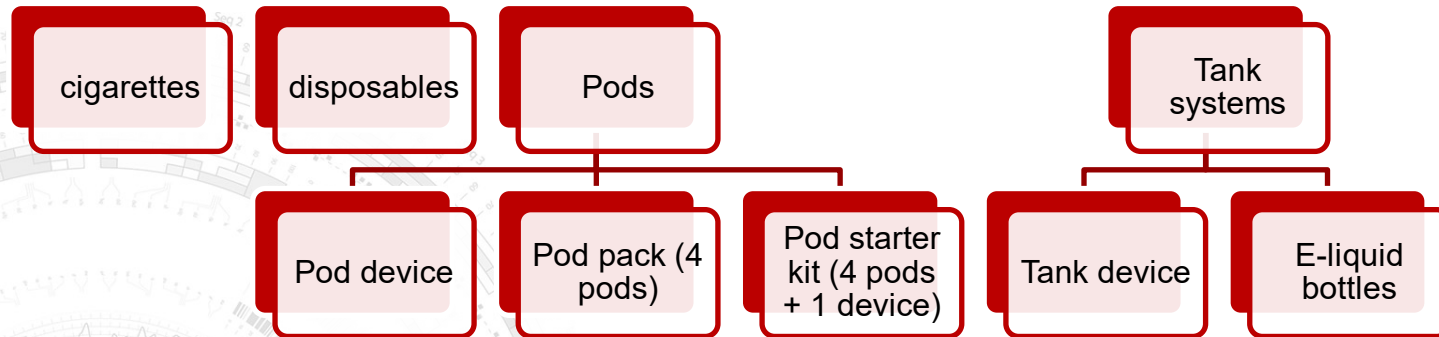
- Participants are allowed not to buy any product (opt-out)

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VCE design – price variation based on tax levels at the time of survey

Attributes (levels)	Tank systems (tank & e-liquid) (60 ml)	Pods (pack of 4 pods/starter kit/device) (0.7 ml)	Disposables (1 ml)	Cigarettes (pack of 20)
Device prices	Low (25% percentile), median (50%), high (75%)		N/A	N/A
Device taxes	No taxes, low tax burden (10% of retail price), high tax burden (40% of retail price)		N/A	N/A
Refill prices	Low (25%), median (50%), high (75%)			
Refill taxes	No taxes, low tax burden (20%), high tax burden (40%)			Current + 0%, 10%, 20%

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Mean prices per unit based on the VCE design

$ per unit in VCE design

Category	Price
Disposables	$16
Pod device	$23.25
Pod kit	$34.28
Pod refill pack	$23.46
Tank device	$55.41
E-liquid bottle	$22.49
Cigarettes	$9.90

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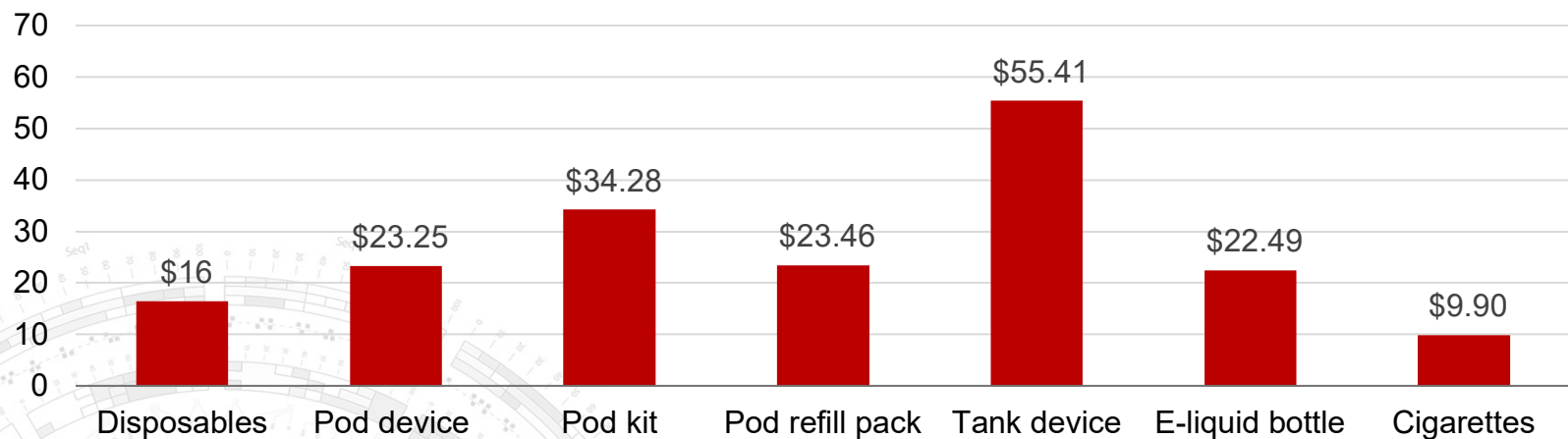
VCE instruction & example question

Please click on the product type of interest to navigate.

DISPOSABLES

Disposables	
Nicotine strength: 50 mg/ml	
Flavor: Your preferred flavor	
Unit Price:	$17.99
Excise Tax:	$0.00
Sales Tax:	$1.30
Total Price:	$19.29

Add **3** items to cart

Please choose the quantity of the product you'd like to buy.

PODS

Pod Device	
Unit Price:	$17.99
Excise Tax:	$0.00
Sales Tax:	$1.30
Total Price:	$19.29

Cost $1.61 per month with 12-month payment plan

Add **0** items to cart

Not required to make a purchase, if not interested.

Pack of 4 pods	
Nicotine strength: 50mg/ml	
Flavor: Your preferred flavor	
Pack Price:	$12.99
Excise Tax:	$0.00
Sales Tax:	$0.94
Total Price:	$13.93

Add **0** items to cart

Starter kit (device + one pack of 4 pods)	
Nicotine strength: 50mg/ml	
Flavor: Your preferred flavor	
Kit Price:	$34.99
Excise tax :	$0.00
Sales Tax :	$2.53
Total Price:	$37.52

Cost $3.13 per month with 12-month payment plan

Add **1** items to cart

TANKS

Tank Device	
Unit Price:	$59.99
Excise Tax:	$0.00
Sales Tax:	$4.35
Total Price:	$64.34

Cost $5.36 per month with 12-month payment plan

Add **0** items to cart

E-liquid Bottle	
Volume: 60 ml	
Nicotine strength: 6 mg/ml	
Flavor: Your preferred flavor	
Unit Price:	$29.99
Excise Tax:	$0.00
Sales Tax:	$2.17
Total Price:	$32.16

Add **0** items to cart

CIGARETTES

Cigarettes (Pack of 20)	
Flavor: Your preferred flavor	
Pack Price:	$5.24
Excise Tax:	$5.22
Sales Tax:	$0.76
Total Price	$11.22

Add **3** items to cart

☐ **I would not buy any of these**

You can choose not to purchase any of the products in the store.

Cart: 7.00

Subtotal: $ 104.68

Taxes: $ 24.37

This shows your monthly budget based on your response.

Your usual monthly budget: $ 200

Total: $ 129.05

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Questions?

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RESULTS

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Results

Distribution of units reported (N=33,473)*

Units	Frequency [%]
0	26,926 [80.44%]
1-10	6,013 [17.96%]
11-20	311 [0.99%]
21-30	119 [0.36%]
31-100	53 [0.16%]
101 or above	31 [0.09%]
Mean	1.47
Standard Deviation	20.5

* 700 individuals × 7 products × an average of 6.8 answered questions

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Use patterns (N = 33,473)

Legend: Everyday, Some days, Not at all

	EC use frequency	CIG use frequency
Not at all		63%
Some days	29%	15%
Everyday	71%	21%
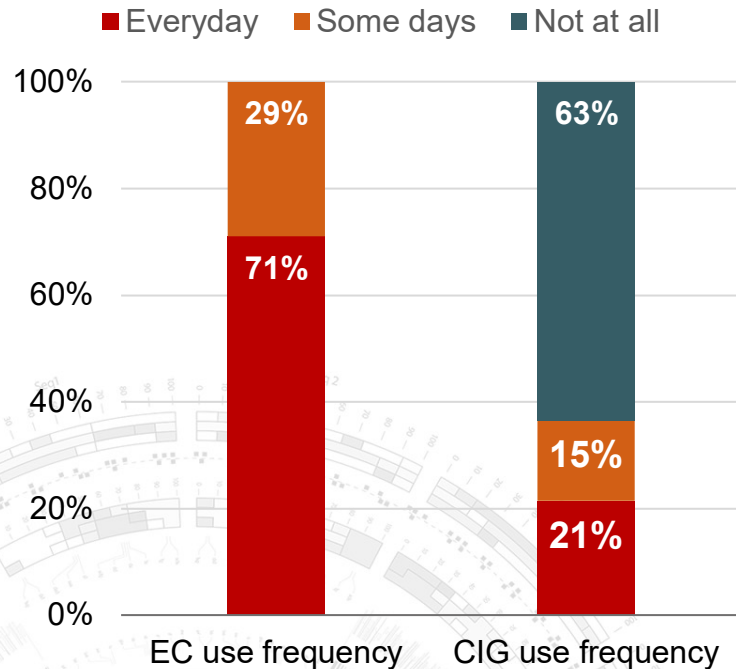
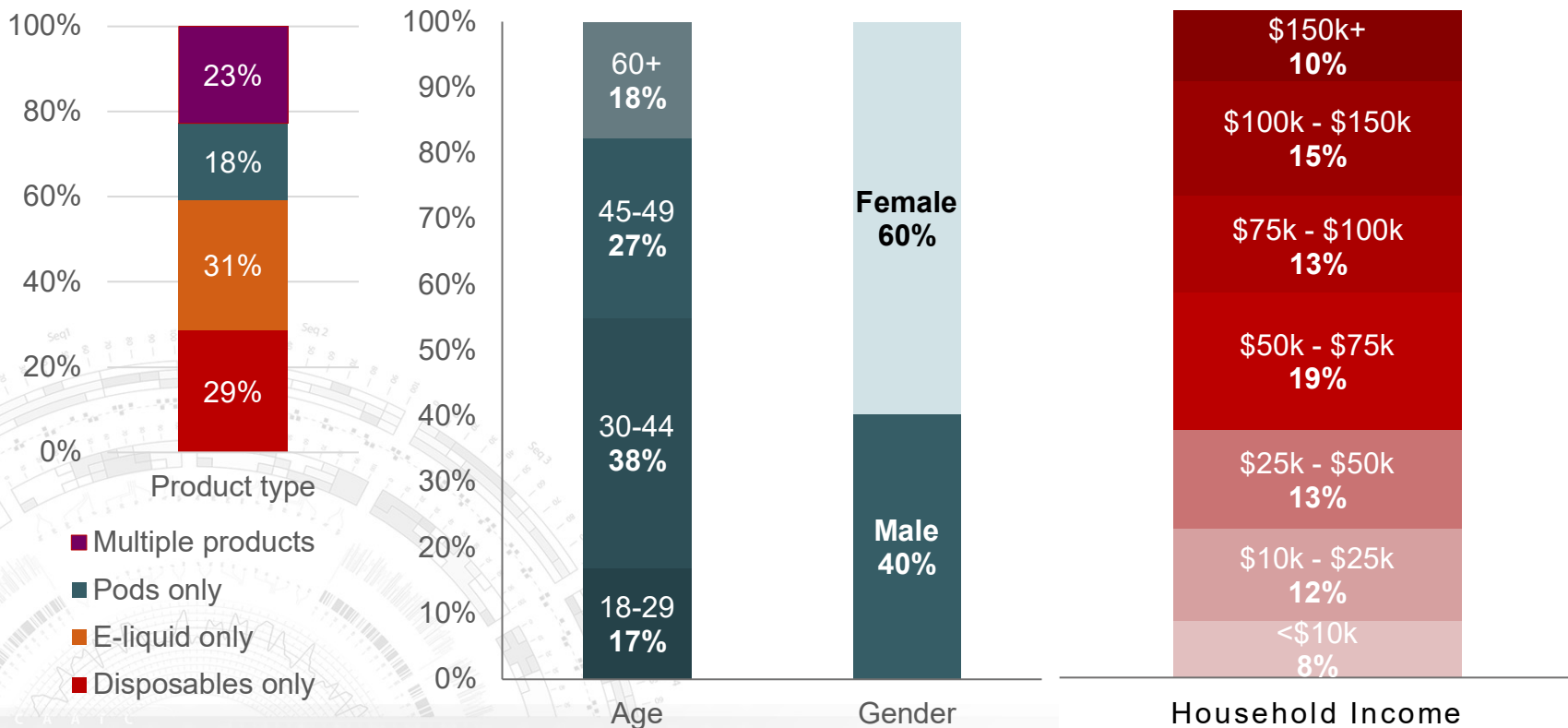**E-cigarettes (EC) and cigarettes (CIG) dual use status: 36% of total EC users**

Smoking status by EC use patterns (N = 33,473)

Legend: Never smoked, Smoked in the past, Currently smoke

	Daily EC user	Some days EC user
Currently smoke	26%	64%
Smoked in the past	67%	22%
Never smoked	8%	14%
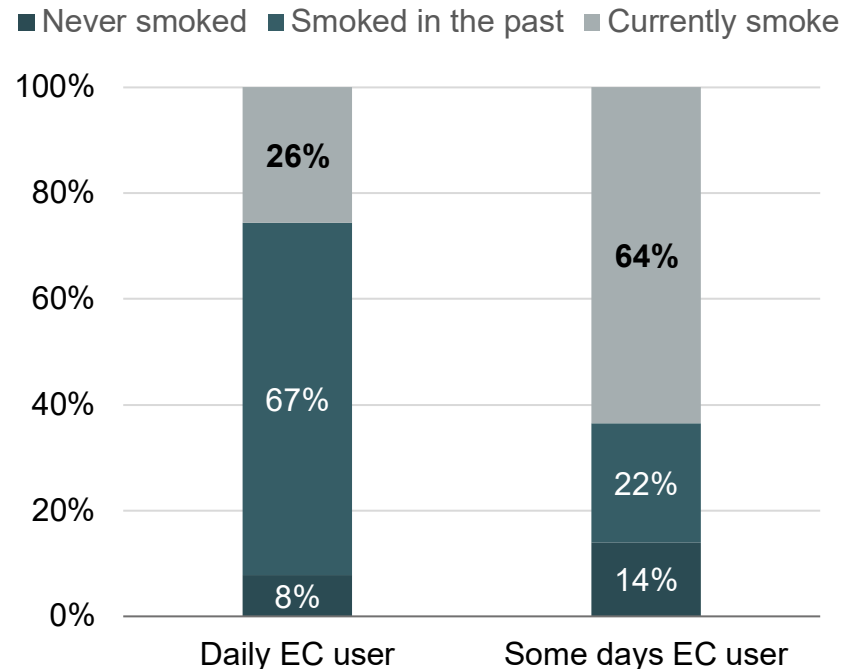
26% of daily EC users and 64% of some days EC users smoke CIG too

E-cigarette product of use and demographics (%, N = 33,473)

Product type

- Multiple products
- Pods only
- E-liquid only
- Disposables only

Product type:
- Multiple products: 23%
- Pods only: 18%
- E-liquid only: 31%
- Disposables only: 29%

Age
- 60+: 18%
- 45-49: 27%
- 30-44: 38%
- 18-29: 17%

Gender
- Female 60%
- Male 40%

Household Income
- $150k+: 10%
- $100k - $150k: 15%
- $75k - $100k: 13%
- $50k - $75k: 19%
- $25k - $50k: 13%
- $10k - $25k: 12%
- <$10k: 8%

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Zero-inflated negative binomial regression

$$U_{ijm} = \beta_0 \, \text{ASC}_{ijm} + \beta_1 \, \text{OwnPrice}_{ijm} + \beta_2 \, \text{CrossPrice}_{ijm} + \beta_5 \, X_i + \varepsilon_{ijm}$$

- *U*: person *i*'s consumption units of product *j* in choice set *m*

- *ASC*: alternative-specific constant to estimate how the consumption of product *j* significantly differs by product or alternatives of person *i* when they are in choice set *m*

- **OwnPrice**: a price of product *j* that person *i* faces in choice set *m*

- **CrossPrice**: a vector of prices of alternatives to product *j* that *i* faces in choice set *m*

- **X_i**: individual-level fixed effects

- **β_1** & **β_2** capture own-price elasticity & cross-price elasticity

- **Group difference by EC only vs. EC-CIG dual use:** interactions between group and elasticities are added. Individual fixed effects are replaced by tobacco use patterns & socio-demographics for convergence

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Own price elasticities (N = 33,473; 700 unique individual persons using EC)

* p<0.05, ** p<0.01, *** p<0.001

% change in consumption in response to 10% change in price

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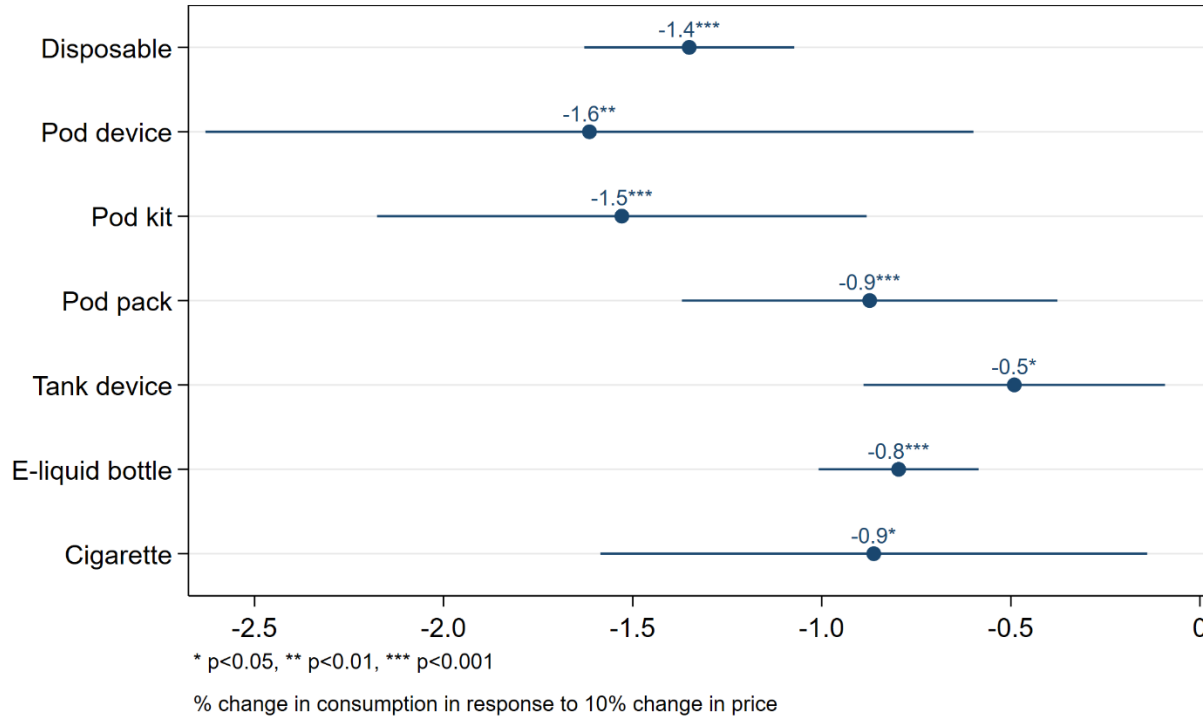
Cross price elasticities (N = 33,473; 700 unique persons using EC)

Complement ← → Substitute

Pod device to disposable price	0.5*
Pod device to e-liquid bottle price	0.5***
Pod kit to disposable price	0.4*
Pod kit to pod pack price	0.8*
Pod kit to e-liquid bottle price	0.3*
E-liquid bottle to tank price	-0.5***

* p<0.05, ** p<0.01, *** p<0.001

% change in consumption in response to 10% change in price

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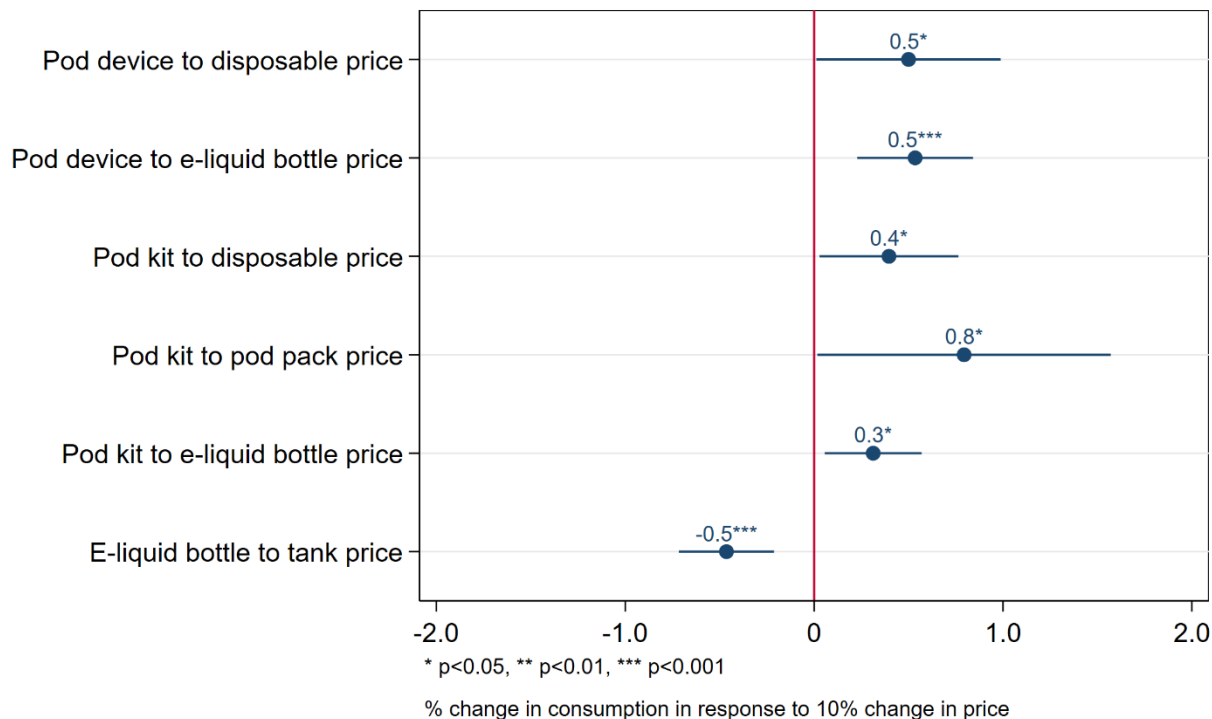
CONCLUSIONS

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Conclusions

- Using VCE, we found that higher prices and taxes on ECs & cigarettes will reduce consumptions among adult EC users in the US.

  - A 10% increase in own prices will reduce the consumption of ECs by 0.5%-1.6% among vapors and the consumption of cigarettes by 0.9%.

- Cross-price elasticities between ECs & CIGs for vapors were largely nonsignificant

  - Cigarette taxes unlikely move dual users of CIGs & ECs to more EC use instead of cigarette smoking.

  - Similarly, higher EC prices or taxes may not lead to increased CIG use of adult EC users.

  - The conclusions did not vary by whether an EC user is a dual user or not

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Conclusions (continued)

- Different EC types are substitutes

    - Pods are substitutes for disposables and tank systems (e-liquid).

    - Pod kit and pod refills are substitutes (device is relatively cheap and devices and pods may need to be matched in brands)

- Tank systems and e-liquid are complements

    - Reflect the complementarity between components in a platform combo with relatively high costs of devices+ cheaper refills.

- If there is consensus about which EC type has the greatest potential for helping quitting while not as preferred by young populations, tax policies can be designed to promote the use of a certain EC type (e.g., differential taxes by EC types).

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Conclusions continued: why there is a difference in substitutability between ECs and CIG?

- All existing observational studies did not control for individual fixed effects (heterogeneity)

- Differences in samples: Nationally representative sample of adult vapors in our study vs. general adult populations in observational studies.

  - EC/cigarette use may be more impacted by taxes and prices than consumption.

- Differences in outcomes: Consumption units in VCE vs. Use or sales measures in observational studies.

- Possibility of hypothetical biases in choice experiments? (We did take procedures to reduce possible biases)

  - Participants were making choices based on their current budget in real life.

  - Mechanisms such as motivations to complete tasks and to report real-life behaviors.

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Sensitivity and additional analysis in progress

- VCE was not designed to conduct stratified analysis. Nonetheless, we did stratification analyses, and the conclusions did not change.

- Reconduct analyses by converting outcomes from purchasing units into nicotine consumption.

- Estimate the impacts of tax levels instead of prices on outcomes.

- Predict market share shifts under different tax scenarios.

- Assess possible hypothetical biases where we will estimate cross- and own- price elasticities using the Deaton method, which relies on real-world expenditure data that we collect in the same survey from the same population. We will then compare the results between Deaton Method and VCE.

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Questions and comments

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