

# Optimal e-cigarette policy when preferences and internalities are correlated

TOPS

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Michael Darden, Ph.D.

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Carey Business School, Johns Hopkins University

- I have never received funding from the tobacco industry or any tobacco industry-supported organization.
- Funding for this project came from the Carey Business School at Johns Hopkins University.

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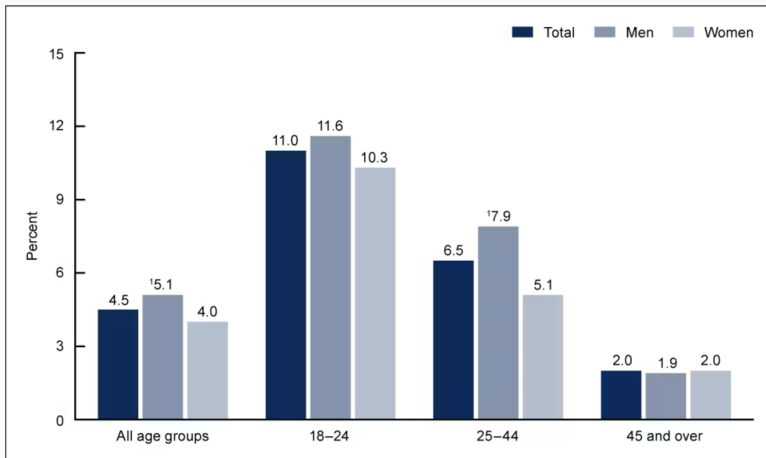
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# Introduction

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# Vaping Prevalence



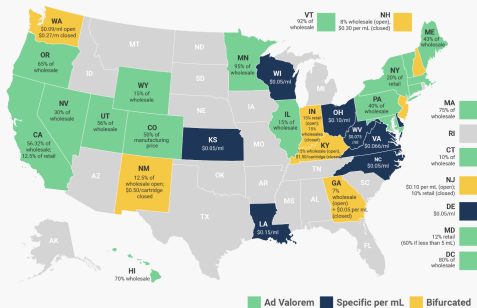
NCHS Data Brief No. 475, July 2023

# What is the optimal e-cigarette tax?

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## State Vaping Tax Rates

State Vapor Products Excise Tax Rates, July 1, 2023



Source: State Statutes; Bloomberg Tax.

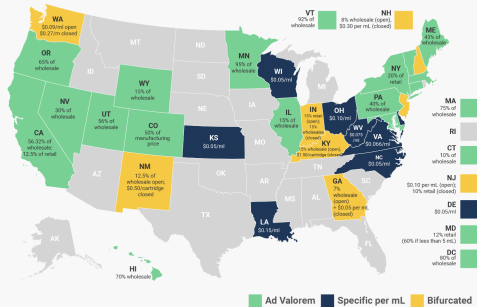
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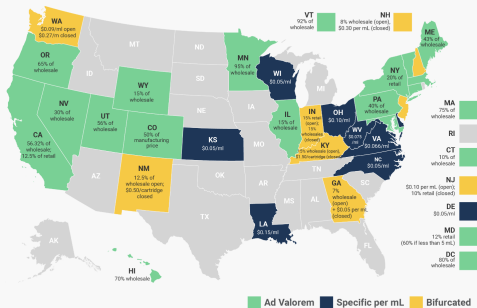
**Policy Dilemma...** E-Cigarette Taxes may:



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## Policy Dilemma... E-Cigarette Taxes may:

- Discourage youth initiation but...
- Discourage adult substitution!

# Why Tax Something?

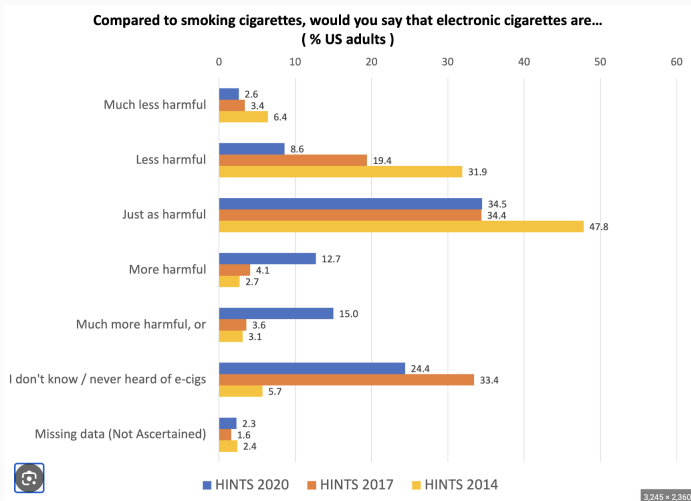
# Why Tax Something?

1. **Externalities:** Costs borne by those external to a market (i.e., not buyers or sellers).
  - Secondhand Smoke.
  - Higher Health Care Expenditures.

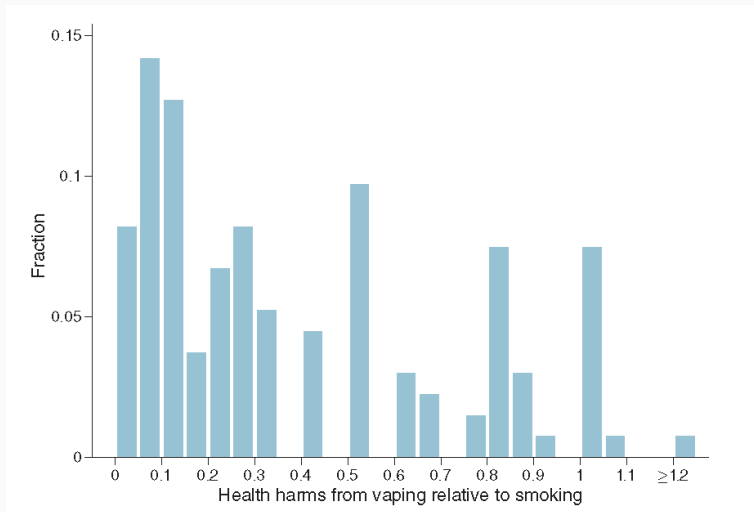
# Why Tax Something?

1. **Externalities:** Costs borne by those external to a market (i.e., not buyers or sellers).
  - Secondhand Smoke.
  - Higher Health Care Expenditures.
2. **Internalities:** Costs imposed on oneself through systematic non-optimizing behavior.
  - Time Inconsistency.
  - Imperfect information.

# Imperfect information.



# Health Harms: E-Cigarettes?



## Stylized Facts

- Cigarette smoking, which is terrible for health, has declined dramatically.
- Cigarette restrictions/regulations are robust.
- E-cigarette use, which has relatively uncertain health effects, has increased, particularly among teens and young adults.
- Traditional tobacco producers have embraced e-cigarettes.
- Many smokers have incorrect information regarding the relative harms of cigarettes and e-cigarettes.

## Stylized Facts

- Cigarette smoking, which is terrible for health, has declined dramatically.
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- Traditional tobacco producers have embraced e-cigarettes.
- Many smokers have incorrect information regarding the relative harms of cigarettes and e-cigarettes.

**Hypothesis:** Incorrect relative risk perceptions may prevent substitution away from cigarettes when relative prices of cigarettes increase.



## Goals:

1. Identify correlation between substitution patterns and biased relative risk perceptions.
2. Incorporate the observed correlation into a model of optimal taxation.
3. Simulate the optimal tax under different substitution patterns.

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## Findings:

1. 56% of survey respondents (smokers) held incorrect beliefs about the relative risks.
2. Correctly informed smokers are 63.4% more likely to respond yes to a question about whether they are open to substituting to e-cigarettes.
3. **Tax Implication:** Larger e-cigarette taxes even when mean substitution is large.

*American Economic Journal: Economic Policy* 2022, 14(4): 1–50  
<https://doi.org/10.1257/pol.20200805>

## Optimal Regulation of E-cigarettes: Theory and Evidence<sup>†</sup>

By HUNT ALLCOTT AND CHARLIE RAKFIN<sup>‡</sup>

*We model optimal e-cigarette regulation and estimate key parameters. Using tax changes and scanner data, we estimate relatively elastic demand. A demographic shift-share identification strategy suggests limited substitution between e-cigarettes and cigarettes. We field a new survey of public health experts who report that vaping is more harmful than previously believed. In our model's average Monte Carlo simulation, these results imply optimal e-cigarette taxes are higher than recent norms. However, e-cigarette subsidies may be optimal if vaping is a stronger substitute for smoking and is safer than our experts report, or if consumers overestimate the health harms from vaping. (JEL D12, D18, D61, H21, H23, I12, I18)*

- Friedman, 2015; Pesko *et al.*, 2016; Tuchman, 2019; Pesko & Courtemanche, 2020; Saffer *et al.*, 2020; Abouk *et al.*, 2020; Cotti *et al.*, 2021.
- Abouk & Adams, 2017; Cotti *et al.*, 2018.

Allcott and Rafkin, (2022) optimal tax: \$3.73/mL

- This paper: optimal tax between \$4 and \$6/mL.
- When cigarettes and e-cigarettes are perfect substitutes, the model without heterogeneity implies a subsidy of \$1.69/mL, but with heterogeneity, the model predicts a tax of \$3.59/mL.

# Theory

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**What we need...** A theory that allows for:

- Externalities
- Internalities
- Multiple product categories
- Dynamics

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**What should the theory produce?**

- Optimal E-Cigarette tax as a function of parameters to be estimated.

**Assume an individual tries to maximize:**

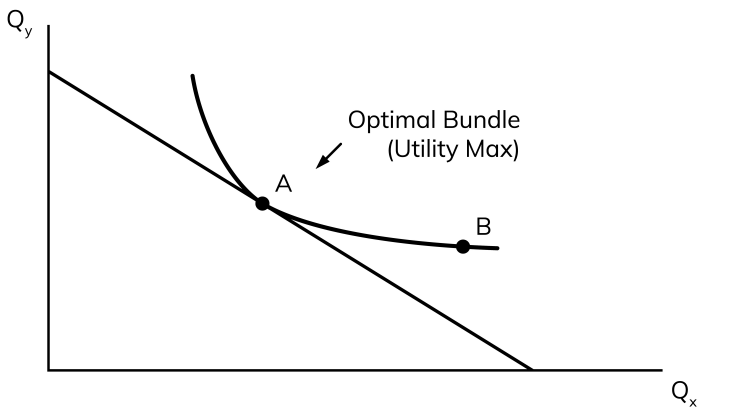
$$U = \sum_{t=0}^{\infty} \delta^t \left( 1 - p(\omega_t = 1 | q_{t-1}, S_{t-1}) \right) \left[ U(q_t; S_t) + q_t^n \right], \quad (1)$$

$$V^*(S_t) = \max_{q_t} \left[ U(q_t; S_t) + q_t^n + \delta \left( 1 - p(\omega_{t+1} = 1 | q_t, S_t) \right) V^*(S_{t+1}) \right] \quad (2)$$



# What is an Internality?

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# What is an Internality in Our Context?

$$\gamma_t^j(p, S_t) = (p^j - \text{Perceived Marginal Utility of Consumption of } j) \neq 0$$

Cost from extra cigarette smoking due to incorrect information and time inconsistency.

# What is an Internality in Our Context?

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## Marginal Distortion

$$\varphi^j = \gamma_t^j(p, S_t) + \psi^j$$

Social planner chooses  $\tau$  to maximize social welfare, defined as:

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In words, the optimal e-cigarette tax is  $\tau^{e*} =$

- *f(elasticity of substitution, marginal uninternalized health impacts)*
  - Greater substitution implies lower e-cigarette tax.
  - Greater internality from imperfect information implies lower e-cigarette tax.
  - Greater internality from time inconsistency or greater externality implies greater e-cigarette tax.

# Data

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Survey posted on *Prolific* on June 1st, 2023, advertising a six-minute survey for current or recent cigarette smokers, and offering an hourly wage of \$15.

- $n = 1,000$  current cigarette smokers.
- Survey respondents were asked about their beliefs regarding the relative harms of e-cigarettes and cigarettes, ranging from “much more harmful” to “much less harmful”.
- Survey respondents also participated in a **stated preference** exercise with a hypothetical change in relative e-cigarette prices.

*We will now ask you about your perceptions of the health effects of tobacco. Compared to smoking cigarettes, would you say that electronic cigarettes are:*

- Much Less harmful
- Less Harmful
- Equally Harmful
- More Harmful
- Much More Harmful

**Incorrect Beliefs:** Equally harmful, More Harmful, Much More Harmful.

# Risk Perceptions

Q9

Compared to someone who never uses tobacco, by how many years do you think lifelong tobacco use would take off someone's life?



# Summary Statistics

**Table 1** Summary statistics

		Incorrect Beliefs	Correct Beliefs		Balance Test	
	Overall	(56.31%)	(43.69%)	<i>p</i> -value	$\chi^2$	<i>p</i> -value
<i>Cigarette and E-Cigarette Behavior</i>						
Daily Smoker	0.628	0.646	0.604	0.191	6.039	0.110
Cigs. > 19/day	0.216	0.203	0.233	0.274	0.804	0.848
# Cigarettes/Day	11.548	11.574	11.515	0.925	104.729	0.191
Current Smoker	0.898	0.902	0.893	0.656	1.136	0.768
Price Paid/Pack	8.068	8.119	8.004	0.785	502.700	0.396
Max. Price/Pack	31.371	32.282	30.197	0.395	83.575	0.584
Ever Tried E-Cigs	0.885	0.861	0.917	0.007	6.850	0.077
Current E-Cig. Use	0.522	0.463	0.597	0.000	6.900	0.075
Daily E-Cig. Use	0.102	0.062	0.153	0.000	6.858	0.077
E-Cig. Share of Days	0.242	0.196	0.302	0.000	26.270	0.196
<i>Years of Longevity Loss from Lifetime:</i>						
Long. Loss Cig	11.973	12.105	11.803	0.362	51.651	0.770
Long. Loss E-Cig	9.343	11.849	6.112	0.000	58.342	0.537

# Summary Statistics

## *Demographic and Socioeconomic Characteristics*

Age in Years	42.411	43.171	41.432	0.030	171.538	0.539
Female	0.460	0.531	0.369	0.000	2.827	0.419
White	0.756	0.727	0.794	0.018	2.285	0.515
Black	0.141	0.177	0.095	0.000	4.038	0.257
Asian	0.031	0.024	0.039	0.206	2.626	0.453
Mixed Race	0.051	0.053	0.049	0.772	1.309	0.727
Other Race	0.021	0.019	0.024	0.566	4.795	0.187
< High School	0.024	0.032	0.015	0.085	1.290	0.731
High School	0.176	0.171	0.182	0.670	1.436	0.697
Some College	0.385	0.395	0.371	0.451	3.476	0.324
College Graduate	0.332	0.326	0.340	0.651	0.435	0.933
Graduate Degree	0.083	0.075	0.092	0.350	1.550	0.671
Employed Full-Time	0.526	0.529	0.522	0.823	3.225	0.358
Annual HH Income	6.459	6.620	6.252	0.220	20.062	0.828



*Have you ever considered, or are you considering, quitting traditional cigarettes and exclusively using electronic cigarettes instead?*

- Yes
- No

	Overall	Incorrect Beliefs (56.31%)	Correct Beliefs (43.69%)	p-value
<i>Preferences</i>				
Open to E-Cig. Subs.	0.509	0.377	0.680	0.000
Immediate Preference	0.706	0.698	0.717	0.213



## Survey Question

*Suppose the price that you currently have to pay for cigarettes increased by \$X. How do you think your current consumption of cigarettes would change?*

- Completely Quit
- Fall by more than half.
- Fall by less than half.
- No Change.
- Increase.

## Survey Question

*If you faced the increase in cigarette prices from the last question, how do you think your consumption of e-cigarettes would change?*

- Large Decrease
- Slight Decrease
- No Change
- Slight Increase
- Large Increase.

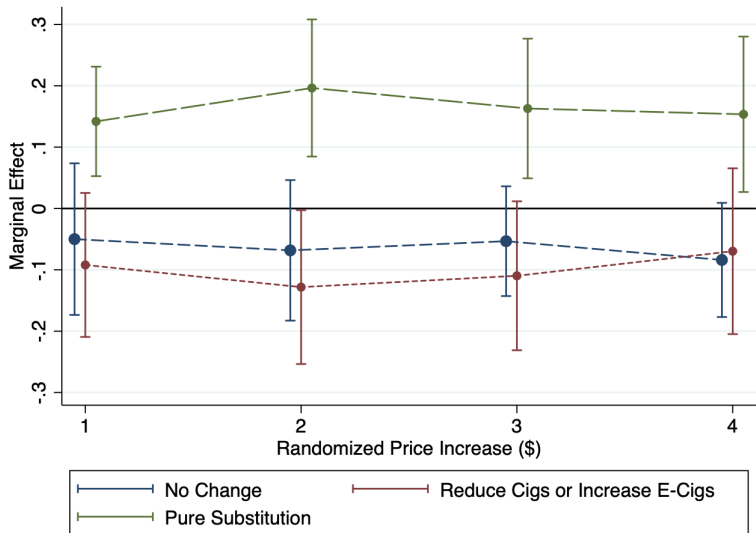
## Dependent Variable

- $d_i = 0 \rightarrow$  no change or an increase in cigarette smoking and no change or a decrease in e-cigarette consumption,
- $d_i = 1 \rightarrow$  a decrease in cigarette consumption or an increase in e-cigarette consumption (but not both),
- $d_i = 2 \rightarrow$  both a decrease in cigarette consumption and an increase in e-cigarette consumption.

## Estimation Equation:

$$\ln \left[ \frac{p(d_i = d)}{p(d_i = 0)} \right] = \lambda_{0d} + \sum_{k=2}^4 \lambda_{k-1d} 1[\text{PriceIncrease}_i = k] + \lambda_{4d} 1[\text{Correct}_i = 1] + \sum_{k=2}^4 \lambda_{k+3d} 1[\text{PriceIncrease}_i = k] 1[\text{Correct}_i = 1] + X_i \lambda_d. \quad (4)$$

# Results



# Optimal Tax

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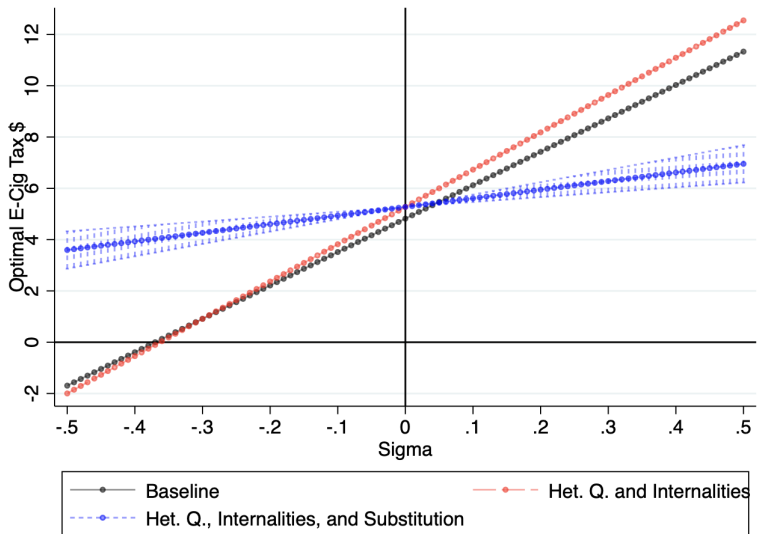
$$\tau^{e*} = \frac{\sum_{\theta} s_{\theta} \eta_{\theta}^e q_{\theta}^e (\varphi_{\theta}^e + \sigma_{\theta} (\varphi_{\theta}^c - \tau^c))}{\sum_{\theta} s_{\theta} \eta_{\theta}^e q_{\theta}^e}, \quad (5)$$

- $s_{\theta}$ : Share of the population of type  $\theta$
- $\eta_{\theta}^j$ : Price elasticity of demand for good  $j$
- $q_{\theta}^j$ : Mean consumption of good  $j$
- $\varphi_{\theta}^j$ : Marginal distortion of good  $j$ .
- $\sigma_{\theta}$ : Substitution parameter
  - $\sigma_{\theta} > 0 \rightarrow$  Complementarity
  - $\sigma_{\theta} < 0 \rightarrow$  Substitutes
- $\tau^j$  Per-unit tax on good  $j$

# Parameters

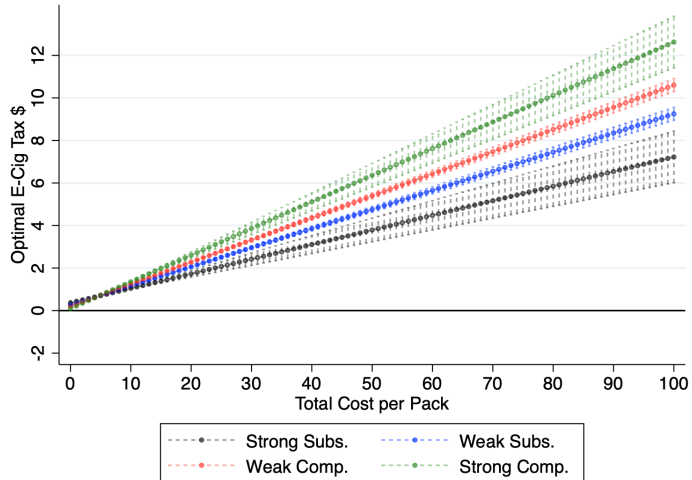
Parameter	Description	Value	Source/Notes
<b>Common Parameters</b>			
$\alpha$	Fraction relative health harms	0.21	Allcott and Rafkin, (2022)
$\Lambda$	E-cig nicotine relative to cigs. (ml/pack)	0.7	Prochaska, Willett
$\Gamma$	Avg. ml/day when vaping	0.58	Allcott and Rafkin, (2022)
$h$	Health care internality	\$52.03	Gruber and Koszegi, (2001)
$\beta$	Present orientation	0.706	Darden, (2024)
$\psi^c$	\$/pack Externality from cigarettes	0.77	DeCicca <i>et al.</i> (2022)
$\tau^c$	\$/pack Cigarette tax	3.04	Tax Policy Center, 2023, U.S. Census
<b>Type Specific</b>			
$s_1$	Fraction with correct information	0.437	Darden, (2024)
$\omega$	Elasticity of sub. scaling	1.576	Darden, (2024)
$\eta^e$	Price Elasticity incorrect and correct info.	-1.318	Allcott and Rafkin, (2022)
$q_0^e$	Share of days vaping incorrect info.	0.196	Darden, (2024)
$q_1^e$	Share of days vaping correct info.	0.302	Darden, (2024)
$\iota$	Information internality proportion	0.178	Parks (2008), Brewer (2016)

# Optimal Policy





# Optimal Policy



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1. Theory says that taxes should depend on the value of externalities, internalities, and the elasticity of substitution.

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2. Evidence suggests:
  - a. Elasticity of substitution is small and internalities from e-cigarettes are small.
  - b. Strong correlation between those substituting and the value of internalities.

## Main Takeaways

1. Theory says that taxes should depend on the value of externalities, internalities, and the elasticity of substitution.
2. Evidence suggests:
  - a. Elasticity of substitution is small and internalities from e-cigarettes are small.
  - b. Strong correlation between those substituting and the value of internalities.
3. Optimal E-cigarette tax is  $\approx$  \$5/ml; typical state tax is \$1.73/ml.
4. Importantly: evidence of substitution is not a rationale for lower taxes if those substituting have incorrect beliefs regarding relative health harms.

# Thanks!

- Comments to  
    [michaeldarden@jhu.edu](mailto:michaeldarden@jhu.edu)
- [medarden.com](http://medarden.com)