The Impact of a Vape Ban on Cigarette Smoking and Life Expectancy

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Disclosure

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No tobacco related funding in last 10 years

Vapes: a controversial tobacco product

- Vapes are believed to be less harmful than cigarettes (CDC, NASEM)
- Vapes may help older smokers quit smoking cigarettes, but may also encourage youth to become addicted and vape/smoke throughout life
- Policymakers have banned the sale of vapes
  - In 34 countries (e.g. India, Brazil, Japan)
  - Within the US (e.g. Massachusetts, San Francisco, Beverly Hills)
- Health harm depends on smoking and vaping persistence and the age of use
  - Smoking at older stages of life is particularly detrimental to life expectancy (Darden et al 2018, Doll et al 2004, Jha et al 2013)

Research question

Q: Would banning the sale of vapes in the US benefit public health?

Key idea: Vape ban $\rightarrow \Delta$ Life cycle profile of tobacco use $\rightarrow \Delta$ Health

Key considerations:

- Substitution between cigarettes and vapes
- Addictiveness of cigarettes and vapes
- Age-specific health effect

This paper

I estimate the impact of a potential US vape ban on smoking behavior and life expectancy

- Document patterns of substitution, addiction, and use over life cycle
    - Panel data on multiple cohorts of youth and adults, cigarette and vape addiction measures

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- Simulate choice over the life cycle with and without a vape ban
- Map life cycle profile of tobacco use to life expectancy
- Compare recommendation to shorter term analyses that do not simulate life cycle choices

Preview of results

Impact of a US vape ban

- Average life expectancy in current US population ↓ by 26 days (total 12M life-years)
- Life expectancy ↓ for all but the youngest cohort (12 to 14 in 2019)

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- Older individuals are more likely to substitute to cigarettes when vapes are banned
  - Effects range from 1% of 14 year old vapers to 75% of 45 year old vapers
- However, vapers who substitute to smoking smoke more persistently than they vaped
- Individuals vape more in youth than in adulthood, so a vape ban prevents vaping earlier in life but generates smoking later

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Shorter term analysis can underestimate long term cumulative health impacts

- Do not fully capture differences in persistent and age-specific health harms between cigarettes and vapes

Related literature

- Impact of vape regulation on smoking
  - Existing state and local policies Abouk Adams 2017, Abouk et al 2023, Cotti et al 2022, Dave Feng Pesko 2019, Friedman 2015, Friedman 2021, Friedman Pesko 2022, Pesko Warman 2022, Pesko 2023, Pesko Currie 2019, Saffer et al 2020
  - Proposed advertising bans and price changes Chen Rao 2020, Tuchman 2019
  - Optimal taxation Allcott Rafkin 2022

    This paper: Impact of national vape ban on tobacco use over life cycle. Implication for life expectancy. Differential impacts on youth and adults.
- Addictive goods: Arcidiacono Sieg Sloan 2007, Becker Murphy 1988, Becker Grossman Murphy 1991, Chaloupka 1991, Choo 2001, Gordon Sun 2015, Gruber Koszegi 2001, Orphanides Zervos 1995, Suranovic Goldfarb Leonard 1999

  This paper: Allow product addictiveness to reflect changing nicotine levels of new good.
- Harm reduction: Burton 2020, Cawley Dragone 2023, Clarke et al 2019, Dave et al 2022, Deza 2015, Doleac Mukherjee 2022, Goonetilleke et al 2023

  This paper: Study health impact of national ban on harm reduction method.
- Unobserved heterogeneity: Heckman Singer 1984, Berry Levinsohn Pakes 1995, Nevo 2001, Pakes et al 2022

  This paper: Application to vape regulation.

Why a national vape ban? Why a structural model?

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  - Authorized 23 vape products, denied >99% of applications, authorization can be rescinded

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- Ideal experiment: Remove option to vape for a random group. Follow control and treatment groups until death

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- Natural experiment: State-level vape bans in 2019
  (Katchmar Gunawan Siegel 2021, Xu et al 2022)
    - Can identify impact of state-level vape ban within time frame and population studied

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- This paper: Impact of national vape ban on life cycle tobacco use and life expectancy

Questions?

Data

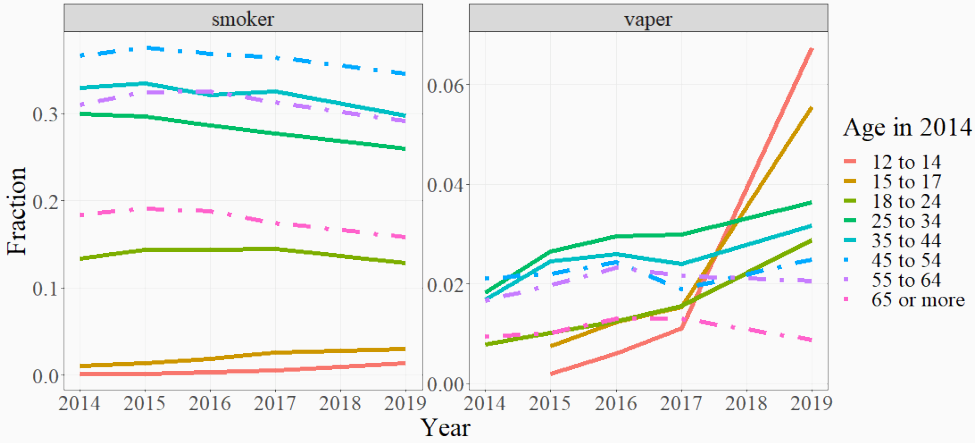
Population Assessment of Tobacco and Health

- Annual panel survey of youth age 12-17 and adults (5 waves, 2014-2019)
  - Entering in 2014: Main cohort age 12 to 65+
  - Entering in 2017: Replenishment cohort age 12 to 65+
  - Entering in other years: Youth age 12-14
- Current consumption: Days smoked and vaped in last 30 days
- Consumption history: Ever tried cigarettes (vapes), smoked 100+ cigs in life, ever vaped regularly
- Addiction: e.g. My use of cigarettes (vapes) is out of control (1-5)
- Health: e.g. high blood pressure, asthma, lung cancer, reported health
- Demographics: Age, education, race, sex, census region (midwest, south, northeast, west)

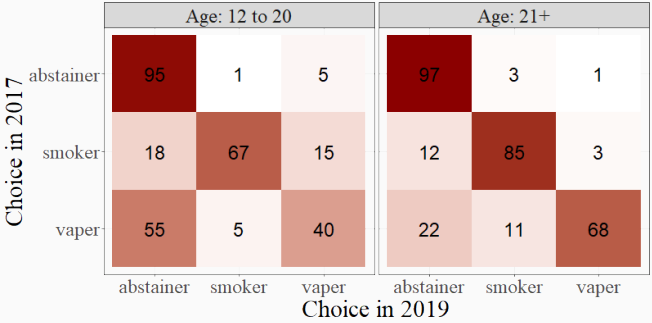
Nielsen Retail Measurement Services

- Cigarette and vape prices at census region level, 2014-2019

Smoking prevalent among ages 25-54, vaping prevalent among youth

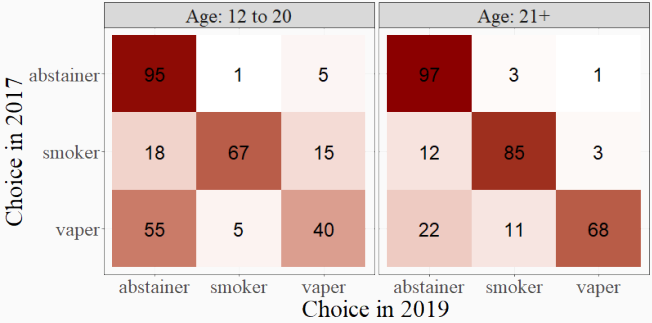


Vaping appears less addictive than smoking



- More young abstainers transition to vaping than smoking
- However, more young vapers transition to abstaining than continue vaping
- In contrast, more young smokers continue smoking than transition to abstaining
- Smoking and vaping are persistent but smoking is more persistent than vaping

Vapers are more likely than abstainers to transition to smoking



- Vapers are more likely than abstainers to transition to smoking
- If vaping caused smoking, vape regulation should also decrease smoking
- However, natural experiments find that vape regulation increases smoking
- Possible explanation: individuals who like to vape also like to smoke

How is addiction measured?

- 5 survey responses measuring addiction to $j \in \{\text{cigarettes,vapes}\}$.
  - Do you ever have strong cravings for j? (0 no, 1 yes)
  - I frequently crave j. (1 not at all - 5 extremely like me)
  - Have you ever felt like you really needed to use j? (0 no, 1 yes)
  - My j use is out of control. (1 not at all - 5 extremely like me)
  - I find myself reaching for j without thinking about it. (1 not at all - 5 extremely like me)
- Reduced to first component from Multiple Correspondence Analysis, $A^c, A^v \in [0, 1]$
- Cigarette (vape) addiction available for individuals who smoked (vaped) this or last year
- Allows products to change in addictiveness over time in addiction model

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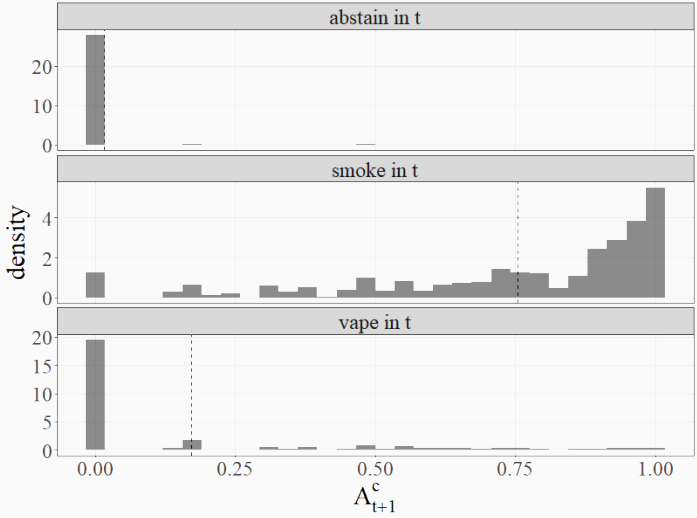
- Cigarette (vape) addiction available for individuals who smoked (vaped) this or last year
  - Assume no addiction if don't use for 2 years
- Allows products to change in addictiveness over time in addiction model

Cigarette addiction is high for smokers and low for non-smokers



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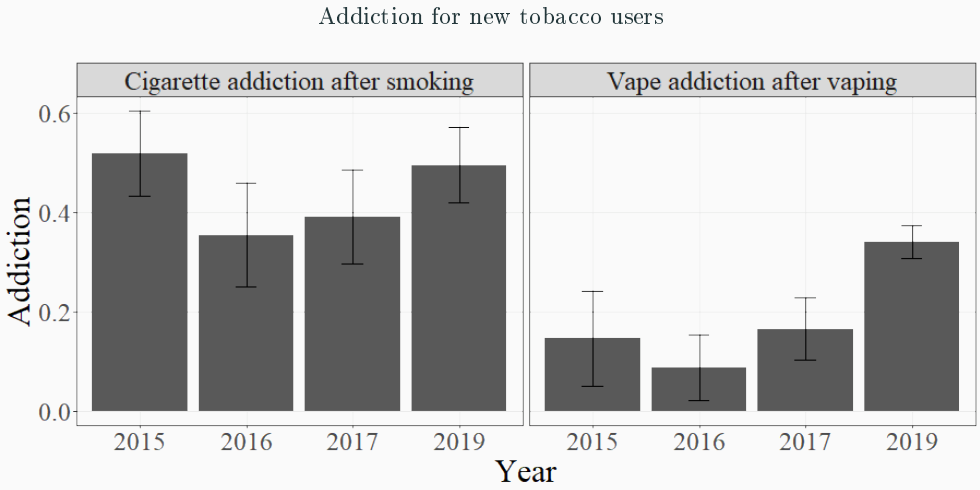
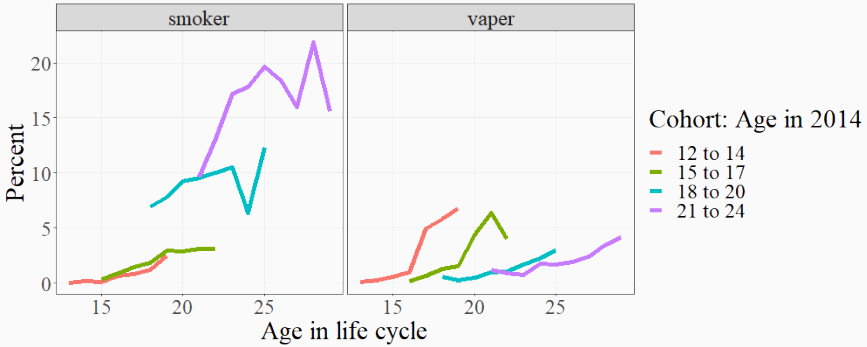


At the same age, younger cohorts smoke less and vape more



Data summary: Implications for a vape ban

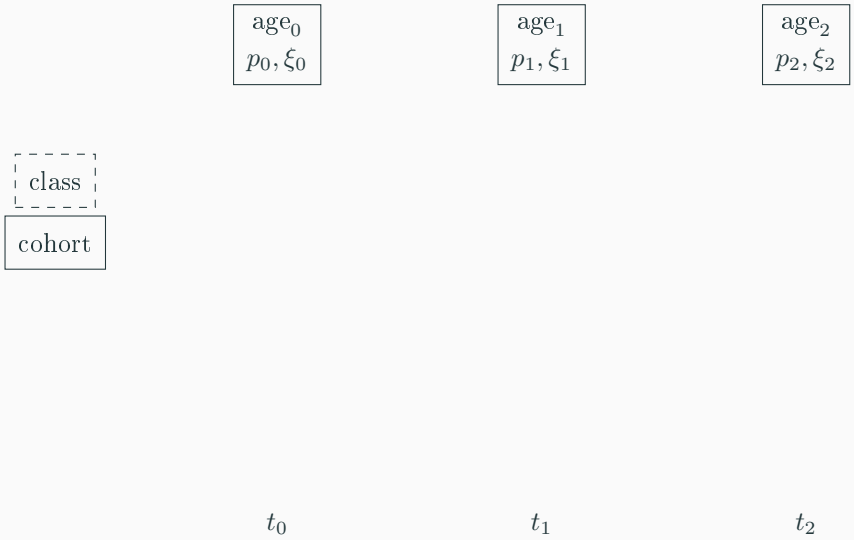
- Vapers may not vape for long
- Vapers who switch to smoking may smoke longer than they would have vaped
- Vapers are more likely than abstainers to transition to smoking. 2 explanations:
  1. Gateway effect $\rightarrow$ Vape ban prevents future vaping and smoking
  2. Correlated taste for vaping and smoking $\rightarrow$ Vape ban drives vapers to smoke
- As they age, young cohorts will vape more and smoke less than current adults

Model framework

Individuals' choices are driven by personal and product characteristics

- Observable to researcher: addiction, choice last year, ever tried cigarettes, health, demographics, prices, product attractiveness in year t
- Unobservable to researcher: Inherent propensity to enjoy cigarettes and vapes
    - Model two classes of individuals who differ in unobservable taste for cigarettes and vapes

Model



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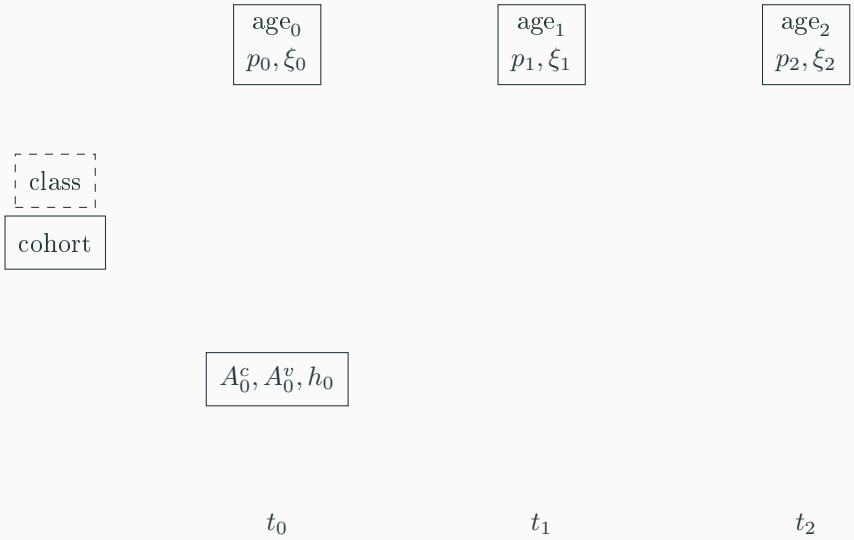
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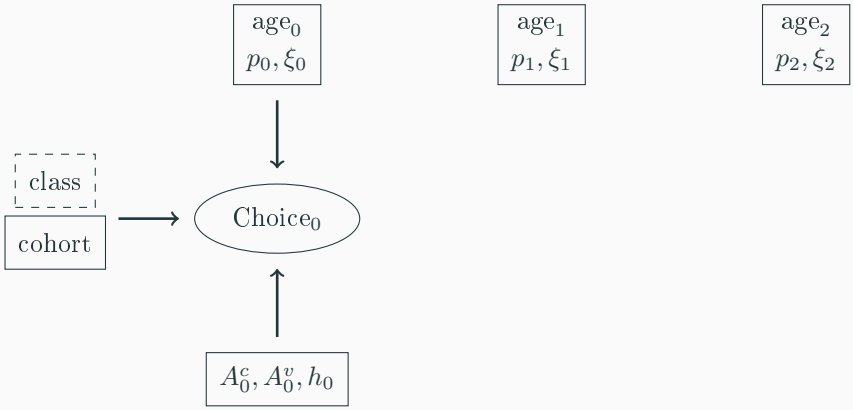
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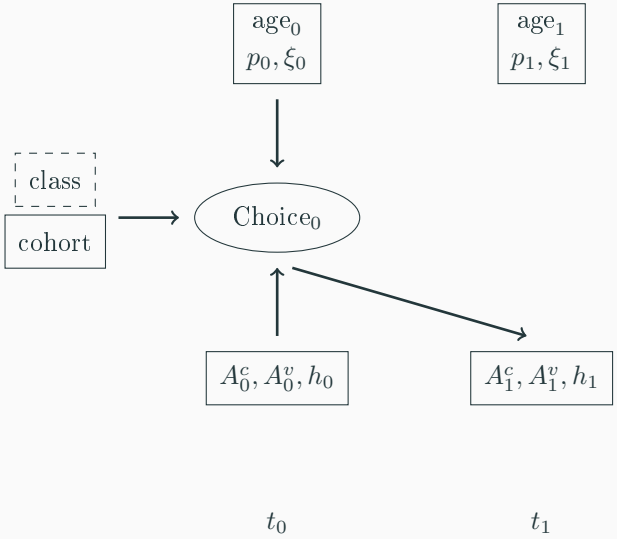
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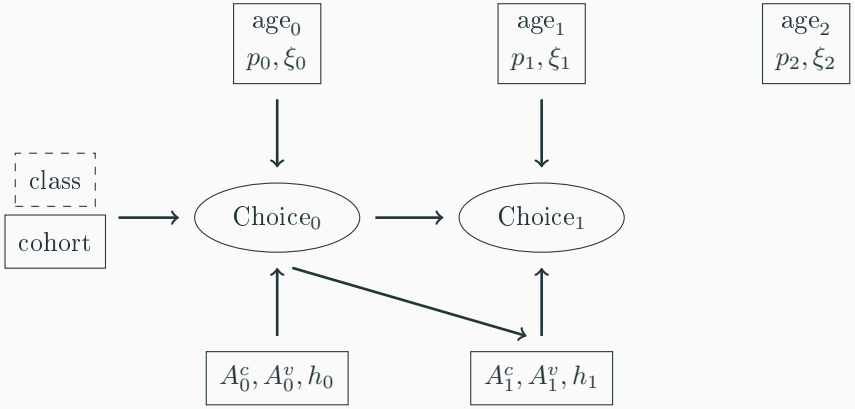
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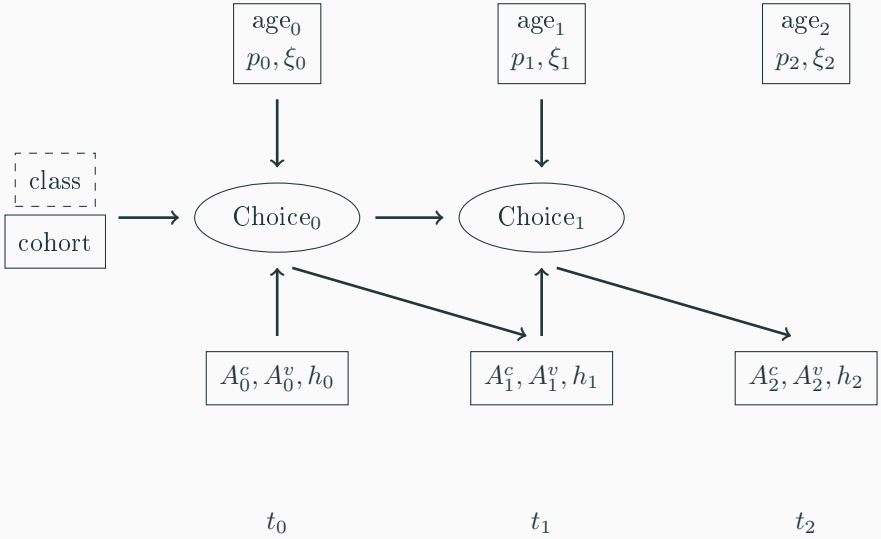
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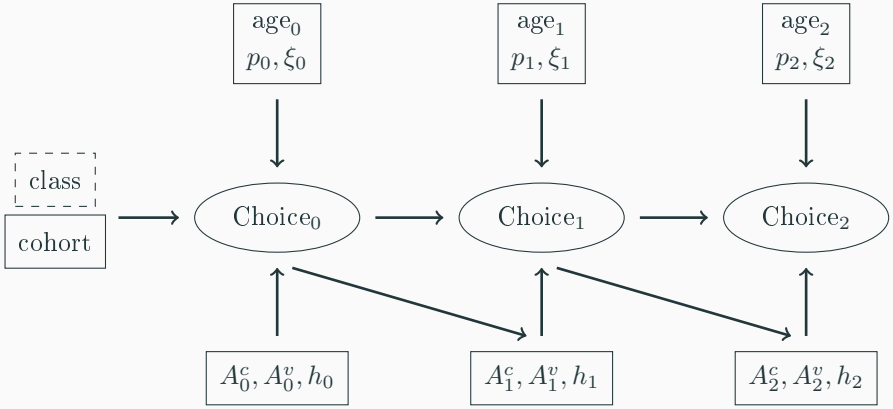
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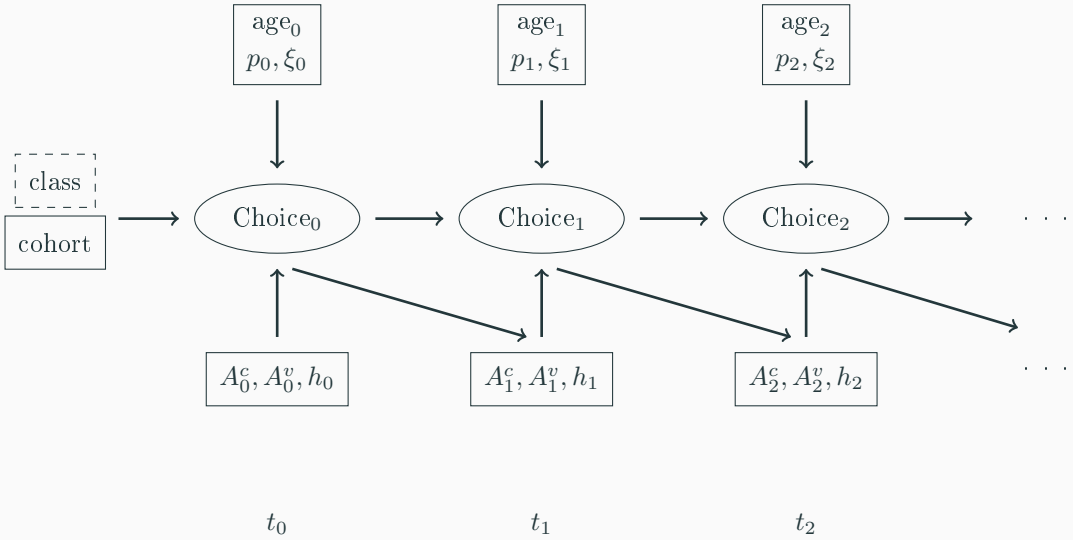
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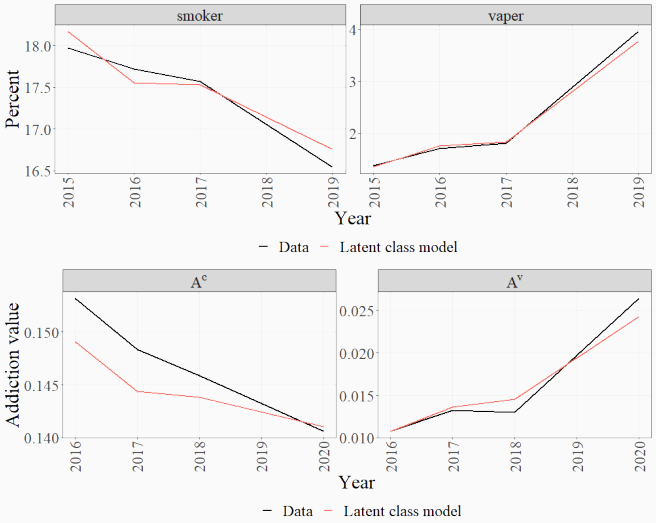
Model fit


smoker
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17.0
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2017
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2019
Year
Data
Latent class model
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A^v
Addiction value
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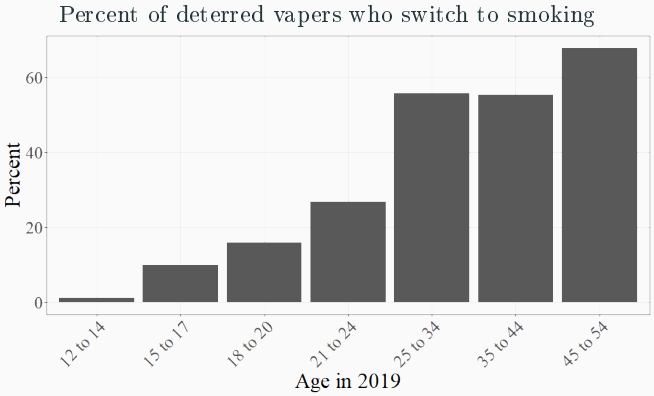
0.145
0.140
0.025
0.020
0.015
0.010
2016
2017
2018
2019
2020
Year
Data
Latent class model

Questions?

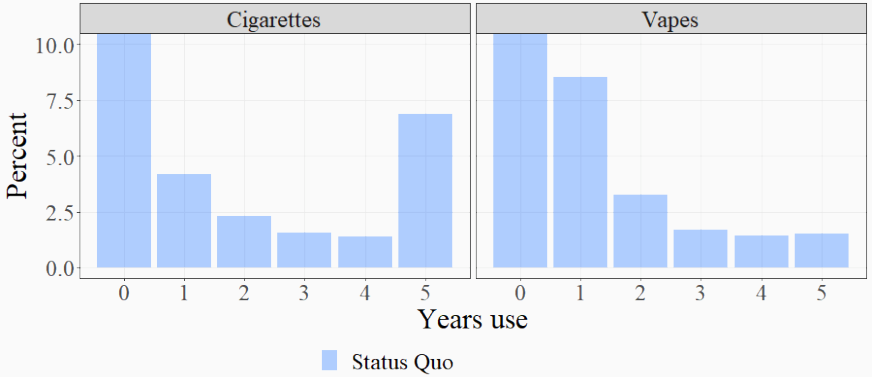
Counterfactuals

- Cohort of individuals age 12+ in 2019
- Fix price and product quality (FE) at 2019 levels
- Simulate future choices with and without a 2019 vape ban over 1 year, 5 years, life cycle
- Map tobacco life cycle profile to life expectancy

1 year after ban: Older vapers are more likely to switch to smoking



5 years after ban: Temporary vaping ↓ and persistent smoking ↑



- Most vape use is temporary

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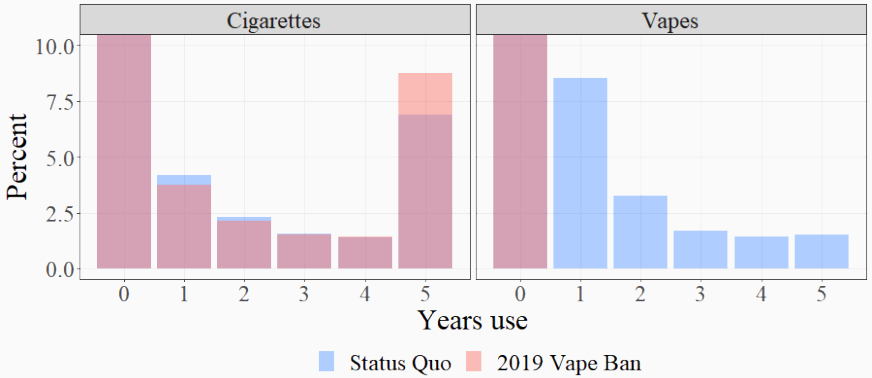


- Of individuals that now smoke all 5 years, 15% increased the number of years they smoked by more than the decrease in number of years they vaped

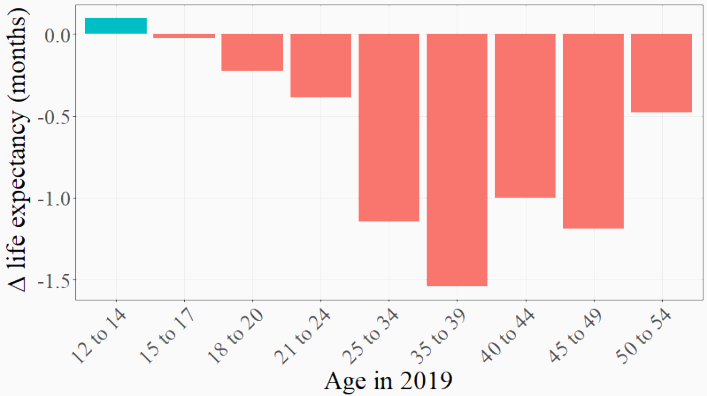
Calculating life expectancy

- Map Δ persistence and age of tobacco use over life cycle to Δ life expectancy
  - Smokers that quit before 40 have similar life expectancy as never smokers (Darden et al 2018, Doll et al 2004, Jha et al 2013, Pirie et al 2013)
  - Darden et al (2018): Smoking from 18 to death decreases life expectancy by 4.3 years
- I focus on tobacco use from age 49-59
- Assumptions
  - Smoking and vaping before age 40 does not decrease life expectancy
  - Starting at age 40, each year of smoking decreases life expectancy by 1.6 months

$$\Big(\underbrace{1.6/12}_{\text{annual harm}} \times \underbrace{(75.5 - 39 - 4.3)}_{\text{years smoked}} = \underbrace{4.3}_{\text{total harm}} \Big)$$

  - Each year of vaping decreases life expectancy by 1.6 * RR months (Relative Risk of harm)
  - RR = .25 from survey of tobacco scholars (Allcott Rafkin 2022)
  - Pattern of smoking and vaping from 55-59 persists until death

Vape ban decreases life expectancy for all but the youngest cohort



- For youngest cohort, benefit from decreased vaping outweighs increase in smoking
- Across cohorts, life expectancy decreases by 26 days on average (12M life-years total)

Among vapers Table

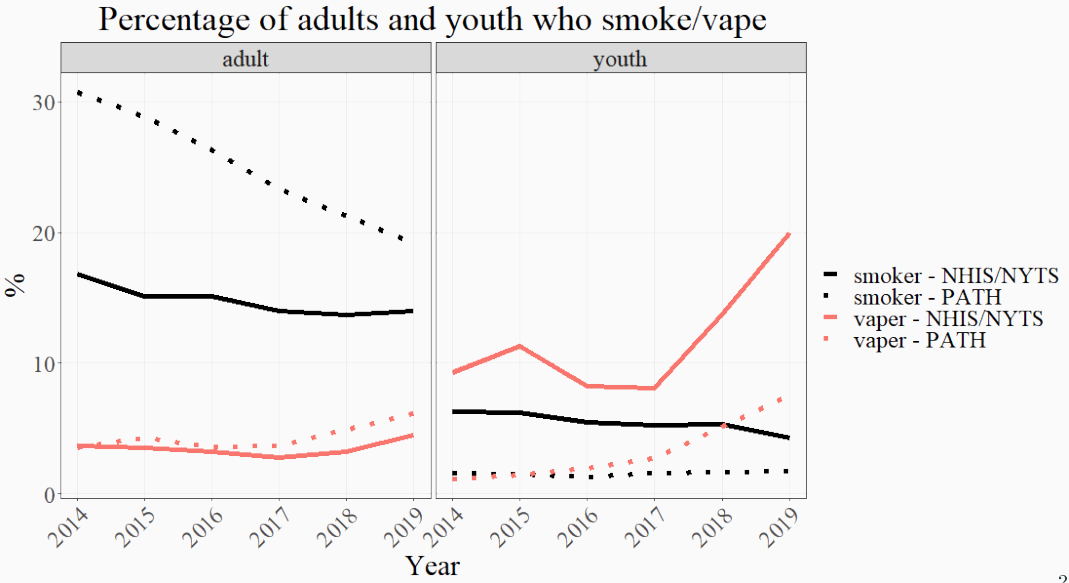
Implications for other vape regulations

- Subsidizing vapes for existing smokers may improve health (eg prescription model)
- Flavor bans may improve life expectancy if only young cohorts enjoy flavors
- Next steps: Alternative policies
  - Nicotine product standards
  - Taxes and subsidies
    - IV using state taxes, minimum age of sale laws
  - Prescription model
    - Vapes available when individual meets threshold for cigarette addiction

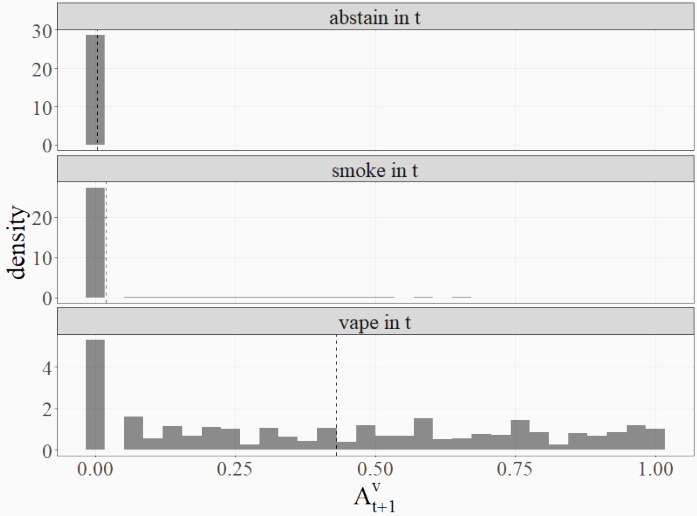
Conclusion

- I develop and estimate a dynamic panel model of cigarette and vape demand
- I simulate the effect of a vape ban on tobacco use over the life cycle and life expectancy
- A vape ban would not improve average life expectancy
  - Decrease of 26 days on average (12M life-years total), assuming vapes are 25% as harmful as cigarettes
  - Life expectancy decreases for all but the youngest cohort
- Vape regulation should consider persistence and age of tobacco use over the life cycle
  - Shorter term analyses would underestimate the negative impact of a vape ban

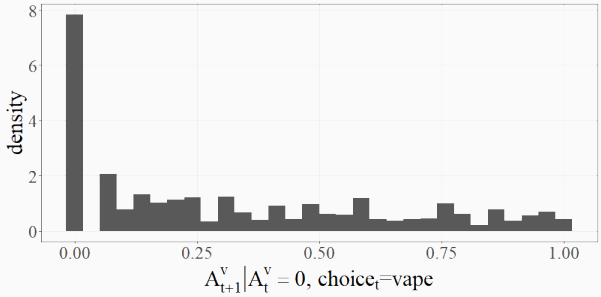
PATH vs other national surveys



Vape addiction distribution



Vape addiction transition



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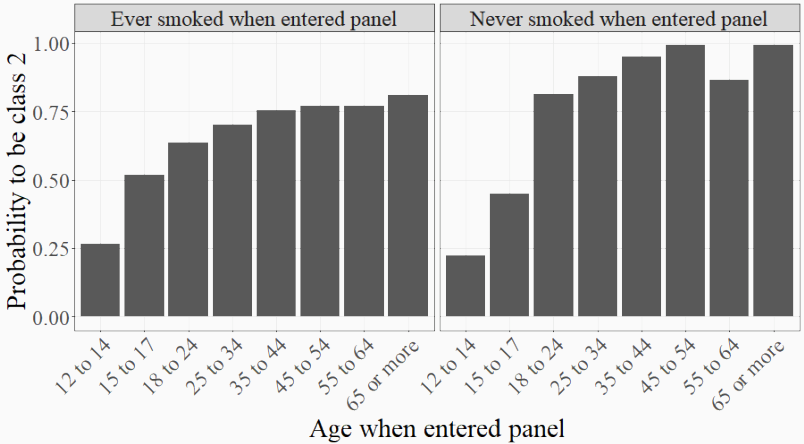
Choice Estimates

		Latent Class Model			
Coefficient Type	Variable	Class 1		Class 2	
Cigarette and vape utility	price	0.01	(0.3)	-0.27	(0.26)
Cigarette utility	intercept	-7.63***	(1.98)	-5.92***	(1.85)
	ever try cigarette$_{t-1}$	2.63***	(0.2)	2.93***	(0.26)
	smoker$_{t-1}$	1.31***	(0.13)	5.85***	(0.25)
	vaper$_{t-1}$	0.61**	(0.25)	3.68***	(0.23)
	A_t^c	1.73***	(0.13)	4.7 ***	(0.33)
	A_t^v	0.92**	(0.37)	1.44***	(0.51)
	bh$_t$	-0.11	(0.34)	1.1 **	(0.53)
	2019	-0.39***	(0.13)	-0.81***	(0.23)
Vape utility	intercept	-6.19***	(1.32)	-4.59***	(1.28)
	ever try cigarette$_{t-1}$	1.41***	(0.12)	1.19***	(0.22)
	smoker$_{t-1}$	0.59**	(0.24)	3.78***	(0.25)
	vaper$_{t-1}$	0.29	(0.37)	5.68***	(0.22)
	A_t^c	1.24***	(0.29)	3.83***	(0.33)
	A_t^v	2.11***	(0.48)	3.98***	(0.46)
	bh$_t$	-1.35	(1.1)	-0.27	(0.6)
	2019	2.36***	(0.31)	-0.48	(0.28)

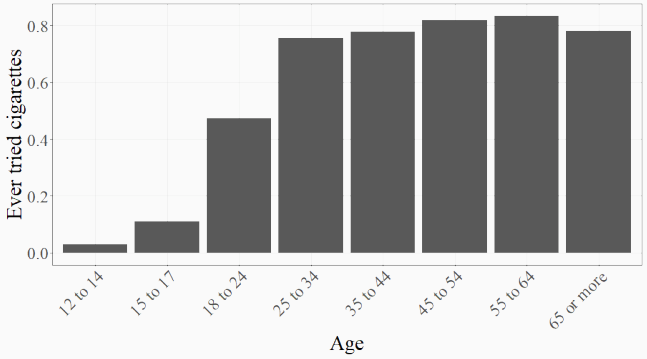
Class probability

Younger cohorts are more likely to be in class 1, and strongly prefer vapes over cigarettes



◂ Interpretation

Ever tried cigarettes when enter panel × Age when enter panel



◂ Interpretation ◂ Class probability

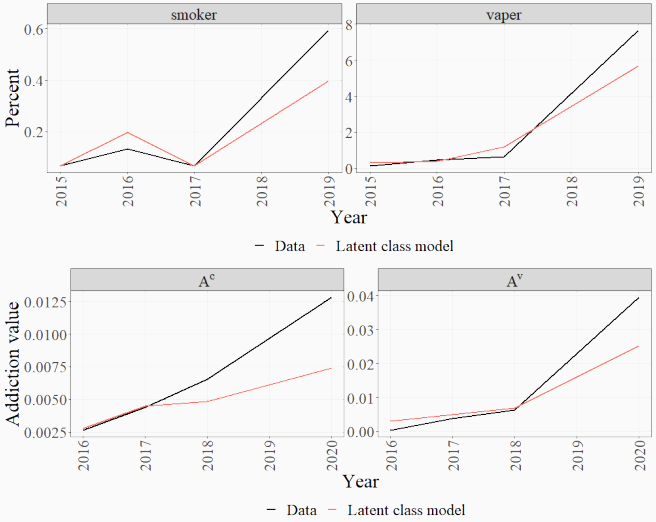
Vape addiction estimates

	$P(A^v_{t+1} > 0)$	$A^v_{t+1} \mid A^v_{t+1} > 0$
	Logistic	*OLS*
	(1)	(2)
Constant	-6.52^{***} (0.14)	0.25^{***} (0.03)
ever tried vape_{t-1}	2.30^{***} (0.07)	0.02 (0.02)
smoke_t	2.66^{***} (0.21)	0.06 (0.05)
vape_t	7.53^{***} (0.24)	0.11^{**} (0.04)
A^v_t	6.38^{***} (0.27)	0.22^{***} (0.04)
$\text{smoke}_t \times$ ever tried vape_{t-1}	-0.39^{**} (0.15)	-0.04 (0.04)
$\text{vape}_t \times$ ever tried vape_{t-1}	-2.40^{***} (0.15)	-0.02 (0.02)
$\text{smoke}_t \times \text{A}^v_t$	-1.58^{***} (0.32)	0.03 (0.05)
$\text{vape}_t \times \text{A}^v_t$	-2.48^{***} (0.49)	0.18^{***} (0.04)
Age FE	*Y*	*Y*
Age-choice interaction	*Y*	*Y*
Year FE	*Y*	*Y*
Year-choice interact	*Y*	*Y*
Observations	111,286	4,296
R^2		0.28
Log Likelihood	-9,264.20	

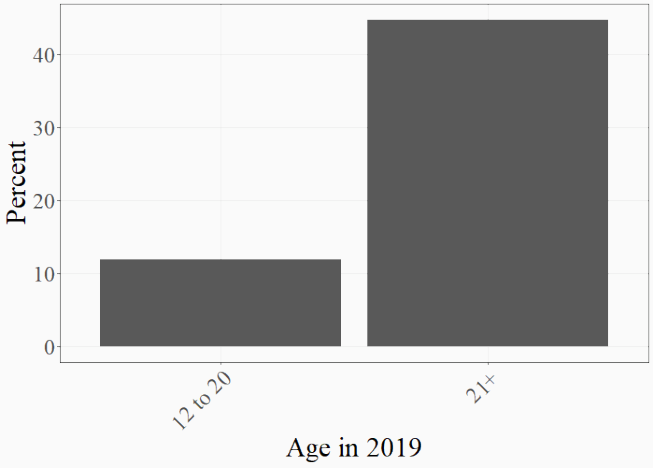
*p<0.05; **p<0.01; ***p<0.001

Note: Reference age is 18-24 and reference year is 2015.

Model fit: Cohort age 15-17 in 2019



Short run: Older vapers are more likely to switch to smoking



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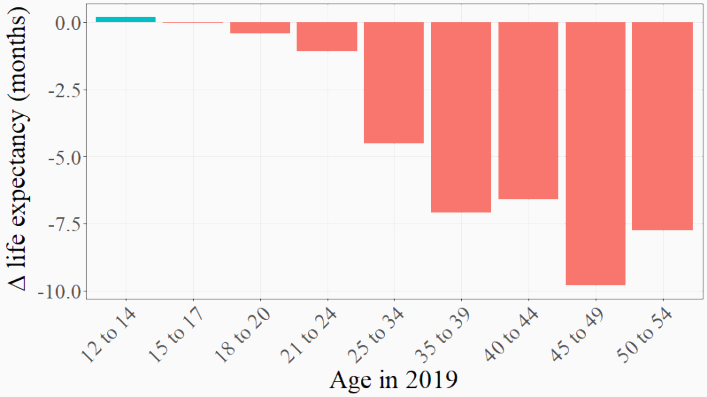
Older vapers lose several months of life expectancy



Many older individuals would not have vaped, but among older vapers, life expectancy decreases by up to 10 months

◂ Average

Vape ban decreases life expectancy for all but the youngest cohort

	Avg change in years vaped		Avg change in years smoked		Avg change in months lived
Age in 2019	Before age 40	Age 40-59	Before age 40	Age 40-59	RR = .25
12 to 14	-3.4	-3.0	0.6	0.7	0.10
15 to 17	-3.3	-2.8	0.6	0.7	-0.03
18 to 20	-2.6	-2.0	0.5	0.6	-0.23
21 to 24	-1.1	-0.6	0.3	0.3	-0.39
25 to 34	-0.5	-0.4	0.3	0.6	-1.15
35 to 39	-0.1	-0.8	0.1	0.8	-1.54
40 to 44	0.0	-0.6	0.0	0.5	-1.00
45 to 49	0.0	-0.4	0.0	0.4	-1.19
50 to 54	0.0	-0.2	0.0	0.1	-0.48

- Vaping prevents more vaping before middle age than during middle age
- Vape ban generates more smoking in middle age than before middle age

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