The Effect of Smokeless Tobacco Excise taxes on Use among US Youth

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What is smokeless tobacco (SLT)?

- Smokeless tobacco (SLT) is tobacco that isn't burned or inhaled by the user, including :
  - Chewing (spit) tobacco
  - Snuff (moist/dry)
    - Moist snuff is more common
  - Snus ("spitless" moist powder, often in a pouch; form of moist snuff)
  - Dissolvable tobacco (least common)

Loose Chewing Tobacco

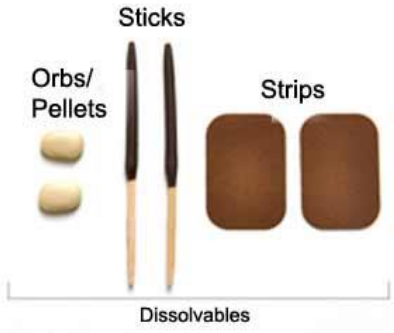
Plug Chewing Tobacco

Moist snuff

Dry snuff

Snus

Sources: CDC (2021) & FDA (2018)



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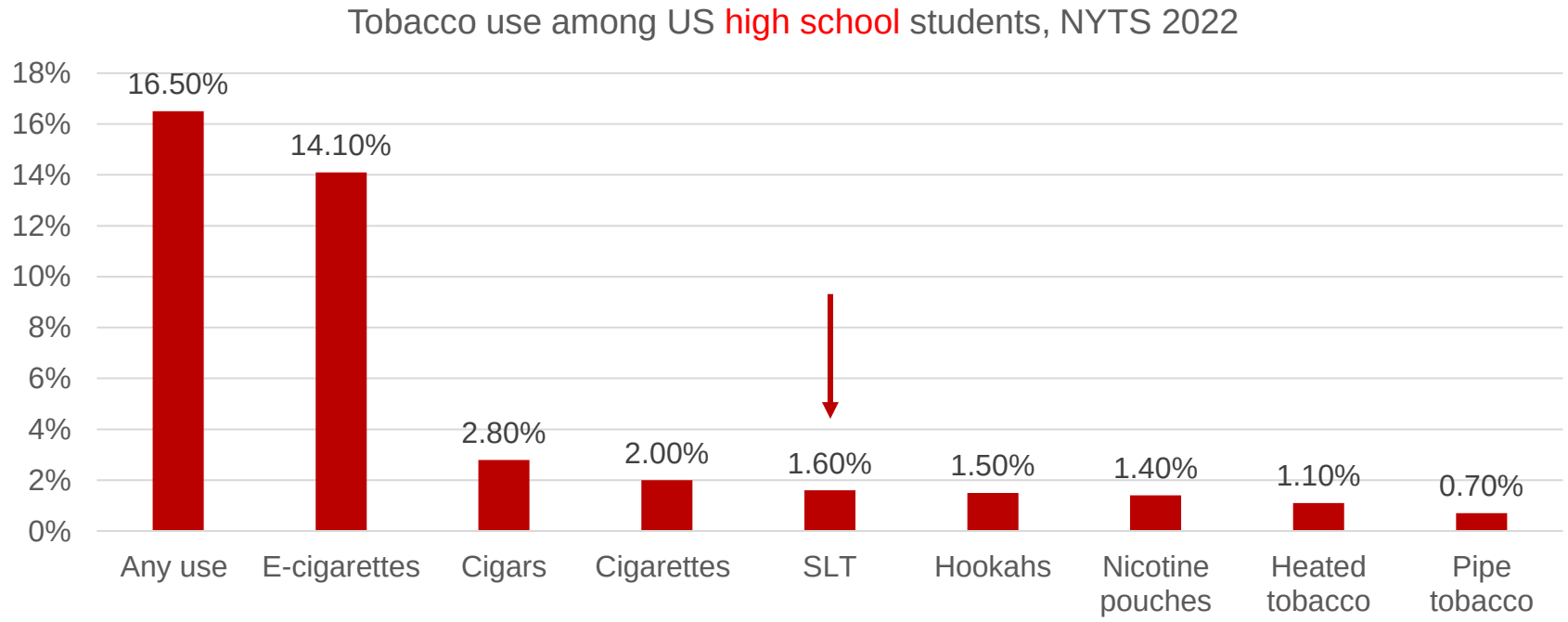
SLT harms and prevalence

- Smokeless tobacco is not a safe alternative to smoking (CDC, 2020)
  - Nicotine addiction
  - Risks for early delivery and stillbirth if used during pregnancy
  - Risks for cardiovascular diseases
- SLT use can pose significant health risks, including a higher incidence of oral, pharyngeal, and esophageal cancer (International Agency for Research on Cancer 2007)
- SLT use prevalence in the United States:
  - 2.3% (or 5.7 millions) of adults were SLT users in 2020 (NHIS, 2020)
  - 0.7% and 1.6% among middle and high school students, respectively in 2022 (NYTS 2022)

SLT remains a relatively popular product among youth



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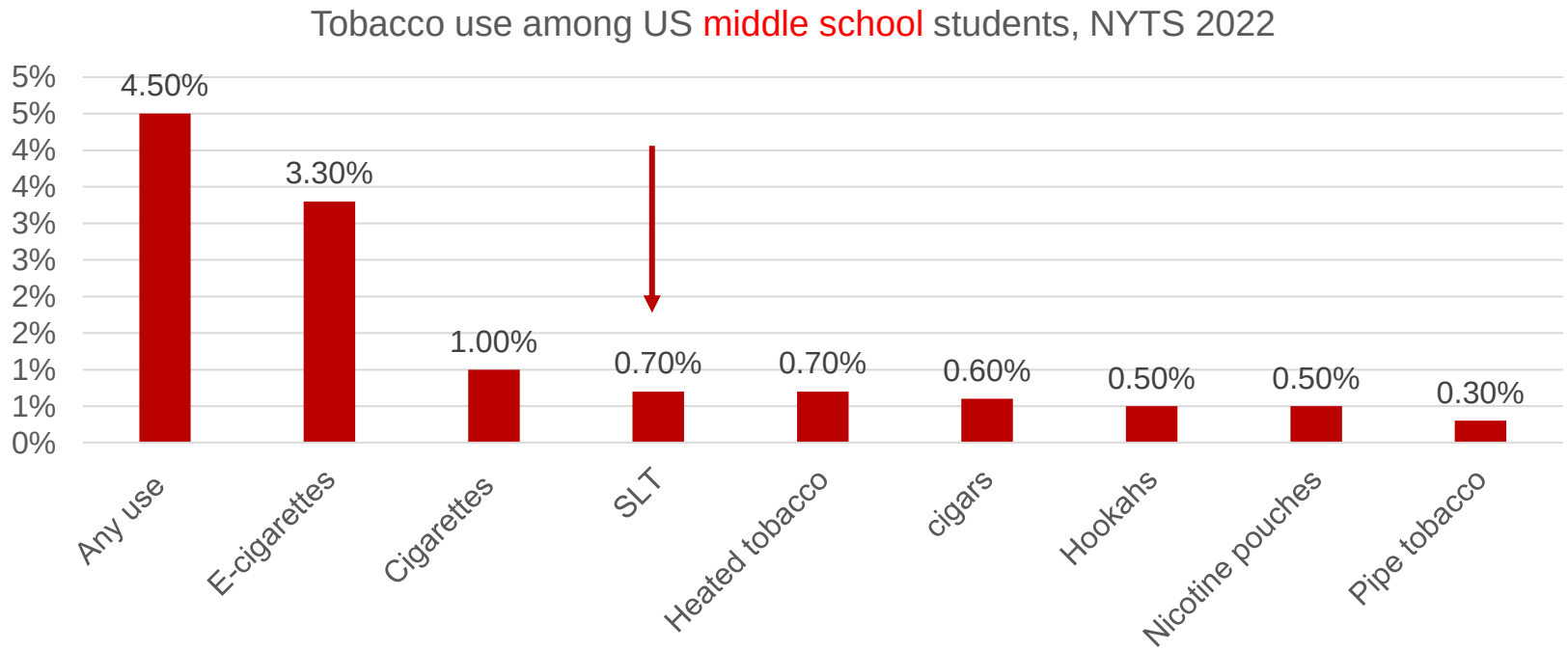
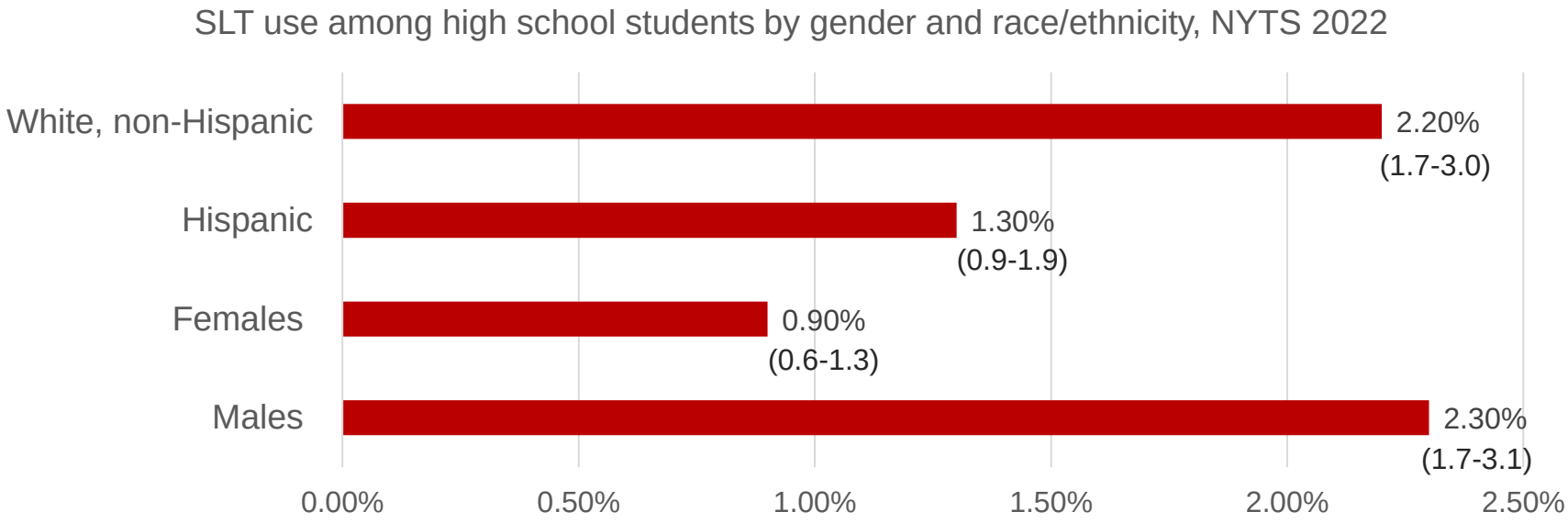


SLT use pattern among youth



Note: 95% CI in brackets

SLT use patterns

- SLT use is higher among certain demographic groups (CDC, 2022, Zavala-Arciniega et al. 2023):
  - Males
  - Non-Hispanic American Indian, Alaska Native, Non-Hispanic White
  - Young adults
- Co-use of SLT and cigarettes is high:
  - Nearly 1 of every 10 (9.3%) of young adults (ages 18-24) who smoked cigarettes also reported using SLT (MMWR, 2022)

Pricing/taxing policies could be effective to curb SLT use

- Own price/tax elasticities
  - (price) Sales data (Nielsen IQ) evidence in recent years:
    - -0.53 (overall), -1.28 (small markets), -0.51 (large markets) (Zheng et al. 2017)
    - -0.6 to -1.1 (moist snuff); -9.2 to 0.1 (dry snuff); -0.1 to -2.5 (chewing tobacco); -0.4 to -1.3 (snus) (Huang et al. 2018)
  - (tax) Survey data evidence:
    - For adult use, mostly ranged from -0.1 to -0.6. Implied price elasticities ranged from -0.2 to -1.0 (Dave and Saffer 2013; Ohsfeldt et al. 1994; Ohsfeldt et al. 1997; Ohsfeldt et al. 1999; Levy et al. 2018; Jawad et al. 2018)
    - For youth use, ranged from -0.1 to -1.8 (Chalpoupka et al. 1997; Tauras et al. 2007; Huang et al. 2012)

Economic relationship between SLT and other tobacco products

- The relationship between SLT and cigarettes is empirically debatable:
  - Cigarettes and SLT are substitutes (Cotti et al., 2016; Ohsfeldt et al., 1998, 1997; Oshfeldt and Boyle, 1994)
  - Cigarettes and SLT are complements (Bask and Melkersson, 2003; Da Pra and Arnade, 2009; Dave and Saffer, 2013; Nguyen et al., 2012; Tauras et al., 2007; Zheng et al., 2017; Huang et al. 2018).
- The relationship between SLT and popular substances other than cigarettes is less studied:
  - E-cigarettes
  - Beer

Evidence gaps on the impact of SLT taxes on youth SLT use in the US

- The US tobacco marketplace has evolved dramatically, with e-cigarettes becoming the most popular tobacco product among US youth
- The prevalence of SLT use among US high school students, particularly male students, is currently as high as cigarette smoking
- However…
  - Most existing evidence dates prior to 2015 (i.e., before e-cigarettes became significantly popular among youth in the US)
  - The economic relationship (i.e., substitutability vs. complementarity) between SLT and tobacco products other than cigarettes is less understood
  - Method limitations (i.e., relied on correlational evidence)

Objective of this study

- Estimating the own and cross tax elasticities of SLT use among US youth:
  - Use recent data from YRBS (2007-2019)
  - Explicitly test how SLT use changes in response to taxes on SLT, cigarettes, e-cigarettes, and beer
  - Examine how SLT use responds to taxes on different types of SLT (chewing tobacco, moist/dry snuff, snus)
  - Examine heterogeneity by sex and race/ethnicity

Data

- Outcome:
  - SLT use prevalence
    - CDC Youth Risk Behavior Surveillance System (YRBS) 2007-2019
    - Biennial nationally representative survey of 9^{th}-12^{th} graders
    - The past 30-day use of any type of SLT products
- Explanatory variable:
  - Mean standardized SLT excise taxes ($/ounce)
    - For chewing tobacco, moist snuff, dry snuff, and snus
    - CDC State Tobacco Activities Tracking and Evaluation (STATE) system
    - State-year level mean price of each type of SLT (Nielsen Retail Scanner Data 2007-2019)
    - Convert the ad valorem tax into the specific tax amount
    - Use the 20% markup rate (Chaloupka & Tauras, 2020)
    - Adjusted for inflation using 2010 dollars

Control variables

- Other state-level controls:
  - Cigarette excise taxes ($/pack)
    - CDC State Tobacco Activities Tracking and Evaluation (STATE) system / Tax Burden on Tobacco
    - Adjusted for inflation using 2010 dollars
  - Standardized beer excise taxes ($/gallon)
    - Per gallon of beer with a 5% alcohol concentration and sold off-premises for each state during 2007-2019: Alcohol Policy Information System (APIS)
    - Adjusted for inflation using 2010 dollars
  - Standardized e-cigarette excise taxes ($/ml)
    - Specific tax per e-liquid ml (Cotti et al., 2021)
    - Assume 35% markup rate
    - Adjusted for inflation using 2010 dollars

Control variables

- Medical/recreational cannabis legalization
  - ProCon (2023), Insurance Institute for Highway Safety (2023)
- Seasonally adjusted unemployment rate
  - Bureau of Labor Statistics

- Demographics:
  - Sex, grade, race/ethnicity

- Final analytical sample:
  - 95,595 observations total
  - 2007-2019 (bi-annual)

Analytical Model

- Logit model (two-way fixed effects framework):
  - $SLT\ Use_{ist} = \alpha + \beta Mean\ SLT\ Tax_{st} + X_{ist}\gamma + Z_{st}\lambda + \delta_s + \theta_t + u_{ist}$

where:

- i: individual, s: state, t: year
- $SLT\ Use_{ist}$: any SLT use of a youth individual
- $Mean\ SLT\ Tax_{st}$: mean of standardized SLT taxes across types for state s in year t
- δ_s & θ_t: state and year fixed effects
- u_{ist}: disturbance term clustered at the state level
- β: coefficient of interest; Odds ratio (OR) is reported for interpretation but also elasticities estimated

- Sub-population analyses stratified by:
  - Sex
  - Race/ethnicity

[Pause for questions]

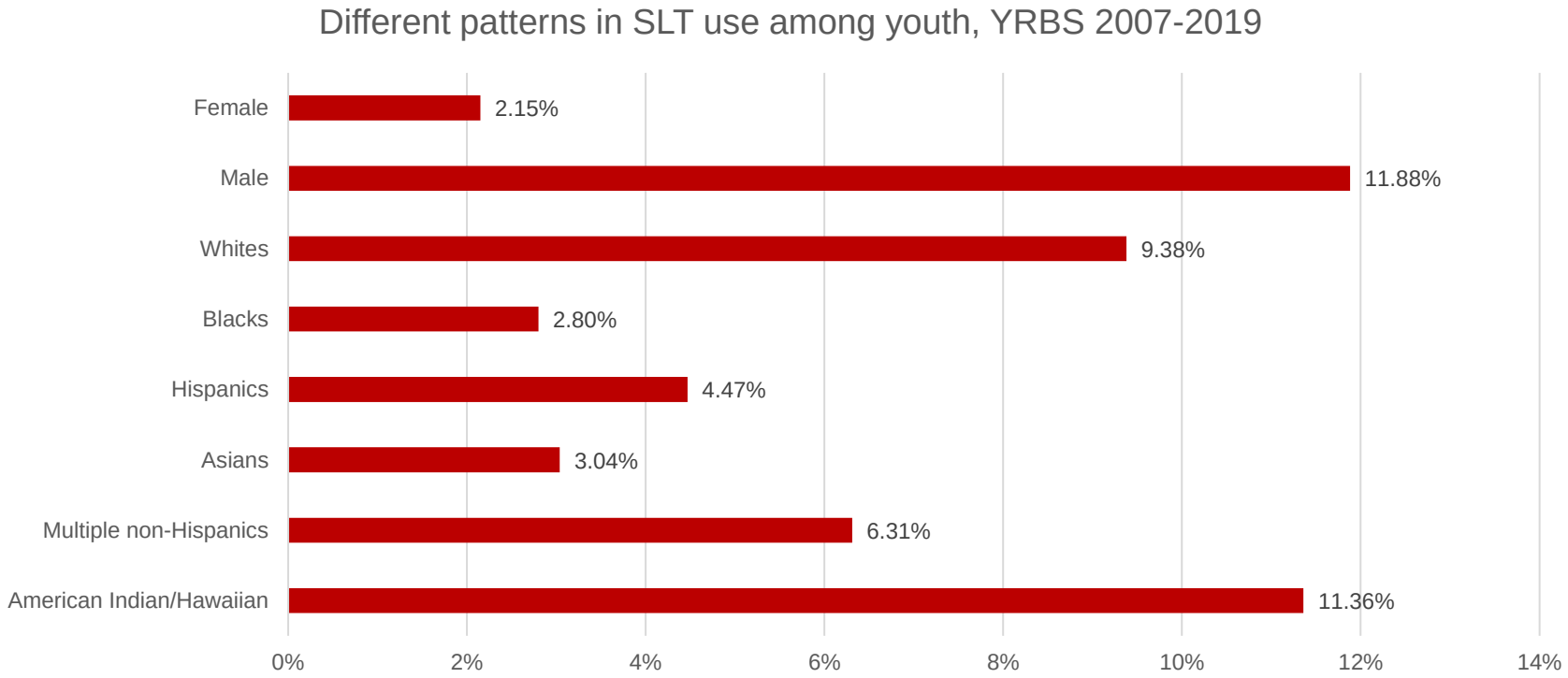
Summary statistics

Table 1: Summary statistics – YRBS between 2007 and 2019 (N = 95,595)

Variables	Mean	Std. Dev.	Min	Max
Outcome variable				
Any SLT use	0.071	0.257	0.000	1.000
SLT taxes				
Average SLT tax ($/ounce)	0.826	0.599	0.000	2.441
Chewing tobacco tax ($/ounce)	0.493	0.360	0.000	1.754
Moist snuff tax ($/ounce)	0.728	0.668	0.000	3.570
Dry snuff tax ($/ounce)	0.727	0.539	0.000	1.968
Snus tax ($/ounce)	1.356	1.014	0.000	4.830
Other state-level variables				
Cigarette tax ($/pack)	1.387	0.874	0.149	4.221
Beer tax ($/gallon)	0.254	0.244	0.052	1.185
Std. e-cigarette tax ($/ml)	0.075	0.333	0.000	2.109
RCL	0.076	0.265	0.000	1.000
MCL	0.414	0.490	0.000	1.000
SA Unemployment rate (%)	6.459	2.439	2.558	13.317
Demographics				
Female	0.492	0.500	0.000	1.000
Male	0.508	0.500	0.000	1.000
Grade - 9th	0.275	0.446	0.000	1.000
Grade - 10th	0.258	0.438	0.000	1.000
Grade - 11th	0.238	0.426	0.000	1.000
Grade - 12th	0.229	0.420	0.000	1.000
White	0.563	0.496	0.000	1.000
Black	0.138	0.345	0.000	1.000
Hispanic	0.209	0.406	0.000	1.000
Asian	0.035	0.184	0.000	1.000
Multiple Non-Hispanic Races	0.041	0.199	0.000	1.000
American Indian/Hawaiian	0.014	0.117	0.000	1.000

Note: Data were weighted using YRBS's sample weight. $ tax values adjusted for inflation using 2010 dollars. State unemployment rate was seasonally adjusted. RCL: recreational cannabis legalization, MCL: medical cannabis legalization, SA: seasonally adjusted.

SLT use pattern among youth in the US



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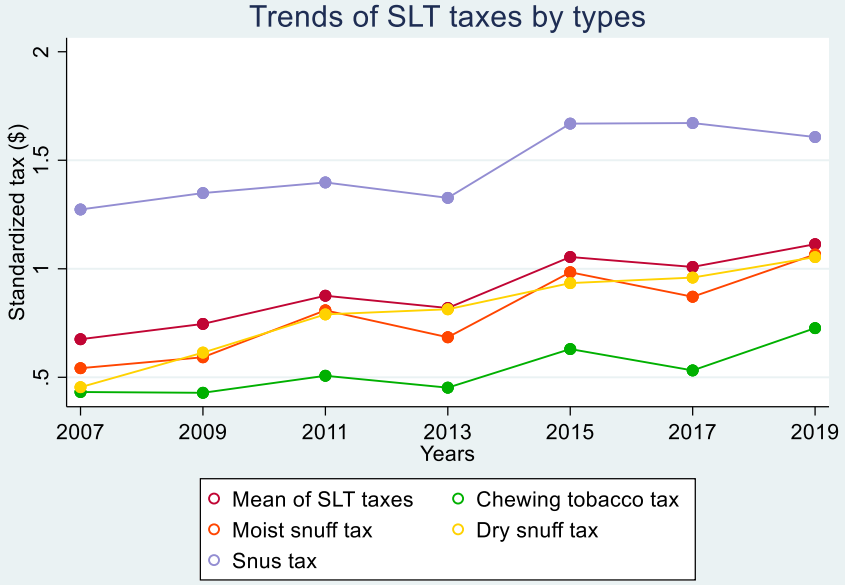
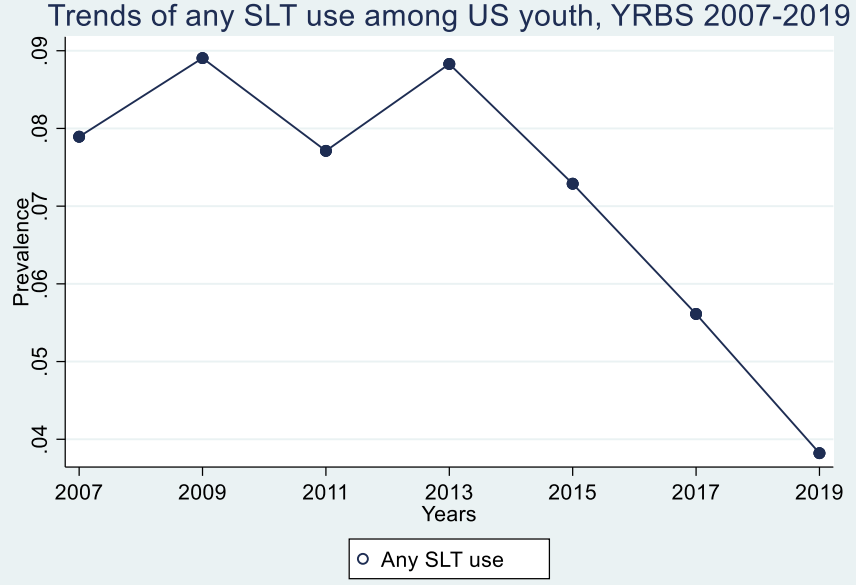
Trends of different SLT taxes and any SLT use in the US





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Main results: Impact of SLT tax on SLT use

Table 2: The effect of average SLT tax on any SLT use among youth.

Variables	Model 1	Model 2	Model 3	Model 4
	Any SLT use	Any SLT use	Any SLT use	Any SLT use
Average SLT tax	0.670***	0.823	0.491**	0.486**
	(0.000)	(0.489)	(0.016)	(0.011)
	[0.571 - 0.787]	[0.473 - 1.430]	[0.275 - 0.875]	[0.279 - 0.846]
	<-0.313>	<-0.153>	<-0.554>	<-0.561>
Cigarette tax			1.669**	1.672**
			(0.016)	(0.013)
			[1.099 - 2.535]	[1.113 - 2.513]
			<0.667>	<0.670>
Beer tax			0.456***	0.444***
			(0.000)	(0.000)
			[0.368 - 0.566]	[0.318 - 0.619]
			<-0.185>	<-0.192>
Std. E-cigarette tax			0.417***	0.418***
			(0.000)	(0.000)
			[0.272 - 0.638]	[0.275 - 0.636]
			<-0.063>	<-0.063>
Demographics	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
State fixed effects	N	Y	Y	Y
State-level controls	N	N	Y	Y
State specific linear trend	N	N	N	Y
State	42	42	42	42
Observations	96,006	96,006	95,595	95,595

Note: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors clustered at the state level. YRBS 2007-2019 data were weighted using YRBS's sample weights. Coefficients reported are odds ratio. p-values, confidence intervals, and elasticities are reported in parentheses, square brackets, and angel brackets, respectively. All the tax variables were adjusted for inflation using 2010 dollars.

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			<-0.063>	<-0.063>
Demographics	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
State fixed effects	N	Y	Y	Y
State-level controls	N	N	Y	Y
State specific linear trend	N	N	N	Y
State	42	42	42	42
Observations	96,006	96,006	95,595	95,595

Own elasticity

Substitutes

Complements

Complements

Note: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors clustered at the state level. YRBS 2007-2019 data were weighted using YRBS's sample weights. Coefficients reported are odds ratio. p-values, confidence intervals, and elasticities are reported in parentheses, square brackets, and angel brackets, respectively. All the tax variables were adjusted for inflation using 2010 dollars.

Main results: Impact of different SLT taxes on SLT use

Table 3: The effect of different SLT taxes on any SLT use among youth.

Variables	Model 1	Model 2	Model 3	Model 4
	Any SLT use	Any SLT use	Any SLT use	Any SLT use
Chewing tobacco tax	0.723	0.460	0.473***	0.445***
	(0.166)	(0.153)	(0.001)	(0.004)
	[0.458 - 1.143]	[0.158 - 1.336]	[0.307 - 0.728]	[0.258 - 0.768]
Moist snuff tax	0.971	0.906	0.946	0.933
	(0.856)	(0.654)	(0.667)	(0.631)
	[0.708 - 1.331]	[0.589 - 1.394]	[0.733 - 1.220]	[0.705 - 1.237]
Dry snuff tax	1.748***	2.152***	1.509***	1.546***
	(0.003)	(0.004)	(0.000)	(0.000)
	[1.216 - 2.513]	[1.272 - 3.641]	[1.240 - 1.837]	[1.290 - 1.853]
Snus tax	0.663***	0.527**	0.425***	0.429***
	(0.000)	(0.012)	(0.000)	(0.000)
	[0.550 - 0.799]	[0.319 - 0.869]	[0.332 - 0.545]	[0.331 - 0.555]
Cigarette tax			1.787***	1.783***
			(0.000)	(0.000)
			[1.403 - 2.278]	[1.408 - 2.258]
Beer tax			0.491***	0.477***
			(0.000)	(0.000)
			[0.396 - 0.608]	[0.339 - 0.671]
Std. E-cigarette tax			0.457***	0.460***
			(0.000)	(0.000)
			[0.335 - 0.624]	[0.342 - 0.619]
Demographics	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y
State fixed effects	N	Y	Y	Y
State-level controls	N	N	Y	Y
State specific linear trend	N	N	N	Y
State	42	42	42	42
Observations	96,006	96,006	95,595	95,595

Note: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors clustered at the state level. YRBS 2007-2019 data were weighted using YRBS's sample weights. Coefficients reported are odds ratio. p-values and confidence intervals are reported in parentheses and square brackets, respectively. All the tax variables were adjusted for inflation using 2010 dollars.

Sub-population analyses: by sex

Table 4: The effect of average SLT tax on any SLT use by sex

Variables	Model 1: female	Model 2: male
	Any SLT use	Any SLT use
Average SLT tax	1.015	0.422***
	(0.953)	(0.010)
	[0.624 - 1.651]	[0.219 - 0.813]
Cigarette tax	1.391**	1.734**
	(0.019)	(0.033)
	[1.055 - 1.835]	[1.045 - 2.876]
Beer tax	0.208***	0.495***
	(0.000)	(0.000)
	[0.118 - 0.368]	[0.399 - 0.614]
Std. E-cigarette tax	0.435***	0.405***
	(0.000)	(0.001)
	[0.308 - 0.615]	[0.239 - 0.686]
State	39	42
Observations	47,998	47,222

Note: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors clustered at the state level. YRBS 2007-2019 data were weighted using YRBS's sample weights. Coefficients reported are odds ratio. p-values and confidence intervals are reported in parentheses and square brackets, respectively. All the tax variables were adjusted for inflation using 2010 dollars. For sub-population analyses, we focus on our preferred specification, Model 3 of Table 2.

Sub-population analyses: by race/ethnicity

Table 5: The effect of average SLT tax on any SLT use by race/ethnicity

Variables	Model 1: White	Model 2: Black	Model 3: Hispanic	Model 4: Asian	Model 5: Multiple non-Hispanic	Model 6: American Indian/Hawaiian
	Any SLT use	Any SLT use	Any SLT use	Any SLT use	Any SLT use	Any SLT use
Average SLT tax	0.374***	2.981*	0.640	1.302	0.729	0.378
	(0.007)	(0.095)	(0.158)	(0.740)	(0.619)	(0.160)
	[0.183 - 0.764]	[0.826 - 10.751]	[0.345 - 1.189]	[0.273 - 6.206]	[0.209 - 2.539]	[0.097 - 1.470]
Cigarette tax	1.938***	0.678	1.663*	1.558	1.173	1.309
	(0.007)	(0.400)	(0.098)	(0.346)	(0.762)	(0.591)
	[1.200 - 3.128]	[0.274 - 1.676]	[0.910 - 3.038]	[0.620 - 3.915]	[0.416 - 3.306]	[0.490 - 3.494]
Beer tax	0.482***	0.252***	0.120***	1.961	0.147***	0.075
	(0.000)	(0.000)	(0.000)	(0.686)	(0.000)	(0.725)
	[0.339 - 0.685]	[0.127 - 0.502]	[0.049 - 0.295]	[0.075 - 51.251]	[0.074 - 0.294]	[0.000 - 140,776.166]
Std. E-cigarette tax	0.397***	0.176	0.285***	0.600	0.135**	0.827
	(0.000)	(0.115)	(0.002)	(0.769)	(0.029)	(0.848)
	[0.257 - 0.614]	[0.020 - 1.528]	[0.127 - 0.636]	[0.020 - 18.125]	[0.022 - 0.819]	[0.117 - 5.836]
State	40	36	39	32	38	33
Observations	41,781	17,005	26,621	3,585	4,187	1,819

Note: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors clustered at the state level. YRBS 2007-2019 data were weighted using YRBS's sample weights. Coefficients reported are odds ratio. p-values and confidence intervals are reported in parentheses and square brackets, respectively. All the tax variables were adjusted for inflation using 2010 dollars. For sub-population analyses, we focus on our preferred specification, Model 3 of Table 2.

Conclusion

- Research question:
  - SLT tax elasticity and cross elasticities of youth SLT use
- Major findings:
  - $1 increase in mean SLT tax is associated with reduced any SLT use among youth (OR = 0.491, $p < 0.05$)
  - Own tax elasticity: -0.554
  - Cross tax elasticity (cig tax): 0.667 (substitutes)
  - Cross tax elasticity (beer tax): -0.185 (complements)
  - Cross tax elasticity (ecig tax): - 0.063 (complements)
  - Heterogeneity in the impact of SLT tax by demographics

Conclusion

- Policy implications:
  - Increasing SLT excise taxes remains effective in reducing SLT use among youth
  - Given that e-cigarettes and beer are economic complements for SLTs, increasing excise taxes on these products will reduce SLT use
  - Cigarettes and SLT are found to be substitutes, continuing to increase cigarette taxes may increase SLT use among youth

- Future approach:
  - Staggered nature of state SLT taxes
    - Local event study given continuous treatment

Questions?

- Contact information
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