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What factors predict the passage of state-level e-cigarette regulations?

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Abstract: E-cigarettes are controversial products. They may help addicted smokers to consume nicotine in a less harmful manner or to quit tobacco cigarettes entirely, but these products may also entice youth into smoking. This controversy complicates e-cigarette regulation as any regulation may lead to health improvements for some populations and health declines for other populations. Using data from 2007 to 2016, we examine factors that are plausibly linked with U.S. state e-cigarette regulations. We find that less conservative states are more likely to regulate e-cigarettes and that states with stronger tobacco lobbies are less likely to regulate e-cigarettes. This information can help policymakers as they determine how best to promote public health through regulation.

Keywords: E-cigarettes; smoking; voter preferences; diffusion; regulation.

JEL classification: I1

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1. Introduction

In this study we provide the first analysis of the factors that lead U.S. states to regulate e-cigarettes; emerging and controversial products in tobacco markets. E-cigarettes are battery-operated, often cigarette-shaped, devices containing a liquid which typically includes nicotine along with other components such as propylene glycol and flavorings. A heating element vaporizes the liquid and the resulting vapor is inhaled. Unlike tobacco cigarettes, many e-cigarettes do not contain tobacco.[1] E-cigarettes were developed in China in 2003 and entered the U.S. in 2007 (Riker et al., 2012). Since that time, e-cigarette use has proliferated among Americans; 3.6% of adults (Schoenborn and Gindi, 2015) and 16% of high school students (Singh, 2016) use these products.

Although e-cigarette use is rapidly increasing among both adults and youth, state governments have only recently begun to impose regulations on these products. Moreover, the majority of regulations passed to date have focused on youth access (e.g., minimum purchase ages) with only a few states implementing standard tobacco control regulations (e.g., taxation and bans on use in public places). Despite the potential importance of regulating e-cigarettes and previous studies exploring factors driving tobacco cigarette, marijuana, and alcohol regulation (Bradford and Bradford, 2016, Sloan et al., 2005, Macinko and Silver, 2015), economists have not investigated which factors drive e-cigarette regulations. However, health scholars note that this information is critical to promote effective regulation (Bradford and Bradford, 2016). The goal of this paper is to address this critical gap in the literature. The paper proceeds as follows: Section 2 discusses controversy surrounding e-cigarettes and public health; data, variables, and methods are outlined in Section 3; Section 4 presents the results; and Section 5 concludes.

[1] We note that many e-cigarettes contain nicotine. Tobacco is a primary source, but not the only source, of nicotine. Hence, we note that some e-cigarettes may contain trace amounts of tobacco through nicotine.

2. Controversy surrounding e-cigarette use and public health

The public health community has reached a consensus that tobacco cigarette use, which has been irrefutably linked with cancer and is a leading cause of morbidity and mortality (U.S. Department of Health and Human Services, 2014), should be mitigated. However, there is controversy as to whether e-cigarette use should be supported or curtailed. Indeed, the extent to which expanded e-cigarette use will enhance or harm overall health is arguably one of the most fiercely debated questions within the public health community at this time (Riker et al 2012).

Two key factors propagate this contentious debate. First, the clinical literature on e-cigarette health effects is limited due to the newness of these products. In particular, there is insufficient evidence from which to draw strong conclusions on whether expanded e-cigarette use will improve or harm public health. The available evidence is generally descriptive in nature or captures short-term health effects (e.g., through randomized control trials) and cannot, without strong and likely untenable assumptions, shed light on the causal role of e-cigarette use in overall health production (Glasser et al., 2017). Second, the health effects, whatever they maybe, likely vary across consumers due to the different reasons that lead to e-cigarette use. Such potential heterogeneity across consumers implies that expanded e-cigarette use may improve health for some groups and harm health for other groups, leaving the net health effect ambiguous.

In terms of the potential health effects of e-cigarettes, because tobacco is not burned, and therefore cancer-causing toxins are not released, e-cigarettes are generally considered to be healthier than tobacco cigarettes based on current medical information (Pisinger and Døssing, 2014). E-cigarettes may therefore offer addicted smokers, who are unlikely to quit otherwise (Centers for Disease Control and Prevention, 2011), a less harmful way to consume nicotine (the addictive component of tobacco cigarettes). Such a harm reduction pathway will likely enhance

overall public health.[2] This pathway is plausibly important given that, in 2016, 16% of U.S. adults smoke tobacco cigarettes and 56% of smokers unsuccessfully attempted to quit smoking in the past year.[3] However, while e-cigarettes are believed to be less harmful to health than tobacco cigarettes, e-cigarettes are not harmless to users and recent evidence suggests that e-cigarettes could be more harmful than initially believed. For example, e-cigarette ingredients may cause cancer (Yu et al., 2016) and serious problems with lung function (Reidel et al., 2017). Moreover, e-cigarette use is linked with a range of adverse health outcomes such as coughing, nausea, chest pain, and increased blood pressure[4] (Grana et al., 2014, Orellana-Barrios et al., 2015). Within the field of economics, a recent study by Viscusi (2016) documents that the e-cigarette-attributable mortality risky is only 1/100 to 1/1000 the tobacco cigarette-attributable mortality risk. These estimates suggest that, while both products harm health, e-cigarettes are substantially less harmful than tobacco cigarettes and that expanded e-cigarette use, if it follows from decreased tobacco cigarette use, will increase overall health. In addition, e-cigarettes can serve as a cessation device and may therefore help some smokers quit entirely (Brown et al., 2014, Bullen et al., 2013, Caponnetto et al., 2013), which should improve public health.

However, while e-cigarettes may serve as an effective cessation device for some groups of tobacco cigarette smokers, there is mixed evidence on the extent to which e-cigarettes help all

[2] Harm reduction is an important component of the Food and Drug Administration (FDA) official position on regulation of tobacco products. This agency has the authority to regulate e-cigarettes at the federal level. For example, in July 2017, FDA Commissioner Scott Gottlieb argued for the importance of harm reduction in the FDA's regulatory efforts to reduce the health consequences of tobacco addition: 'Envisioning a world where [tobacco] cigarettes would no longer create or sustain addiction, and where adults who still need or want nicotine could get it from alternative and less harmful sources, needs to be the cornerstone of our efforts – and we believe it's vital that we pursue this common ground' (https://www.fda.gov/newsevents/newsroom/pressannouncements/ucm568923.htm; accessed September 30th, 2017).

[3] Authors' analyses of the 2016 Centers for Disease Control and Prevention Behavioral Risk Factor Surveillance Survey data. More details available on request.

[4] We note that increased blood pressure is likely concentrated among those who use e-cigarette containing nicotine.

smokers quit (Pearson et al., 2014, Harrell et al., 2014) suggesting a more limited link between expanded e-cigarette use and smoking cessation.

Smokers may also use e-cigarettes to circumvent tobacco cigarette smoking bans in public places (McKee and Capewell, 2015). Such use may harm public health by reducing the motivation to quit (as the full costs, in particular hassle costs, of smoking have declined) and by increasing the locations in which a smoker can use cigarettes (both electronic and tobacco). Thus, expanded e-cigarette use may reduce cessation and lead to increases in nicotine addiction overall. Finally, public health advocates argue that e-cigarettes encourage youth, who would not otherwise use any cigarettes, to take up tobacco cigarette smoking through gateway effects (Fairchild et al., 2014).

Thus, the net effects of expanded e-cigarette use on public health overall are unclear and complicated by both limited information on e-cigarette health effects and the complex set of reasons motivating consumers to use e-cigarettes. While our study does not address these thorny issues, we attempt to address why states opt to regulate e-cigarettes.

3. Data and methods

We next review our data sources, which are at the state-year level, and our methods.

3.1 E-cigarette regulations

Our outcomes are state e-cigarette regulations implemented between 2007 and 2016, and extracted from the Centers for Disease Control and Prevention (CDC) (2016). We construct an indicator variable indicating whether a state has one or more of the following regulations: e-cigarette tax, minimum purchase age, or ban on use in public places (worksites, restaurants, bars, or schools). We chose these regulations as they are the most common e-cigarette regulations.

We construct indicators for each specific regulation we study: taxation, minimum purchase age, and public use ban.[5]

3.2 State-level factors

The study of factors that determine how states regulate is longstanding and encompasses a wide-range of disciplines, including, but not limited to, political science, public health, sociology, legal studies, and economics (e.g., Bradford and Bradford (2016), Sloan et al. (2005), Snyder et al. (2004), Berry and Berry (1990), and Marlow (2008)). While it is beyond the scope of our study to comprehensively review this large body of inter-disciplinary research, we use insight developed from this literature to select factors that could impact states' e-cigarette regulation decisions. We examine the following factors: voter preferences, diffusion of regulations across state borders, special interest groups, previous regulatory experience with related products, fiscal health, and consumer tastes.

To proxy for voter preference, we use a measure of state citizen ideology developed by Berry et al. (1998). In particular, we use the revised 1960 to 2013 citizen ideology series.[6] Broadly, for each state this index reflects the ideological ranking of each member of Congress and each district. Lower scores indicate more conservative ideology within the state. We refer interested readers to Berry et al. (1998) for more details on this index. Conservative ideology is correlated with less regulation of markets in general while progressive ideology is correlated with support for health-related regulations in particular (Beland, 2015). Unfortunately, the ideology data are only available through 2013. To avoid excluding 2015 and 2016 (our right hand side variables are lagged one year), during which time numerous states implemented e-

[5] For regulations that are passed within a year, we code the fraction of the year in which the law is in place. More details are available on request.

[6] https://rcfording.wordpress.com/state-ideology-data/; accessed October 27th, 2017.

cigarette regulations (Centers for Disease Control and Prevention, 2016), we linearly impute values for these years.[7] Moreover, there is no ideology data for the District of Columbia. To address these data limitations, we have estimated an alternative set of regressions in which we utilize the Governor's political party, specifically whether the Governor is a Democrat using data drawn from the University of Kentucky Center for Poverty Research (2016), to proxy for political preferences. We treat the mayor of DC as the *de facto* Governor of this locality (Maclean and Saloner, 2017). Results generated in this auxiliary specification are not appreciably different from our core results (reported later in the manuscript), although somewhat less precise (see Appendix Tables 1 and 2).

Regulations have been documented to 'diffuse' from state to state (Macinko and Silver, 2015, Bradford and Bradford, 2016). In particular, a state government learns from the experiences of its geographic neighbors and adopts similar regulations. In our context, diffusion predicts that if a neighbor implements an e-cigarette regulation, then a state would be more likely to also implement this regulation. We measure the fraction of geographic neighboring states with an e-cigarette regulation. We develop separate diffusion variables for each regulation we study (e.g., a taxation diffusion variable is used in the taxation regression).[8]

We proxy for the strength of the tobacco lobby using annual financial contributions to political campaigns from the tobacco industry. We include the tobacco industry lobbying as health policy experts predict that this industry may either support the growth of the e-cigarette market (Lempert et al., 2016). Many tobacco cigarette companies are now selling e-cigarettes or this industry may oppose the growth of the e-cigarette market as tobacco companies may fear losing market share as consumers substitute from tobacco cigarettes to e-cigarettes (Lempert et

[7] More details on imputation are available on request.
[8] We exclude Alaska and Hawaii as they have no geographic neighbors.

al., 2016). We also include financial contributions to political campaigns from the public health community. The public health community has mixed opinions as to whether increased use of e-cigarettes will help or harm health overall. We use data from FollowtheMoney.org[9] to construct financial contribution variables. As an additional measure of lobbying/special interest efforts, we include state tobacco control funding from the Centers for Disease Control and Prevention STATE system (Centers for Disease Control and Prevention, 2016).[10] Such funding reflects state government tobacco control efforts to alter tobacco product use and associated health effects, which may be positively or negatively correlated with passage of e-cigarette regulations depending on whether states seek to expand or curtail e-cigarette use.

A state's experience with regulations of related goods may impact future regulations (Bae et al., 2014). We measure the tobacco cigarette tax per pack to proxy for related goods as tobacco cigarettes have been identified as e-cigarette substitutes for some individuals (Friedman, 2015). Data on tobacco cigarette taxation is drawn from the CDC.

During periods of poor state fiscal health, public interest tends to shift towards regulations targeting economic growth and government austerity, and away from other regulations; e.g., e-cigarette regulation. On the other hand, during periods of poor fiscal health, states may favor relatively 'costless' regulations, such as the e-cigarette regulations we examine. To proxy for state fiscal health we include the annual unemployment rate (Macinko and Silver, 2015, Bradford and Bradford, 2016) using data from the U.S. Bureau of Labor Statistics.

We control for the proportion of the adult population that smokes tobacco cigarettes using data from the CDC's Behavioral Risk Factor Surveillance Survey to reflect consumer

[9] Accessed December 14th, 2016.
[10] We note that tobacco control expenditures would be preferable to funding, but the former variable is not available for all years of our study. More details available on request.

tastes for tobacco cigarette smoking and demand for e-cigarettes for harm reduction, dual use, and/or cessation purposes.

Finally, we include state demographics from the American Community Survey (Ruggles et al., 2015) to proxy for factors not captured by other controls. Specifically, we include the percentage of the population that: is male, is less than 19 years, and has less than a high school education in regression models.

We convert financial variables to 2016 dollars using the Consumer Price Index.

3.3 Methods

We follow Bradford and Bradford (2016) and estimate the duration regression model outlined in Equation (1):

$$(1) \qquad L_{st} = \alpha_0 + \alpha_1 X'_{st} + \gamma_s + \tau_t + \varepsilon_{st}$$

This model is formally referred to as the instantaneous hazard of adoption with state-year data (Bradford and Bradford, 2016). L_{st} is a state e-cigarette regulation. This variable is coded 0 in all years prior to the passage of the law, 1 in the law passage year, and missing thereafter. This coding structure incorporates the fact that a state is only 'at risk' for an event (an e-cigarette law passage) prior to the event actually occurring. X_{st} is a vector of state-level factors that are allowed to vary across time, γ_s is a vector of state fixed effects, τ_t is a vector of year fixed effects,[11] and ε_{st} is the error term. We estimate linear probability models (LPM), lag our state-level factors by one year, and cluster standard errors by state (Bertrand et al., 2004). We select the LPM over a probit or logit model as these alternative models are vulnerable to the incidental

[11] We followed Bradford and Bradford (2016) and estimated a series of regressions which employed different methods to controlling for time effects (e.g., a linear time trend, polynomials in time, and year splines). We compared goodness-of-fit metrics (likelihood ratio tests and r-squared values) and determined that the model that included year fixed effects offered the best fit to the data. More details available on request.

parameters problem when state fixed effects are included in the regression (Greene, 2004). All analyses are unweighted (Solon et al., 2015).

4. Results

Figure 1 graphically displays the number of e-cigarette regulations, overall and for each of the specific regulations we study in each U.S. state included in our analysis sample in 2016. The vast majority of states (45) have passed an e-cigarette regulation by 2016. Minimum purchase age regulations are the most common (44 states) and taxes are the least common (3 states). There is no obvious regional clustering in terms of minimum purchase ages or taxes, however, public use bans appear to be clustered to some extent in the Northeast (13 states).

Table 1 reports summary statistics overall and by year for our analysis sample (all U.S. states and localities with the exception of Alaska, the District of Columbia, and Hawaii); we report both percentages and the number of states that have passed each year.[12] 45 states had implemented any e-cigarette regulation overall; 0 in 2007, 6 in 2011, and 45 in 2016. 3 states implemented a tax over the full study period; 0 in 2007, 1 in 2011, and 3 in 2016. In terms of minimum purchase ages, 44 states had implemented such a regulation over the full study period; 0 in 2007, 6 in 2011, and 44 in 2016. Finally, 13 states passed a ban on e-cigarette use in public places between 2007 and 2016; 0 in 2007, 4 in 2011, and 13 in 2016.

Selected regression results are reported in Table 2 (we suppress coefficient estimates on demographic variables for brevity). We have also estimated models without state fixed effects; results, which are not appreciably different (although somewhat more precise), are reported in Appendix Table 3. Overall, and somewhat surprisingly, factors that the literature suggests may lead states to implement e-cigarette regulations are generally not statistically significant

[12] Summary statistics are not reported in duration format. That is we code laws as 1 in the years following the law passage rather than coding these observations as missing.

predictors of the regulations we examine. Moreover, the coefficient estimates are generally small in magnitude and imprecise.

There are two deviations from this pattern of null results. (i) Less conservative states are more likely to pass a ban on e-cigarette use in public places. (ii) A stronger tobacco lobby, as proxied by tobacco lobbying expenditures, reduces the probability that a state will regulate e-cigarettes. These findings are in line with our expectations (see Section 3.2).

5. Discussion

In this study we explore state-level factors that are potentially related to the passage of state-level e-cigarette regulations among U.S. states. We contribute to two complementary literatures. First, we add to the small literature that examines e-cigarette regulations. While previous studies evaluated the impact of e-cigarette regulations on use of e-cigarettes and tobacco cigarettes (Friedman, 2015, Pesko et al., 2016), we explore factors that drive regulation implementation. Second, our study contributes to the large literature that seeks to understand the factors that determine state regulations more broadly, e.g., Bradford and Bradford (2016). Our study adds information on a new and controversial topic: e-cigarettes.

By far the most common regulation during our study period was a minimum purchase age. This pattern suggests that policymakers have been most concerned with minimizing e-cigarette use among youth and, in turn, the potential health effects for this population. States have also begun to pass regulations that protect non-users and increase the hassle costs of e-cigarettes (public place bans), and increase the financial costs of e-cigarettes (taxation).

Overall, our findings do not suggest that factors emphasized by the large and inter-disciplinary literature on regulation determinants are important for the emergence of e-cigarette regulations, at least among states that implemented such regulations over the period 2007 to

2016. In particular, we find no statistically significant evidence that diffusion, the public health lobby, tobacco control efforts by the state, previous regulatory experience, fiscal health, or consumer tastes predict e-cigarette regulation passage.

However, in line with our hypothesis, we find that less conservative states are more likely to prohibit e-cigarette use in public places. We find that states characterized by stronger tobacco lobbies are less likely to regulate e-cigarettes. While our data do not allow us to fully explore this finding, a negative relationship between tobacco lobby strength and the probability of implementing e-cigarette regulations is in line with the hypothesis that tobacco companies are entering the e-cigarette market and do not wish to curtail e-cigarette use, and hence profits.

In summary, our findings are often not statistically different from zero and, in some sense, contradict predictions from theory and previous work which suggests that the factors we study should predict state e-cigarette regulation passage. Whether differences are attributable to our focus on early adopting states, fundamental differences between e-cigarettes and other goods (e.g., tobacco cigarettes), or some other factors is not clear. However, further study, once the U.S. e-cigarette market becomes more established, may be able to offer additional insights on factors that prompt states' regulation of these controversial products.

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Table 1. State summary statistics: 2007-2016

Sample:	**All years**	**2007**	**2011**	**2016**
E-cigarette regulations				
Any regulation [%, (N)]	28.96 (45)	0 (0)	12.50 (6)	93.75 (45)
E-cigarette tax [%, (N)]	1.67 (3)	0 (0)	2.08 (1)	6.25 (3)
Minimum purchase age [%, (N)]	27.50 (44)	0 (0)	12.50 (6)	91.67 (44)
Public place ban [%, (N)]	8.96 (13)	0 (0)	8.33 (4)	27.08 (13)
Voter preference				
State ideology index (%)	46.69	54.52	41.36	--
Regulation diffusion				
Neighboring states with any regulation (%)	28.81	0	12.50	92.22
Neighboring states with an e-cigarette tax (%)	1.57	0	1.91	6.13
Neighboring states with a minimum purchase age (%)	27.50	0	12.50	90.76
Neighboring states with ban in public place (%)	9.32	0	9.13	26.11
Special interest				
Tobacco lobbying dollars (100,000s)	4.63	--	--	--
Health lobbying dollars (100,000s)	26.95	--	--	--
State tobacco control funding dollars (millions)	13.22	--	--	--
Tobacco cigarette regulation				
Cigarette tax ($ per pack)	1.42	--	--	--
Fiscal health				
Unemployment rate (%)	6.67	--	--	--
Demographics				
Smoke (%)	19.20	--	--	--
Observations	480	48	48	48

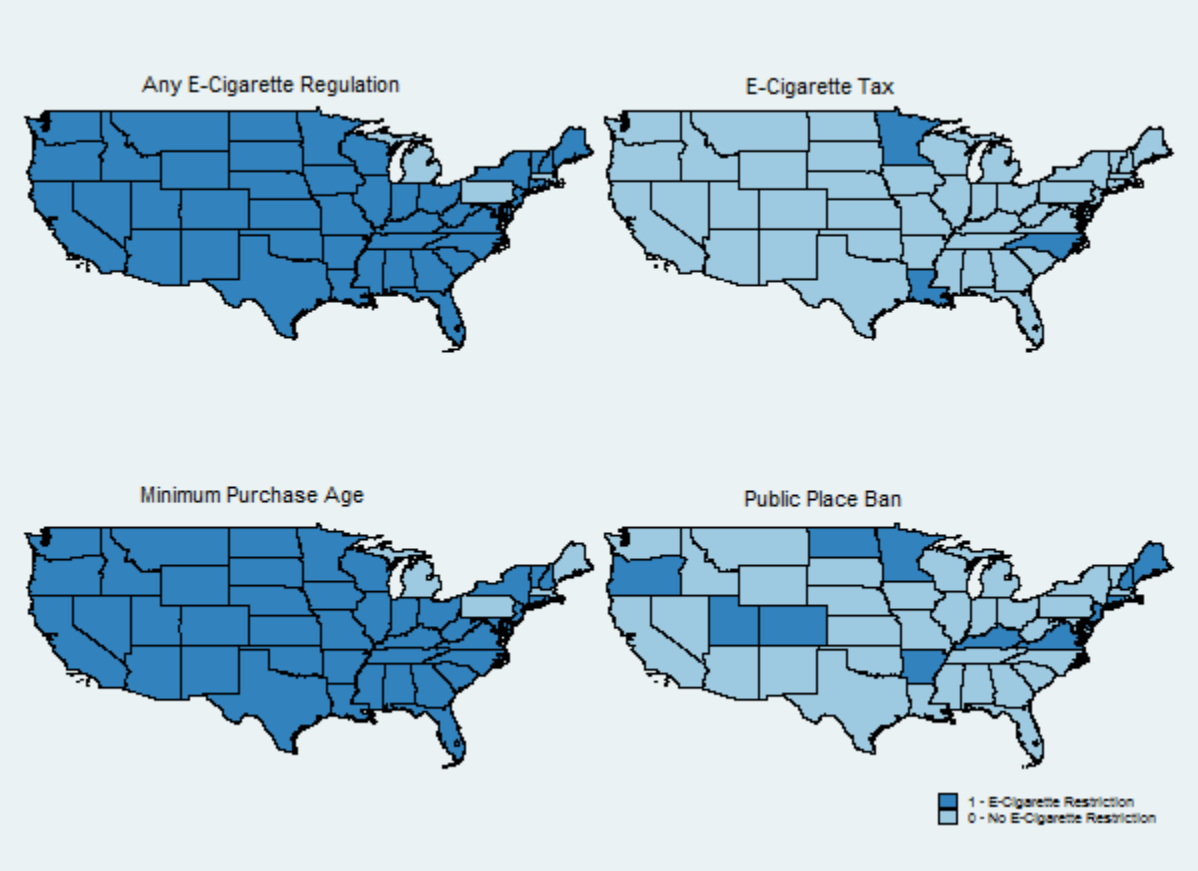
Notes: All variables are at the state-year level and unweighted. AK, HI, and DC excluded. Data are not in duration format; that is we code laws as 1 in the years following the law passage rather than missing.

Table 2. State factors predicting passage of e-cigarette regulations, controlling for state and year fixed-effects: 2007-2016

Outcome:	Any regulation	E-cigarette tax	Minimum purchase age	Public place ban
Duration sample proportion (Number of states that have passed a law):	0.1166 (45)	0.0063 (3)	0.1122 (44)	0.0289 (13)
State ideology index (%)	-0.0002 (0.0016)	-0.0007 (0.0005)	-0.0010 (0.0015)	0.0016* (0.0008)
Regulation diffusion				
Neighboring states with any regulation (%)	-0.0018 (0.0019)	--	--	--
Neighboring states with an e-cigarette tax (%)	--	-0.0009 (0.0008)	--	--
Neighboring states with a minimum purchase age (%)	--	--	-0.0027 (0.0018)	--
Neighboring states with ban in public place (%)	--	--	--	-0.0001 (0.0009)
Special interest				
Tobacco lobbying dollars (100,000)	-0.0003** (0.0001)	0.0000 (0.0000)	-0.0002 (0.0002)	-0.0000 (0.0001)
Health lobbying dollars (100,000)	-0.0001 (0.0004)	0.0000 (0.0000)	-0.0002 (0.0004)	0.0000 (0.0001)
State tobacco control funding dollars (millions)	-0.0004 (0.0026)	-0.0005 (0.0005)	-0.0014 (0.0024)	0.0000 (0.0010)
Tobacco cigarette regulation				
Cigarette tax ($ per pack)	0.0424 (0.0585)	0.0050 (0.0149)	0.0647 (0.0559)	0.0170 (0.0367)
Fiscal health				
Unemployment rate (%)	0.0129 (0.0221)	0.0017 (0.0091)	0.0181 (0.0207)	-0.0031 (0.0097)
Demographics				
Smoke (%)	-0.0055 (0.0149)	-0.0026 (0.0030)	-0.0104 (0.0151)	0.0099 (0.0069)
Observations	386	475	392	450

Notes: All models estimated with a duration model. Dependent variables are coded as 0 in the years prior to law passage, 1 in the year of law passage, and missing thereafter; hence sample sizes vary across outcomes. Observations are at the state-year level. All models are unweighted and control for demographics, and state and year fixed effects. Standard errors are clustered around the state and reported in parentheses. *, **, *** = statistically significant at the 10%, 5%, 1% confidence level.

Figure 1. E-cigarette regulations in U.S. states in 2016: Analysis sample of states



Notes: Data source is the CDC STATE system.

Appendix Table 1. State factors predicting passage of e-cigarette regulations, controlling for state and year fixed-effects using alternative measure of political preferences: 2007-2016

Outcome:	Any regulation	E-cigarette tax	Minimum purchase age	Public place ban
Duration sample proportion (Number of states that have passed a law):	0.1162 (46)	0.0082 (4)	0.1095 (44)	0.0283 (13)
Democrat Governor	0.0003 (0.0002)	-0.0001 (0.0001)	0.0003 (0.0002)	0.0004** (0.0002)
Regulation diffusion				
Neighboring states with any regulation (%)	-0.0019 (0.0015)	--	--	--
Neighboring states with an e-cigarette tax (%)	--	-0.0003 (0.0004)	--	--
Neighboring states with a minimum purchase age (%)	--	--	-0.0030** (0.0013)	--
Neighboring states with ban in public place (%)	--	--	--	0.0001 (0.0011)
Special interest				
Tobacco lobbying dollars (100,000)	-0.0001 (0.0002)	0.0000 (0.0000)	-0.0000 (0.0002)	0.0000 (0.0000)
Health lobbying dollars (100,000)	-0.0003 (0.0004)	-0.0000 (0.0000)	-0.0004 (0.0004)	-0.0001 (0.0001)
State tobacco control funding dollars (millions)	0.0013* (0.0007)	-0.0001 (0.0002)	0.0015* (0.0007)	-0.0002 (0.0003)
Tobacco cigarette regulation				
Cigarette tax ($ per pack)	-0.0263 (0.0212)	-0.0061 (0.0048)	-0.0129 (0.0199)	-0.0022 (0.0118)
Fiscal health				
Unemployment rate (%)	0.0008 (0.0100)	0.0020 (0.0016)	0.0016 (0.0095)	-0.0038 (0.0056)
Demographics				
Smoke (%)	-0.0087 (0.0061)	-0.0008 (0.0013)	-0.0057 (0.0058)	-0.0017 (0.0032)
Observations	396	485	402	460

Notes: All models use an indicator for a Democrat governor rather than the state ideology measure to proxy for political preferences. Analysis sample includes D.C. All models estimated with a duration model. Dependent variables are coded as 0 in the years prior to law passage, 1 in the year of law passage, and missing thereafter; hence sample sizes vary across outcomes. Observations are at the state-year level. Observations are at the state-year level. All models are unweighted and control for demographics, and state and year fixed effects. Standard errors are clustered around the state and reported in parentheses. *, **, *** = statistically significant at the 10%, 5%, 1% confidence level.

Appendix Table 2. State factors predicting passage of e-cigarette regulations, controlling for year fixed-effects using alternative measure of political preferences: 2007-2016

Outcome:	Any regulation	E-cigarette tax	Minimum purchase age	Public place ban
Duration sample proportion (Number of states that have passed a law):	0.1162 (46)	0.0082 (4)	0.1095 (44)	0.0283 (13)
Democrat Governor	0.0004	-0.0001	0.0002	0.0004
	(0.0006)	(0.0001)	(0.0006)	(0.0003)
Regulation diffusion				
Neighboring states with any regulation (%)	-0.0017	--	--	--
	(0.0018)			
Neighboring states with an e-cigarette tax (%)	--	-0.0013*	--	--
		(0.0008)		
Neighboring states with a minimum purchase age (%)	--	--	-0.0031	--
			(0.0020)	
Neighboring states with ban in public place (%)	--	--	--	0.0001
				(0.0009)
Special interest				
Tobacco lobbying dollars (100,000)	-0.0003***	-0.0000	-0.0002	-0.0000
	(0.0001)	(0.0000)	(0.0002)	(0.0001)
Health lobbying dollars (100,000)	-0.0000	0.0000	-0.0002	0.0000
	(0.0004)	(0.0001)	(0.0004)	(0.0001)
State tobacco control funding dollars (millions)	-0.0006	-0.0005	-0.0016	0.0000
	(0.0026)	(0.0005)	(0.0024)	(0.0009)
Tobacco cigarette regulation				
Cigarette tax ($ per pack)	0.0244	0.0091	0.0352	0.0219
	(0.0571)	(0.0146)	(0.0542)	(0.0352)
Fiscal health				
Unemployment rate (%)	0.0107	0.0030	0.0129	-0.0023
	(0.0216)	(0.0088)	(0.0201)	(0.0097)
Demographics				
Smoke (%)	-0.0061	-0.0034	-0.0093	0.0087
	(0.0148)	(0.0032)	(0.0149)	(0.0069)
Observations	396	485	402	460

Notes: All models use an indicator for a Democrat governor rather than the state ideology measure to proxy for political preferences. Analysis sample includes D.C. All models estimated with a duration model. Dependent variables are coded as 0 in the years prior to law passage, 1 in the year of law passage, and missing thereafter; hence sample sizes vary across outcomes. Observations are at the state-year level. Observations are at the state-year level. All models are unweighted and control for demographics, and year fixed effects. Standard errors are clustered around the state and reported in parentheses. *, **, *** = statistically significant at the 10%, 5%, 1% confidence level.

Appendix Table 3. State factors predicting passage of e-cigarette regulations, controlling for year fixed-effects: 2007-2016

Outcome:	Any regulation	E-cigarette tax	Minimum purchase age	Public place ban
Duration sample proportion (Number of states that have passed a law):	0.1166 (45)	0.0063 (3)	0.1122 (44)	0.0289 (13)
State ideology index (%)	0.0006 (0.0007)	-0.0002 (0.0002)	0.0003 (0.0007)	0.0011** (0.0004)
Regulation diffusion				
Neighboring states with any regulation (%)	-0.0021 (0.0015)	--	--	--
Neighboring states with an e-cigarette tax (%)	--	-0.0004 (0.0003)	--	--
Neighboring states with a minimum purchase age (%)	--	--	-0.0031** (0.0013)	--
Neighboring states with ban in public place (%)	--	--	--	-0.0002 (0.0011)
Special interest				
Tobacco lobbying dollars (100,000)	-0.0001 (0.0002)	0.0000 (0.0000)	-0.0000 (0.0002)	-0.0000 (0.0001)
Health lobbying dollars (100,000)	-0.0004 (0.0004)	-0.0000 (0.0000)	-0.0004 (0.0004)	-0.0001 (0.0001)
State tobacco control funding dollars (millions)	0.0014* (0.0007)	0.0000 (0.0002)	0.0015** (0.0007)	-0.0001 (0.0003)
Tobacco cigarette regulation				
Cigarette tax ($ per pack)	-0.0284 (0.0229)	-0.0047 (0.0045)	-0.0133 (0.0223)	-0.0090 (0.0128)
Fiscal health				
Unemployment rate (%)	0.0018 (0.0100)	0.0008 (0.0011)	0.0037 (0.0095)	-0.0038 (0.0058)
Demographics				
Smoke (%)	-0.0072 (0.0058)	-0.0004 (0.0013)	-0.0054 (0.0057)	0.0002 (0.0036)
Observations	386	475	392	450

Notes: All models estimated with a duration model. Dependent variables are coded as 0 in the years prior to law passage, 1 in the year of law passage, and missing thereafter; hence sample sizes vary across outcomes. Observations are at the state-year level. Observations are at the state-year level. All models are unweighted and control for demographics, and year fixed effects. Standard errors are clustered around the state and reported in parentheses. *, **, *** = statistically significant at the 10%, 5%, 1% confidence level.