

ARE E-CIGARETTES SUBSTITUTES OR COMPLEMENTS TO COMBUSTIBLE CIGARETTES AMONG YOUTHS? NEW EVIDENCE FROM CANADA

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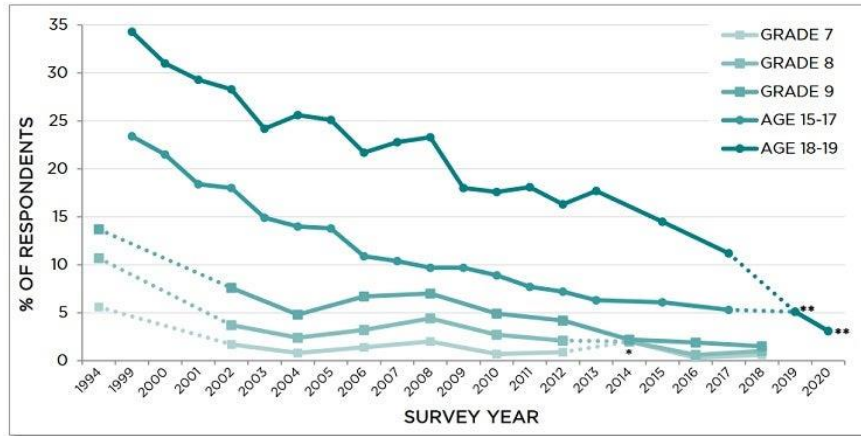
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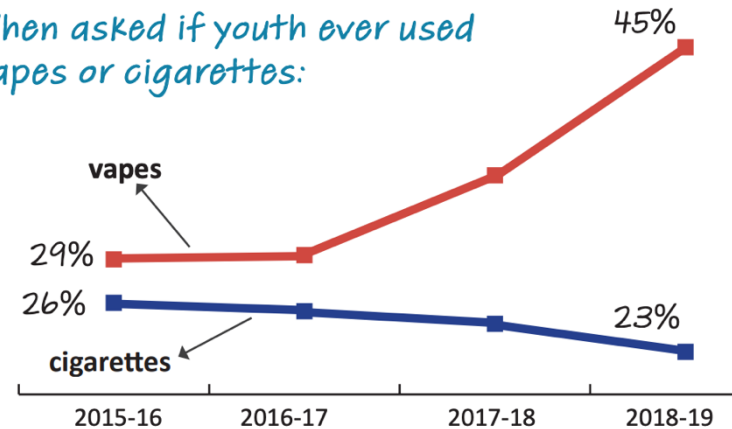
E-cigarettes vs Combustible cigarettes: Substitutes or Complements??

FIGURE 7.4: CURRENT SMOKING PREVALENCE¹ BY GRADE/AGE, GRADES 7-9 AND AGE 15-19, 1994-2020



¹FOR GRADES 7-9: CURRENT DAILY/NON-DAILY SMOKER AND SMOKED IN PAST 30 DAYS; FOR AGE 15-19: CURRENT DAILY OR NON-DAILY SMOKER
 *EXACT ESTIMATES SUPPRESSED IN 2014 DUE TO UNACCEPTABLE QUALITY. THE UPPER BOUNDS FOR THE ESTIMATES ARE LESS THAN 2%.
 **IN 2019 AND 2020, AGE GROUPS 15-17 AND 18-19 COMBINED DUE TO LOW NUMBERS
 DATA SOURCES: CANADIAN TOBACCO USE MONITORING SURVEY (CTUMS), 1999-2012; CANADIAN TOBACCO, ALCOHOL AND DRUGS SURVEY (CTADS), 2013, 2015, 2017; CANADIAN TOBACCO AND NICOTINE SURVEY (CTNS), 2019, 2020; YOUTH SMOKING SURVEY (YSS), 1994, 2002, 2004-05, 2006-07, 2008-09, 2010-11, 2012-13; CANADIAN STUDENT TOBACCO, ALCOHOL AND DRUGS SURVEY (CSTADS), 2014-15, 2016-17, 2018-19

When asked if youth ever used vapes or cigarettes:



Source: https://www.publichealthontario.ca/-/media/documents/y/2021/youth-health-trends-vaping.pdf?sc_lang=en

Decline in smoking started before e-cig introduced

BUT

But recent declines in smoking larger & No resurgence in smoking alongside increased vaping

Existing Literature

Effects of E-cigarette MLA

- **Early studies** (Friedman 2015, Pesko et al 2016) used **aggregate state-level data**
 - Found **e-cigarette MLA laws increase cigarette use**
 - E-cigarettes and cigarettes **substitutes**
- **Later studies** used **individual level data**, found **mixed results**
 - Reduction in cigarette use (Abouk & Adams 2017; Dutra et al. 2018)
 - Increase in cigarette use (Dave et al. 2019; Pesko 2023)

Existing Literature

Broader literature on 'substitution vs complementarity' debate

- Cigarette and E-cigarette taxes (Cotti et al. 2018, 2020; Pesko and Warman, 2017, 2021; Pesko et al., 2020; Saffer et al., 2020; Abouk et al., 2021; He et al. 2024)
- Ban on ENDS in Massachusetts (Xu et al. 2022; Chen et al. 2024)
- E-cigarette flavor bans (Saffer et al. 2024; Cotti et al. 2024)
- **Mixed conclusions depending on nature of policy & age group, although most studies point towards substitution**

No study has teased out effects on both smoking initiation and cessation

Smoking Initiation vs Smoking Cessation



Smoking initiation among youth never-smokers

- 'Gateway hypothesis': discourage smoking initiation by reducing e-cig use
- OR
- More likely to initiate smoking when e-cig unavailable



Smoking cessation among existing smokers

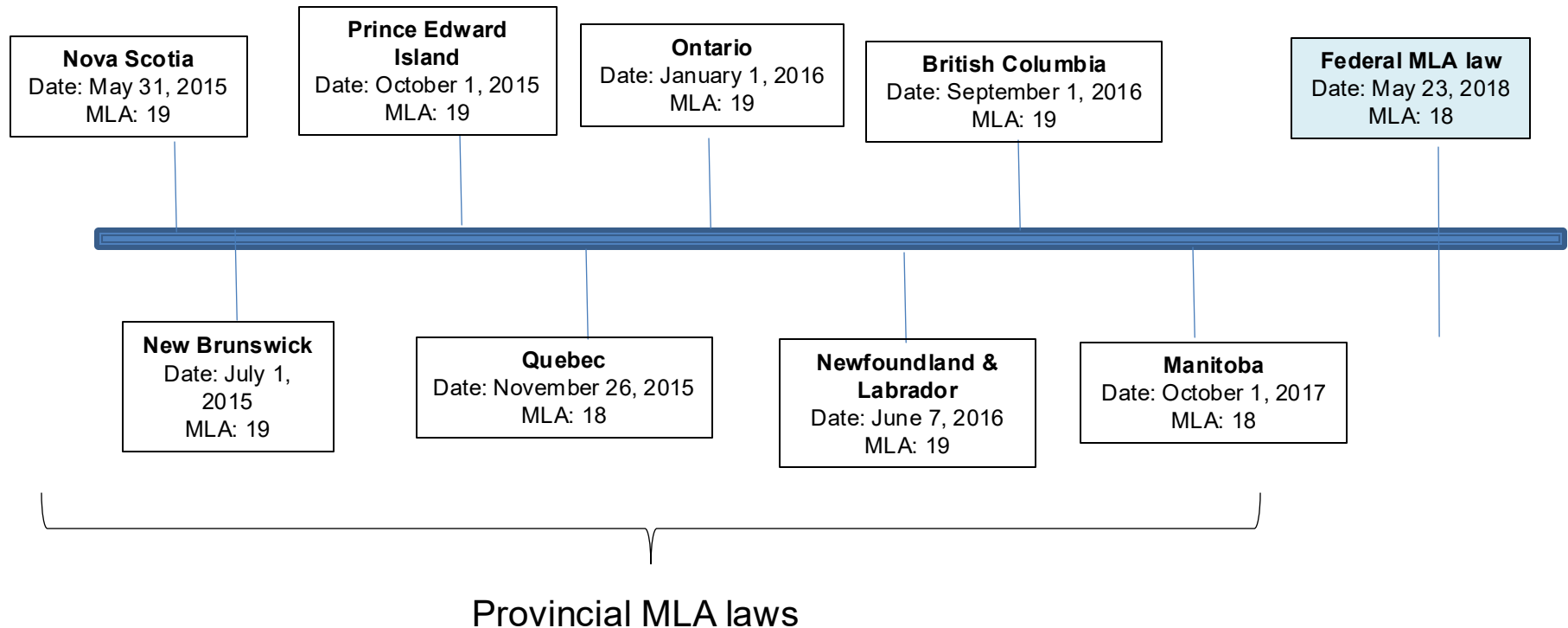
- Continue smoking as e-cig unavailable

Effect on smoking prevalence = Effect on smoking initiation + Effect on smoking cessation

METHODS



E-cigarette MLA Adoption across Provinces



Difference-in-Differences Regressions

$$Y_{ipt} = \alpha + \beta_1(MLA\ Law)_{pt} + \beta_2\eta_p + \beta_3\chi_t + \beta_4Z_{pt} + \beta_5X_{ipt} + \xi_{ipt}$$

- *DD term: MLA law*
- *X* vector of individual level controls (age, sex, household size)
- *Z* vector of province level controls (cigarette price, unemployment rate, menthol cigarette ban)
- η_p and χ_t are province and time fixed effects
- Estimated by OLS (Ai and Norton, 2003)

Statistical Inference: *t*-distribution with ($G^* - 1$) *d.f.* (G^* is effective number of clusters; Carter, Schnepel & Steigerwald, 2017)

Triple Differences Regressions

$$Y_{ipt} = \alpha + \beta_1(MLA\ Law)_{apt} + \beta_2\Psi_a * \eta_p + \beta_3\Psi_a * \chi_t + \beta_4\eta_p * \chi_t + \beta_5\Psi_a + \beta_6\eta_p + \beta_7\chi_t + \beta_8Z_{pt} + \beta_9X_{ipt} + \xi_{ipt}$$

- *DDD term: MLA law*
- Ψ_a : *indicator for whether respondent in target age*

Study Outcomes & Data Sources

Study Outcomes

Smoking Participation

- Ever cigarette use (Y/N)
- Current cigarette use (Y/N)

Smoking Initiation

- Past 12-month smoking initiation (Y/N)
- Past 12-month initiation into regular smoking (Y/N)
- Past 12-month initiation into experimental smoking (Y/N)

Smoking Cessation

- Past 12-month smoking cessation (Y/N)

Data sources:

- Canadian Tobacco Use Monitoring Survey (CTUMS) 2004 – 2012
- Canadian Tobacco, Alcohol and Drugs Survey (CTADS) 2013-2017
- Youth Smoking Survey/Canadian Student Tobacco Alcohol and Drugs Survey (in robustness check)

Study Period: 2004-2017

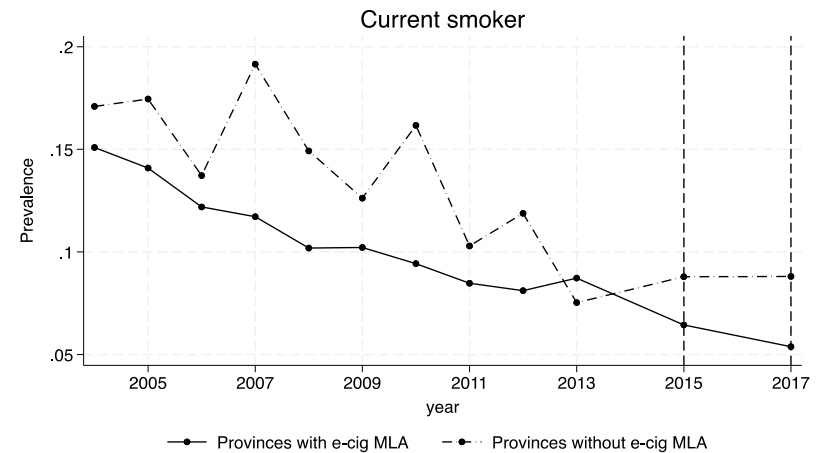
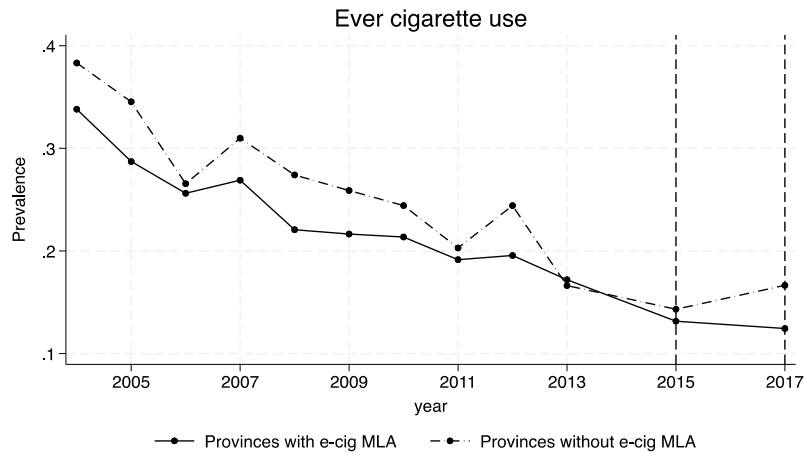
Survey Questions

Outcome	Variable construction
Ever cigarette use	Based on survey question: “Have you ever smoked a whole cigarette? – Yes/No”.
Current cigarette use	Follows the Survey on Smoking in Canada (SOSIC) definition, i.e., a current smoker is “a person who currently smokes cigarettes daily or occasionally.” (Statistics Canada, 1995).
Past 12-month smoking initiation	Binary variable equal to 1 if age of first cigarette use equals age at survey and respondent is current or experimental smoker; 0 if respondent never smoked a whole cigarette
Past 12-month initiation into regular smoking	Binary variable equal to 1 if age of first cigarette use equals age at survey and respondent is current smoker; 0 if respondent never smoked a whole cigarette
Past 12-month smoking experimentation	Binary variable equal to 1 if age of first cigarette use equals age at survey and respondent is experimental smoker; 0 if respondent never smoked a whole cigarette
Past 12-month smoking cessation	Binary variable equal to 1 if respondent said they quit smoking less than one year ago (based on survey question: “When did you stop smoking?”) and did not report smoking in past 30 days; 0 if respondent is current smoker or said they quit smoking less than one year ago but smoked in past 30 days.



RESULTS

Trends in Combustible Cigarette Use



Note: Treated provinces are Newfoundland and Labrador, Prince Edward Island, Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, and British Columbia. Control provinces are Alberta and Saskatchewan. Solid vertical lines indicate start and end years for implementing provincial e-cigarette MLA laws.

Effect of E-cigarette MLA law on Smoking Participation: DD Results

Outcome is →	Ever cigarette use	Current cigarette use
<u>Panel A: Full sample</u>		
<i>Pre-policy mean of the outcome</i>	0.23	0.10
E-cigarette MLA laws	-0.002 (0.921)	0.004 (0.783)
R-squared	0.07	0.03
N	46,001	46,000
<u>Panel B: Youths aged 15-16</u>		
<i>Pre-policy mean of the outcome</i>	0.17	0.07
E-cigarette MLA laws	-0.006 (0.831)	0.019 (0.507)
R-squared	0.05	0.02
N	24,698	24,698
<u>Panel C: Youths aged 17-18</u>		
<i>Pre-policy mean of the outcome</i>	0.29	0.14
E-cigarette MLA laws	-0.005 (0.886)	-0.014 (0.577)
R-squared	0.04	0.03
N	21,303	21,302

P values are in parentheses. Significance levels are: ***p < 0.01, **p < 0.05, *p < 0.1.

Effect of E-cigarette MLA law on Smoking Participation: DDD Results

Outcome is →	Ever cigarette use	Current cigarette use
<u>Panel A: Full sample</u>		
E-cigarette MLA laws	0.006 (0.894)	0.024 (0.433)
R-squared	0.09	0.04
N	105,980	105,975
<u>Panel B: Youths aged 15-16</u>		
E-cigarette MLA laws	0.012 (0.810)	0.040 (0.205)
R-squared	0.11	0.05
N	82,137	82,133
<u>Panel C: Youths aged 17-18</u>		
E-cigarette MLA laws	0.008 (0.870)	0.009 (0.834)
R-squared	0.06	0.03
N	81,282	81,277

P values are in parentheses. Significance levels are: ***p < 0.01, **p < 0.05, *p < 0.1.

Supports DD result of no effects of e-cigarette MLA laws on smoking participation

Effect of E-cigarette MLA law on Smoking Initiation & Cessation: DD Results – 2004-2017

Outcome is →	Smoking initiation in past 12 months	Smoking initiation into regular smoking	Smoking experimentation	Smoking cessation in past 12 months
<u>Full Sample</u>				
<i>Pre-policy mean of the outcome</i>	0.025	0.008	0.018	0.064
E-cigarette MLA laws	-0.026** (0.045)	-0.012 (0.195)	-0.015** (0.048)	-0.015 (0.757)
R-squared	0.00	0.00	0.00	0.01
N	35,861	35,198	35,541	5,541
<u>Youths aged 15-16</u>				
<i>Pre-policy mean of the outcome</i>	0.026	0.007	0.019	0.070
E-cigarette MLA laws	-0.015 (0.324)	-0.010 (0.496)	-0.006 (0.390)	0.003 (0.945)
R-squared	0.00	0.00	0.00	0.02
N	20,835	20,456	20,661	2,020
<u>Youths aged 17-18</u>				
<i>Pre-policy mean of the outcome</i>	0.024	0.009	0.016	0.061
E-cigarette MLA laws	-0.042** (0.018)	-0.017 (0.118)	-0.026* (0.097)	-0.042 (0.469)
R-squared	0.01	0.00	0.01	0.03
N	15,026	14,742	14,880	3,521

Lower smoking initiation, esp. among 17-18 year olds

Effect on cessation imprecisely estimated but large magnitude for 17-18 year olds

P values in parentheses. Significance levels are: ***p < 0.01, **p < 0.05, *p < 0.1.

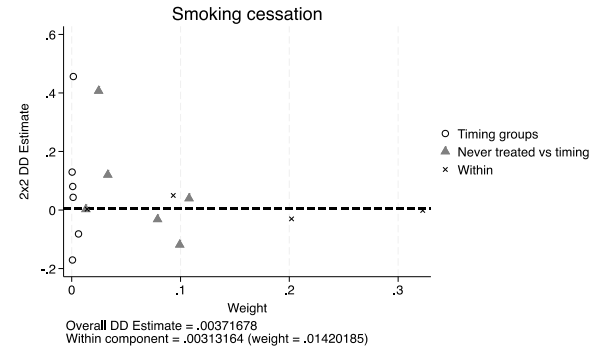
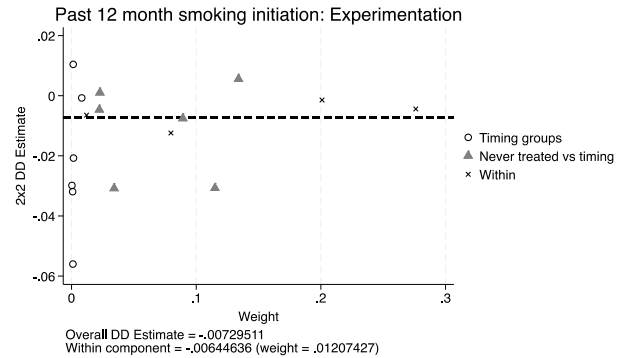
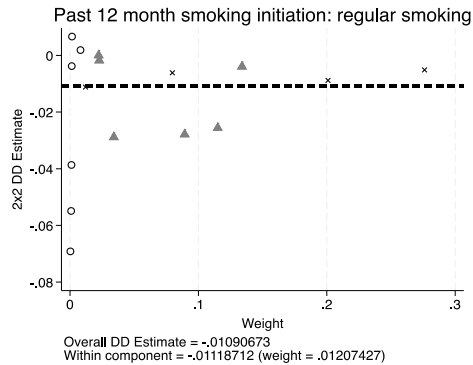
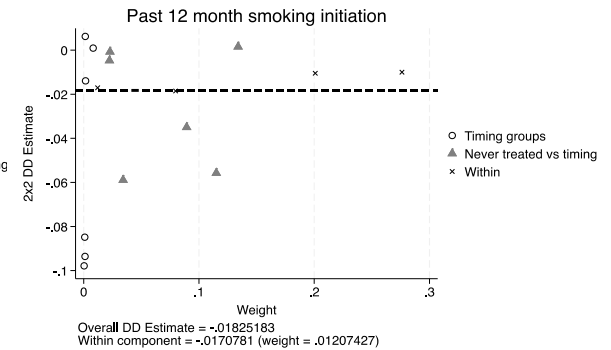
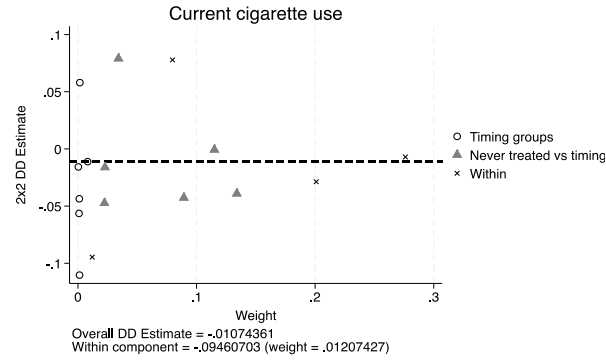
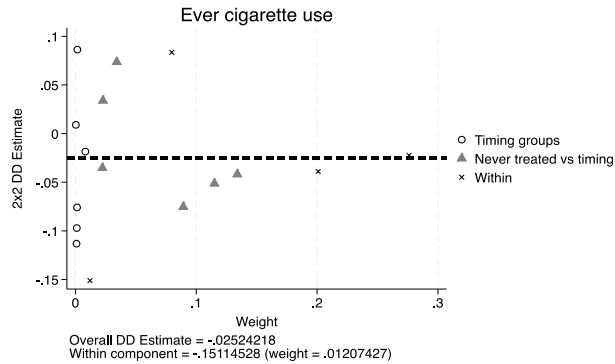
Effect of E-cigarette MLA law on Smoking Initiation & Cessation: DDD Results – 2004-2017

Outcome is →	Smoking initiation in past 12 months	Smoking initiation into regular smoking	Smoking experimentation	Smoking cessation in past 12 months
<u>Full sample</u>				
E-cigarette MLA laws	-0.018 (0.177)	-0.010 (0.348)	-0.008 (0.215)	-0.041 (0.413)
R-squared	0.01	0.00	0.01	0.01
N	67,487	66,641	67,038	21,625
<u>Youths aged 15-16</u>				
E-cigarette MLA laws	-0.002 (0.909)	-0.003 (0.856)	0.001 (0.869)	0.036 (0.243)
R-squared	0.01	0.01	0.01	0.01
N	50,834	50,290	50,550	17,538
<u>Youths aged 17-18</u>				
E-cigarette MLA laws	-0.032** (0.028)	-0.018 (0.168)	-0.016 (0.217)	-0.073 (0.174)
R-squared	0.01	0.01	0.01	0.01
N	46,652	46,185	46,377	19,605

P values in parentheses. Significance levels are: ***p < 0.01, **p < 0.05, *p < 0.1.

- Support DD results
- **Null effect on participation due to offsetting reductions in smoking initiation and cessation, concentrated among 17-18 year olds**

Bacon Decomposition

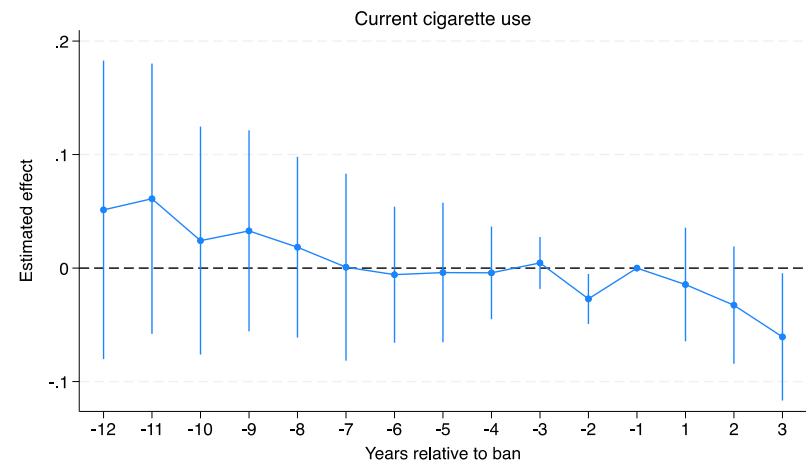
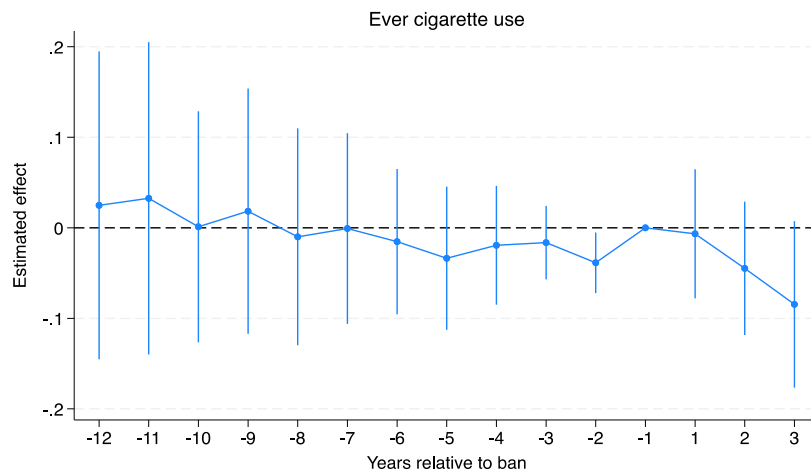


Jakiela's Test for Homogeneity

	Ever cigarette use	Current cigarette use	Smoking initiation in past 12 months	Smoking initiation into regular smoking	Smoking experimentation	Smoking cessation in past 12 months
Residualized treatment	0.006	0.012	-0.001	0.000	-0.001	-0.012
	(0.74)	(0.39)	(0.89)	(0.94)	(0.83)	(0.78)
E-cigarette MLA Laws	0.009	0.011	0.001	0.002	-0.001	-0.042
	(0.54)	(0.29)	(0.92)	(0.54)	(0.77)	(0.25)
Residualized treatment x E- cigarette MLA Laws	-0.040	-0.052	-0.003	-0.010	0.007	0.168
	(0.41)	(0.16)	(0.89)	(0.41)	(0.69)	(0.15)
<i>N</i>	46,001	46,000	35,861	35,198	35,541	5,541

Dependent variable is residual from regression of each outcome on province and year fixed effects. Residualized treatment is the residual from regression of indicator for e-cigarette MLA laws on province and year fixed effects. The statistically insignificant coefficients for the 'Residualized treatment x E-cigarette MLA Laws' interaction suggests that policy effects are homogenous (Jakiela, 2021). Standard errors are in parentheses and *p*-values are in brackets.

Event Study: Smoking Participation



No significant differences in trends between treated and control provinces in pre-policy period

Robustness Checks: Smoking Participation

Outcome is ↓	Time period 2010-2017	Including province specific linear time trends	Control for vape-free air laws	Control age group up to age 22 in DDD analysis	Excluding provinces that adopted menthol ban at same time (NS, QC, ON)	Using YSS/CSTADS sample
Ever cigarette use	-0.023	-0.032	0.011	0.010	-0.003	-0.031
	(0.356)	(0.149)	(0.586)	(0.844)	(0.914)	(0.163)
<i>N</i>	20,323	46,001	46,001	88,679	32,067	226,529
Current cigarette use	0.020	-0.004	0.004	0.002	-0.006	-0.013
	(0.276)	(0.830)	(0.811)	(0.946)	(0.773)	(0.273)
<i>N</i>	20,322	46,000	46,000	88,676	32,066	226,440

P values in parentheses. Significance levels are: ***p < 0.01, **p < 0.05, *p < 0.1.

Robustness Checks: Smoking Initiation & Cessation

Outcome is ↓	Time period 2010-2017	Including province specific linear time trends	Control for vape-free air laws	Control age group up to age 22 in DDD analysis	Excluding provinces that adopted menthol ban at same time (NS, QC, ON)
Smoking initiation in past 12 months	-0.021	-0.025*	-0.031*	-0.020	-0.026
	(0.128)	(0.077)	(0.058)	(0.143)	(0.175)
N	16,870	35,861	35,861	59,367	24,967
Smoking initiation into regular smoking in past 12 months	-0.007	-0.007	-0.016	-0.012	-0.014
	(0.492)	(0.505)	(0.169)	(0.226)	(0.286)
N	16,569	35,198	35,198	58,534	24,511
Smoking experimentation in past 12 months	-0.015*	-0.019**	-0.016*	-0.008	-0.013
	(0.090)	(0.017)	(0.071)	(0.284)	(0.250)
N	16,733	35,541	35,541	58,933	24,731
Smoking cessation in past 12 months	-0.064	-0.062	-0.032	-0.046	0.002
	(0.369)	(0.364)	(0.408)	(0.438)	(0.961)
N	1,915	5,541	5,541	16,569	3,985

P values in parentheses. Significance levels are: ***p < 0.01, **p < 0.05, *p < 0.1.

Key Findings

- **Null effect** of e-cigarette MLA law on youth smoking participation **masks reduction in smoking initiation offset by lower smoking cessation**
 - Effects particularly pronounced for 17-18 year olds
- **Relationship between e-cigarettes and combustible cigarettes depends on smoking status**
 - **Never smokers:** MLA reduces smoking initiation & reduces e-cig use → complements
 - **Existing smokers:** MLA reduces smoking cessation & reduces e-cig use → substitutes
- Explains lack of effects of rising e-cigarette use on declining trend in combustible cigarette use

Policy Implications

- Alleviates concerns that e-cigarette MLA laws will induce youths to switch to combustible cigarettes
 - In fact, may prevent smoking initiation among youths
- But policy regulations should consider possible adverse impacts on smoking cessation

THANK YOU

Questions?