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Abstract: We study the effects of traditional cigarette tax rate changes and e-cigarette tax adoption on use of these products among US adults. Data are drawn from the Behavioral Risk Factor Surveillance System and National Health Interview Survey data over the period 2011 to 2017. Using a difference-in-differences model, we find that higher traditional cigarette taxes reduce adult traditional cigarette use and increase adult e-cigarette use, suggesting that the products are economic substitutes. E-cigarette tax adoption reduces e-cigarette use, with some heterogeneity across groups, and dilutes the own-tax responsiveness of traditional cigarettes.

Keywords: smoking, e-cigarettes, taxation, elasticity

JEL codes: H2, I12, I18

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1. Introduction

As of 2017, 34.4 million adults (14.0%) in the United States smoked traditional cigarettes and 6.9 million (2.8%) used electronic cigarettes (e-cigarettes) and other vaping devices delivering nicotine (Wang et al. 2018).[1] Because they deliver nicotine (the addictive ingredient in tobacco products) without carcinogens and other toxicants found in traditional cigarettes, e-cigarettes may be a healthier alternative to traditional cigarettes for smokers who cannot quit. The US Surgeon General has concluded that, while e-cigarettes are not harmless, these products contain fewer toxicants than traditional cigarettes (US Department of Health and Human Services 2016).

The potential substitutability of traditional cigarettes and e-cigarettes presents a unique challenge to policymakers. On one hand, taxing and restricting access to e-cigarettes may help to reduce overall nicotine intake within the population. On the other hand, such measures may harm the health of those who smoke by discouraging them from switching to safer sources of nicotine such as e-cigarettes or from using e-cigarettes as a cessation device (Hajek et al. 2019). US localities have taken a variety of approaches toward e-cigarette regulation. Early regulations focused on youth access and curtailing use in some public places. More recent regulations include taxes. At the end of 2018, all but two states had prohibited youth from purchasing e-cigarettes,[2] 15 states had banned e-cigarettes in some public places, and nine states had passed e-cigarette excise taxes (Centers for Disease Control and Prevention 2019).

[1] Throughout the paper, we refer to the act of smoking as exclusive to traditional cigarette use. We also refer to the act of vaping as exclusive to nicotine consumption via e-cigarettes. E-cigarettes are also referred to as e-cigs, vapes, e-hookahs, vape pens, and electronic nicotine delivery systems (ENDS). There are three types of e-cigarettes: (1) disposable single-use products, (2) kits that include a rechargeable device and cartridges containing liquid nicotine, and (3) tank or pod systems used to vaporize liquid nicotine. In this paper, we follow the US Surgeon General's convention in referring to all of these products as e-cigarettes (US Department of Health and Human Services 2016). While most vaping products contain nicotine, some contain marijuana and some contain only flavoring.

[2] Regardless of state law, the Food and Drug Administration's 2016 Deeming Rule established a federal minimum legal sales age of 18.

In this study, we leverage cross-state, over-time variation in the traditional cigarette excise tax rate increases that occurred in 18 states from 2011 to 2017, as well as the implementation of e-cigarette taxes in eight states and two counties, to examine own- and cross-product tax responsiveness. We utilize two national large-scale health survey data sources—the Behavioral Risk Factor Surveillance System and the National Health Interview Survey—that include detailed information on both smoking and vaping. We have several key findings. First, traditional cigarette taxes reduced smoking among adults from 2011 to 2017. Second, traditional cigarette taxes increased e-cigarette use among adults, suggesting that the products are economic substitutes. Third, e-cigarette taxes may reduce e-cigarette use, particularly for males. Fourth, the introduction of an e-cigarette tax appears to *reduce* traditional cigarette own-tax elasticity; increasing the price of e-cigarettes could discourage smokers from using e-cigarettes as a smoking cessation device or transitioning to e-cigarettes as a less harmful source of nicotine when faced with a traditional cigarette tax-rate increase. Policymakers developing an overall tobacco-control strategy that targets both traditional cigarettes and e-cigarettes should carefully consider spillovers from one policy to another.

The paper proceeds as follows. Section 2 reviews the related literature. Data and variables are described in section 3, and our methods are discussed in section 4. Results are reported in section 5. Section 6 concludes.

2. Related literature

Our paper builds on the existing bodies of work on the own- and cross-price elasticities of traditional cigarettes and e-cigarettes among US adults.[3] Below, we discuss the existing literature on these topics as well as our specific contributions.

2.1 Own-price elasticity of traditional cigarettes

A voluminous economics literature estimates the price elasticity of traditional cigarettes across various countries and periods. Chaloupka and Warner (2000) review studies prior to 2000, concluding that smoking is responsive to price but relatively inelastic, with most estimated price elasticities of total demand falling in the –0.3 to –0.5 range for adults. A more recent review by the Community Preventive Services Task Force (2014) estimates a traditional cigarette total demand price elasticity of –0.37 for adults, which is approximately equally split by effects on the extensive and intensive smoking margins.

The endogeneity of traditional cigarette prices is a potential concern with these estimates, as prices are determined by changes in demand and supply factors, which could lead to omitted variable bias in regression coefficient estimates and associated elasticity calculations (Gruber and Köszegi 2001; Gruber and Frakes 2006). A large number of more recent economics studies use traditional cigarette *taxes* rather than *prices* to reduce these endogeneity concerns.[4] In 2018, state taxes represented 23 percent of the weighted retail price for traditional cigarettes (Orzechowski and Walker 2018), suggesting that an adult price elasticity of demand of –0.40 converts to a state-level tax elasticity of demand of approximately –0.10.

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[3] There is also a literature on the effects of various e-cigarette policies—particularly minimum age laws—on youth smoking (Dave, Feng, and Pesko 2019; Friedman 2015; Pesko and Currie 2019; Pesko, Hughes, and Faisal 2016).
[4] While tax rates are not as directly determined by demand as prices, they are nonetheless established within the state's political economy and thus not purely exogenous (Besley and Case 2000).

Our contribution to the literature on the own-price elasticity of demand for traditional cigarettes is to calculate an adult smoking participation tax elasticity during the period when e-cigarettes were widely available. Given this objective, benchmarking adult traditional cigarette tax-rate responsiveness for comparison with our findings is important.[5] We identify several studies calculating traditional cigarette tax-rate responsiveness for adults using nationally representative US data just before e-cigarettes became widely available. We contend that these studies are the most relevant to our own work while acknowledging that they do not reflect the universe of studies estimating traditional cigarette demand equations.

Cotti, Nesson, and Tefft (2016) use household scanner data from 2004 to 2012 to calculate a tax elasticity of –0.16. Similarly, Nesson (2017) finds an elasticity of –0.15 using the 1988 to 2012 National Health and Nutrition Examination Surveys; Bishop (2018) documents an elasticity of –0.18 using 1999 to 2012 Behavioral Risk Factor Surveillance System data; and Callison and Kaestner (2014) estimate an elasticity range from –0.06 to –0.03 using data from the 1995 to 2007 Current Population Survey Tobacco Use Supplements.

By examining more recent data, we explore whether the introduction of e-cigarettes into US tobacco product markets may have altered traditional cigarette tax responsiveness. The availability of a popular smoking cessation product as a close substitute may have lowered smokers' disutility from quitting cigarettes. E-cigarettes may enable some smokers to quit or to switch to a less harmful nicotine source as cigarette taxes rise.

[5] Though our focus here is on prime age adults, we note that there is also a literature using quasi-experimental methods to estimate the tax elasticity of cigarettes among youth (DeCicca, Kenkel, and Mathios 2002; Carpenter and Cook 2008; Hansen, Sabia, and Rees 2017; Courtemanche and Feng 2018) and older adults (DeCicca and McLeod 2008; Maclean, Kessler, and Kenkel 2016).

2.2 Own-price elasticity of e-cigarettes, and cross-price elasticity between traditional cigarettes and e-cigarettes

Several recent studies estimate the own-price elasticity of e-cigarettes along with the cross-price elasticity between traditional cigarettes and e-cigarettes. To the best of our knowledge, all studies use e-cigarette prices generated from retail scanner data: researchers construct aggregated, area-level price measures based on prices that retailers in that area scan at purchase.[6] As we discuss later in this paper, US localities have only recently implemented e-cigarette taxes. Thus, earlier studies could not exploit this source of plausibly exogenous variation. They instead relied on prices, which are likely vulnerable to similar endogeneity concerns noted by Gruber and Köszegi (2001) and Gruber and Frakes (2006) in the context of traditional cigarette prices.

Three studies evaluate the effect of these e-cigarette prices on traditional cigarette and e-cigarettes sales. Huang et al. (2018) use data from 2007 to 2014 to estimate e-cigarette own-price elasticities for rechargeable e-cigarettes of –1.4 and for disposable e-cigarettes of –1.6. Zheng et al. (2017) use data from 2009 to 2013 to document an e-cigarette own-price elasticity of demand of –2.1, a cross-price elasticity of traditional cigarette prices on e-cigarettes sales of 1.9, and a cross-price elasticity of e-cigarette prices on traditional cigarette sales of 0.004. Stoklosa, Drope, and Chaloupka (2016) use European data from 2011 to 2014 to estimate an e-cigarette own-price elasticity of demand of –0.8 and a cross-price elasticity of traditional cigarette prices on e-cigarette sales of 4.6.

Survey data have also been used in four studies to estimate the effect of e-cigarette prices on e-cigarette use. Saffer et al. (2018) use data on adults from the 2014 to 2015 Tobacco Use Supplement of the Current Population Survey to estimate an e-cigarette price elasticity of vaping

[6] These prices include excise taxes but do not include sales taxes.

participation of –1.2. Pesko et al. (2018) use two years of the Monitoring the Future Survey data of middle and high school students and find a –1.8 own price elasticity of days vaping. Pesko and Warman (2017) use National Youth Tobacco Survey (NYTS) data from 2011 to 2015 to show a substitution effect: higher prices for e-cigarette cartridges (the fixed component of a rechargeable e-cigarette) reduce youth e-cigarette use and increase current traditional cigarette consumption, especially for males and for older teenagers. Finally, Cantrell et al. (2019) use national longitudinal cohort data on a sample of 15- to 21-year-olds from 2014 to 2016 and find no effect of e-cigarette prices, but a cross-cigarette price elasticity of 0.9.

Discrete choice experiments (DCEs) have also been applied to estimate the price-responsiveness of traditional cigarettes and e-cigarettes. DCEs are a stated preference method in which respondents are presented with hypothetical purchasing decisions when product attributes such as prices are varied. Marti et al. (2019), for example, use a sample of adult smokers who are asked to choose between traditional cigarettes and e-cigarettes when price, relative health of e-cigarettes, effectiveness of e-cigarettes as a smoking cessation aid, and coverage of smoking bans in public places are varied. While the probability of selecting an e-cigarette declines as its hypothetical price increases, health reasons appear to be more important than prices for adult smokers' e-cigarette choices. Another recent study suggests more of a role of price in the choice of traditional cigarettes and e-cigarettes (Pesko et al. 2016), with an estimated e-cigarette own-price elasticity among current adult smokers of 1.8.

One study explores the effects of traditional cigarette taxes on adult e-cigarette use. Cotti, Nesson, and Tefft (2018) use Nielson household scanner data to show that traditional cigarette tax increases lead to a decline in purchases of both products. This finding implies that the products are economic complements, which contrasts with the results from the majority of studies discussed above that suggest substitutability across the products.

We contribute to the literature on the own-price elasticity of e-cigarettes by providing, to the best of our knowledge, the first exploration of the effect of e-cigarette *taxes*—rather than *prices*—on e-cigarette use. Our study also makes three distinct contributions to the literature on cross-price effects. First, we provide the first analysis of the effect of e-cigarette taxes (rather than prices) on adult smoking. Second, we use survey data to examine the impact of cigarette taxes (rather than prices) on adult e-cigarette use.

Finally, we investigate the potential interactive effect of traditional cigarette and e-cigarette taxes, which has not been explored. The intuition is similar to that discussed above regarding the possibility that the widespread availability of e-cigarettes may have altered traditional cigarette own-tax responsiveness. Increasing the price of e-cigarettes implicitly reduces their availability,[7] which could inhibit some smokers from quitting or from switching to the less harmful product as a source of nicotine as traditional cigarette taxes rise. This question is interesting from both an economics perspective and from a practical standpoint.

From an economics perspective, this question explores whether price elasticities are potentially a function of the prices of related goods. Additionally, policymakers often adopt both traditional cigarette and e-cigarette regulations as part of an overall tobacco control strategy (Maclean et al. 2018). If these policies have interactive effects, then policymakers may wish to consider how policies operate jointly when selecting the optimal set of regulations for their

[7] It does this through standard price effects. When the price increases, the quantity demanded should decrease. There are other nonprice pathways from taxes to changes in tobacco product use. For instance, taxes may signal to consumers that the taxed product is unsafe. This phenomenon has been documented in other health behavior contexts: for example, soda taxes. See an excellent discussion of this issue by Gostin (2017). We are not able to distinguish between these alternative mechanisms. However, at the market level, both predict that consumption should decline following a tax hike.

jurisdiction. Put differently, if taxing both products enhances the effectiveness of either tax, then policymakers should consider developing tobacco control strategies that incorporate both policies. On the other hand, if taxing one product mutes the effectiveness of the alternative tax, then policymakers may wish to consider adopting just one tax to maximize the social objective (e.g., reducing smoking within the population).

3. Data

We use data for the period 2011 to 2017 from the Behavioral Risk Factor Surveillance System (BRFSS) and the National Health Interview Survey (NHIS).[8] The US federal government and health economists use these data sources to track health behaviors such as vaping and smoking (Barbaresco, Courtemanche, and Qi 2015; Miller and Wherry 2017; Horn, Maclean, and Strain 2017; Pesko 2014). We use geocoded versions of the BRFSS and the NHIS available through federal statistical research data centers. Thus, we have access to granular geographic information not available in the public use files, which allows us to accurately study sub-state taxes.

We combine these two data sources to maximize data on e-cigarette use, which have only recently been added to national surveys. Combing data sets in this manner is not uncommon within economics (Maclean, Tello-Trillo, and Webber 2019; Webber 2016; Farber et al. 2018; Altonji, Kahn, and Speer 2016; Miller 2012). The BRFSS surveys over 400,000 adults annually, and the NHIS surveys approximately 33,000 adults annually as part of its adult sample, where e-cigarette information is queried. Both data sources ask about traditional and e-cigarette use. To

[8] We begin our study period in 2011 due to a change in the BRFSS survey frame. Prior to 2011, the BRFSS, which is a telephone survey, only conducted surveys on landlines. Beginning in 2011, cellphones were added to the survey frame to better capture a population that represented the United States. This change lead to a compositional shift in survey respondents, and thus we follow CDC recommendations and do not combine pre- and post-2011 data. In addition, the focus on relatively recent years enables us to isolate the period in which e-cigarettes were widely available in US tobacco product markets, which is our main contribution to the traditional cigarette tax elasticity literature.

measure traditional cigarette use, surveyors first ask respondents if they have smoked at least 100 traditional cigarettes in their lifetime. If so, do they now smoke every day, some days, or not at all? The BRFSS added e-cigarette questions in 2016 and the NHIS did so in 2014. Both surveys ask respondents if they have ever used e-cigarettes and, if so, if they now use e-cigarettes every day, some days, or not at all.

We make two sample restrictions. First, we drop respondents ages 18 to 20 to avoid confounding from laws that raised the minimum age for tobacco and nicotine sales to 21 during our study period (Winickoff, Gottlieb, and Mello 2014). Second, we drop responses from Alaskans because of limited geographical information, even in the restricted versions of these files that we use; full details are available on request. On a related note, the years of data differ across our smoking and vaping outcomes based on data availability in the BRFSS and the NHIS. We use 2011 to 2017 for our smoking outcomes in both data sources. For our vaping outcomes, we use 2014 to 2017 in the NHIS and 2016 to 2017 in the BRFSS; these are the years for which we have vaping information.

We create harmonized demographic variables, which we include in our empirical models, across the two data sources. We include the following individual-level control variables in our regressions: sex (female and male), education (less than high school, high school or GED, some college, college or more, and missing), race (white, black, Asian, Native American/Alaskan Native, other, and missing), marital status (married, divorced, widowed, separated, never married, and missing), age, health insurance status (insured, not insured, and missing), employment (currently employed, not currently employed, and missing), and income.

While most variables in the data sources are similar, an exception is income information. The BRFSS collects household income while the NHIS collects personal income. We account for this difference as follows. Separately for each data source, we convert the categories into a pseudo-continuous variable and then impute missing values using state-year means. We control for the differences in income across data source by interacting the harmonized income variable with an indicator for data source. We also control for separate indicators for the top income category, the amounts of which vary across the data sources. Our results are insensitive to including/excluding income as a control variable; regression results without income as a control are not shown but are available on request.

We obtain dates of state cigarette excise tax changes from the Centers for Disease Control and Prevention (2019). We also obtain sub-state traditional cigarette excise tax changes affecting localities with 100,000 people or more using proprietary data obtained from the American Non-Smokers Rights Foundation. Effective dates of e-cigarette taxes are from the CDC State System (2019) and the Vapor Products Tax Data Center (2018).

Appendix table 1 lists the localities that changed their traditional cigarette tax rate from 2011 to 2017, and appendix table 2 lists localities that levied an e-cigarette tax by the end of 2017. Figures 1 and 2 depict these taxes graphically, and figures 3 and 4 report the number of traditional cigarette changes and e-cigarette tax adoptions in each year of our study period. While there is some clustering of higher traditional cigarette taxes in the West and the Northeast, we do have reasonable variation in these taxes across the country. In terms of e-cigarette tax adoption, there is no obvious clustering in specific geographic areas and we observe adopting localities in all four regions of the country. Traditional cigarette tax changes are relatively homogenous across years, while e-cigarette tax adoptions are more concentrated in the latter half of the study period.

While traditional cigarette excise taxes are standardized across localities (i.e., a dollar value per pack of 20 traditional cigarettes), localities levy e-cigarette taxes in different ways. Of the 11 localities levying an e-cigarette tax by the end of 2017, five use an ad valorem tax on the wholesaler, five use an excise tax, and one uses a sales tax.[9] Given the difficulty of comparing the magnitudes of these different types of taxes, our regression models simply use an indicator for whether or not a locality has levied an e-cigarette tax. We note this variable construction as a limitation of the study.

We also control for several time-varying area-level factors in our regression models: county-level percent of the population covered by indoor vaping restrictions in bars, restaurants, and private workplaces (Cooper and Pesko 2017); state-level bans on smoking in restaurants, private workplaces, or bars (separate indicators) (Centers for Disease Control and Prevention 2019); beer taxes (National Institute on Alcohol Abuse and Alcoholism 2019); medical marijuana laws (Sabia and Nguyen 2018); marijuana decriminalization laws (Pacula, Chriqui, and King 2003);[10] prescription drug monitoring programs (Ali et al. 2017); Affordable Care Act Medicaid expansion status (Maclean, Pesko, and Hill 2019); and unemployment rate (University of Kentucky Center for Poverty Research 2019). All monetary values are consumer price index-adjusted to 2010 dollars. We link all area-level variables to the combined BRFSS and NHIS data set using year/quarter and county/state information available in both data sources.

Descriptive statistics for both data sources combined are presented in table 1, and separately for the BRFSS and the NHIS in appendix tables 3 and 4, respectively. For each table, variable means are presented separately for all respondents, for respondents residing in localities

[9] Both Chicago and Cook County adopted an e-cigarette tax. We assume that the earlier tax in Chicago affected all of Cook County, since we cannot separate Chicago residents from residents of the rest of Cook County in our data.
[10] We thank Rosalie Pacula for sharing an updated version of the marijuana decriminalization variable with us.

that had not levied an e-cigarette tax by the end of 2017, and for respondents residing in localities that had levied such a tax by the end of 2017. Overall, 15.8 percent of respondents use traditional cigarettes, 11.4 percent of respondents use traditional cigarettes daily, 3.1 percent of respondents use e-cigarettes, and 1.1 percent use e-cigarettes every day. The share of respondents residing in a locality that had adopted an e-cigarette tax by 2017 is 6.3 percent.

Among respondents residing in localities adopting an e-cigarette tax, current traditional cigarette use is 0.1 percentage points higher and current e-cigarette use is 0.2 percentage points lower than use rates among respondents residing in localities not adopting such a tax. Localities adopting e-cigarettes taxes are more racially and ethnically diverse, younger, and lower income that nonadopting localities. The localities adopting e-cigarette taxes also have lower traditional cigarette and beer taxes and more restrictions on marijuana use (both recreational and medical). While there are some differences in policies and demographics across groups, they do not appear to be substantial. Moreover, we control for these differences in all regression models.

4. Methods

We estimate difference-in-differences regression-style models. Specifically, we estimate the regression model outlined in equation (1):

$$Y_{i,c,s,t} = a + \beta Ttax_{c,s,t} + \partial Etax_{c,s,t} + Z_{c,s,t}\emptyset + X_{i,c,s,t}\theta + \gamma_{c,s} + \tau_t + \varepsilon_{i,c,s,t} \quad (1)$$

In this equation, i indexes an individual interviewed in year-quarter t, who resides in county c of state s. $Y_{i,c,s,t}$ is an indicator for whether the individual smokes, smokes every day, vapes, or vapes every day. $Z_{c,s,t}$ includes the time-varying state- or county-level policies. $X_{i,c,s,t}$ includes demographics, an indicator for whether the observation was surveyed in the BRFSS or the NHIS, and an interaction between data source and income. We control for county fixed effects ($\gamma_{c,s}$), which mitigate potential bias from time-invariant, county-specific factors. Note that county fixed effects incorporate state fixed effects. Including these fixed effects allows us to leverage within-locality (county or state) variation in tobacco and e-cigarette taxes for identification of treatment effects. We also control for year-quarter fixed effects (τ_t) that account for time varying factors affecting the nation as a whole, such as the general decline in smoking and the sharp increase in e-cigarette popularity that occurred over our study period.

β and ∂ are our primary coefficients of interest; they capture the effect of tobacco and e-cigarette taxes on our outcomes. We expect own taxes will reduce current use of these products, but the cross-tax effects are *a priori* ambiguous. Cross-tax effects will be positive if the goods are substitutes, negative if the goods are complements, and zero if the goods are unrelated. As discussed in section 2, the literature has not yet reached consensus on whether these products are complements or substitutes among adults, although most studies to date suggest they are substitutes.

A necessary assumption for the difference-in-differences model to recover causal estimates is that the treatment group (i.e., localities changing traditional cigarette taxes or adopting e-cigarette taxes) and the comparison group (i.e., localities not changing traditional cigarette taxes or adopting e-cigarette taxes) would have followed the same trend in the post-treatment period had the treatment localities not been treated (i.e., had they not changed the traditional cigarette tax or adopted an e-cigarette tax). This assumption is referred to as "parallel trends." Clearly this assumption is untestable as treated localities were treated in the post-period, preventing us from observing counterfactual trends. Instead, we follow the economics literature and provide suggestive evidence on whether the parallel trends assumption is satisfied in our data by modifying equation (1) to conduct an event study (Autor 2003).

To implement the event study, we replace the traditional cigarette tax rate with an indicator variable for if the traditional cigarette tax increased by $0.50 or more at any point during the study period following; we refer to such a change as a large traditional cigarette tax increase (Callison and Kaestner 2014).[11] For both the large traditional cigarette tax increase and e-cigarette tax adoption variables, we create mutually exclusive policy lead variables for more than two years in advance and for two to more than one year in advance of the tax. We include one lag indicator for the post period. The omitted category is the year prior to the tax adoption (one to more than zero years).[12] We code all nonadopting localities as zero for all event-time indicators (Lovenheim 2009). All other variables are as defined in equation (1). If the policy lead coefficients are small in magnitude and statistically indistinguishable from zero, this pattern of results suggests that there were no changes in smoking or vaping before the policy's adoption. Such results can be interpreted as providing suggestive evidence that a covariate-adjusted version of the parallel trends assumption is met and that our difference-in-differences models can recover causal estimates.

To further assess the validity of our design, we follow Pei, Pischke, and Schwandt (2018) and test for balance across treatment and comparison groups by separately regressing traditional cigarette and e-cigarette taxes on all covariates in equation (1); we aggregate demographic variables to the county level. If the covariates are uncorrelated with our tax variables, we can interpret this finding as providing suggestive evidence that treatment and comparison groups are conditionally balanced and that our data satisfy the conditional independence assumption (CIA).

[11] Eleven states passed a cigarette excise tax increase of ≥ $0.50 during the study period, and no states passed more than two such increases. Due to local taxes, both Cook County and Philadelphia County had more than one $0.50 excise tax increase. In those cases, we study trends before the first large increase.

[12] We exclude three states (Illinois, Massachusetts, and Minnesota) that passed large cigarette tax increases from 2011 to 2013 to ensure that our policy lead coefficients are not reflecting any compositional effects in the population of tobacco product users. This exclusion also removes the only locality passing an early e-cigarette tax and is therefore a treated control. Minnesota passed an e-cigarette tax in 2010, before our study period.

We also test whether the adoption of an e-cigarette tax alters traditional cigarette tax responsiveness. The relatively new availability of e-cigarettes offers smokers another option for smoking cessation, and recent clinical trial evidence suggests that e-cigarettes are an effective option for some smokers (Hajek et al. 2019). On the one hand, higher traditional cigarette taxes could therefore result in a steeper decline in smoking if people who would otherwise not quit in the absence of e-cigarettes now do so, implying that traditional cigarette tax responsiveness may be *larger* in recent years as e-cigarettes have become widely available and the potential of these products as smoking cessation devices has become better understood. On the other hand, e-cigarette taxes could reduce individuals' ability to purchase these products, restricting options to quit smoking and leading to a *smaller* traditional cigarette own-tax elasticity. To explore this hypothesis, we estimate a version of equation (1) that includes an interaction between the traditional cigarette tax rate and e-cigarette tax adoption variables. As documented in appendix tables 1 and 2, most localities adopting an e-cigarette tax also implemented changes to their traditional cigarette tax rate during the study period, providing researchers useful variation to explore the effect of traditional cigarette taxes in localities with and without an e-cigarette tax.

We estimate unweighted linear probability models. We cluster standard errors at the level of the state (Bertrand, Duflo, and Mullainathan 2004); we use both county- and state-level variation in taxes and thus the most appropriate level at which to cluster is unclear. In unreported analyses, we have clustered at the county level and the results are similar.

5. Results

5.1 Effects of traditional cigarette and e-cigarette taxes on adult tobacco product use

Our main difference-in-differences results are reported in table 2 for all individuals in both data sources. We also report results generated in the BFRSS only (table 3) and the NHIS only (table 4). A $1.00 increase in the traditional cigarette tax reduces current traditional cigarette use by 0.3 percentage points and everyday traditional cigarette use by 0.4 percentage points, which represents a 1.9 percent and 3.5 percent reduction compared to the smoking rates in the sample. Given a mean traditional cigarette state excise tax rate of $1.45, these estimates imply a modest own-tax elasticity of demand of –0.03 for current smoking and –0.05 for daily smoking. Our modest tax elasticity estimates are in line with those of Callison and Kaestner (2014), who report elasticities of –0.03 to –0.06. We note, however, that our elasticities are lower than other recent estimates of –0.15 to –0.18 (Cotti, Nesson, and Tefft 2016; Nesson 2017; Bishop 2018). In sum, we do not find evidence that traditional cigarette tax responsiveness is greater as e-cigarettes become more available.

A $1.00 traditional cigarette excise tax increase also increases current vaping by 0.3 percentage points (9.7% of the mean) and everyday vaping by 0.1 percentage points (11.1% of the mean), suggesting that the two products are economic substitutes. We do not find any evidence that e-cigarette taxes influence traditional cigarette use, however. These findings depart from previous work using scanner data (see section 2). We suspect that we are potentially underpowered to detect these effects. For instance, five times more people report current smoking than current vaping in our data, which implies that the vaping market is much smaller. All else equal, the researcher is more likely to detect statistically significant effects of a tax change when the market is larger,[13] which could explain why we were able to measure

[13] As an example, imagine a hypothetical market in which 50% of individuals purchase product A and 10% of individuals purchase closely related product B. Further, the cross-tax elasticity of demand for both products is 0.1. A 10% increase in the tax on product A would therefore increase consumption of product B by five percentage points (50%), whereas a 10% increase in the tax on product B would increase consumption of product A by only one

statistically significant increases in the effect of cigarette taxes on e-cigarette use but not the reverse. We suspect that over time, given trends in e-cigarette use, the market will increase and future studies will provide more insight on this question. Nonetheless, given the regulatory action on the part of numerous US localities, providing an early evaluation of e-cigarette taxation effects is important and useful.

Adoption of an e-cigarette tax leads to a 0.2 percentage point (6.5%) reduction in vaping, but this estimate is not statistically significant. However, in looking strictly at the BRFSS data in table 3, we find that adoption of an e-cigarette tax reduces current e-cigarette use by 0.3 percentage points (9.7%), and this estimate is statistically distinguishable from zero. The NHIS data in table 4 suggest a 0.2 percentage point decrease in e-cigarette use, which is nearly identical in magnitude to what we observe in the BRFSS, although like in our combined sample, this estimate is not statistically significant.

While we cannot fully explore why estimates are more precise in the BRFSS than in the combined BRFSS and NHIS or NHIS datasets, one possibility is that the data sources use somewhat different sources of variation. E-cigarette questions were added to the BRFSS in 2016 and to the NHIS in 2014. Later e-cigarette taxes (and changes in these taxes for early adopters, since several early adopters later changed the rate) could plausibly have been more impactful than earlier taxes. Appendix table 2 provides some suggestive support for this hypothesis. Several tax changes contribute to the identifying variation in the NHIS sample years but not the BRFSS sample years, including those in Washington, DC; Montgomery County, Maryland; Louisiana; and North Carolina. The e-cigarette taxes levied by these early adopters appear smaller than taxes levied by later adopting localities. In particular, the $0.05 excise tax per fluid

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percentage point (2%). Therefore, it is much easier in this illustrative case to detect statistically significant product A cross-tax effects than product B cross-tax effects.

milliliter in Louisiana and North Carolina is smaller than all subsequently enacted initial excise tax levels.

The results in table 4 (which rely exclusively on the NHIS) suggest larger effects of taxes on traditional cigarette use. For example, a $1.00 increase in traditional cigarette taxes reduces current traditional cigarette use by 0.8 percentage points (4.5%) and adoption of an e-cigarette tax increases current traditional cigarette use by 0.4 percentage points (2.3%). While this latter result is not statistically significant, the point estimate suggests substitution. However, these taxes have little effect on e-cigarette use in the NHIS data.

5.2 Internal validity of the research design

In table 5, we report estimates and associated standard errors for our tobacco and e-cigarette use outcomes generated using our event study. The reference period is the year immediately prior to adoption of a large traditional cigarette tax increase and adoption of an e-cigarette tax. For both the large traditional cigarette tax and e-cigarette tax adoption leads, coefficient estimates are statistically indistinguishable from zero and small in magnitude. We interpret these null findings to suggest that our data are potentially able to satisfy a covariate-adjusted version of the parallel trends assumption. Compared to the year immediately prior to large traditional cigarette excise-tax adoption, such an increase in this tax reduced everyday traditional cigarette use by 0.3 percentage points and increased current vaping by 0.4 percentage points.

We also assess the ability of our data to satisfy the conditional independence assumption by following Pei, Pischke, and Schwandt (2018) and regressing both taxes on all other right-hand side variables. In results not shown, but available on request, we observe that demographics do not predict cigarette tax rates or e-cigarette tax adoption, suggesting that individuals do not migrate in observable ways in response to changes in tobacco taxation. Tobacco control policies and medical marijuana laws do predict the traditional cigarette tax rate. Given that these policies all attempt to regulate addictive substances, the observed correlations may reflect overall strategies adopted by localities to reduce substance use. Under the hypothesis of an overall strategy adopted by a locality, these correlations are potentially not unexpected. In terms of e-cigarette adoption, only the traditional cigarette rate predicts this outcome, which plausibly reflects localities adopting broader tobacco control efforts to reduce nicotine consumption (Maclean et al. 2018). We acknowledge that our data display some evidence of policy imbalance—in particular, in terms of regulation of related goods—but we are able to control for all variables in our regression models.

5.3 Heterogeneity in tax effects on adult tobacco product use

In tables 6, 7, and 8, we explore whether subgroups differ in responsiveness to these taxes. Given differences in use of these products (Wang et al. 2018) and perceptions regarding their health harms (Glasser et al. 2017), tax responsiveness may also vary. For both men and adults younger than 35, we document similar traditional cigarette tax effects. A $1.00 increase in the traditional cigarette tax reduces current and daily smoking and increases current e-cigarette use by 0.6 percentage points. This tax hike also increases daily vaping by 0.2 percentage points. E-cigarette tax adoption, however, reduces current e-cigarette use by approximately 0.6 percentage points for both populations. Women do not appear to change their smoking or vaping patterns following traditional cigarette tax rate changes or e-cigarette tax adoption.

5.4 Interactions between traditional cigarette and e-cigarette taxes

In tables 9 and 10, we report results from our interactive model (i.e., interacting the traditional cigarette tax with an indicator for e-cigarette tax adoption). This specification allows us to explore if e-cigarette tax adoption alters traditional cigarette tax responsiveness by reducing the financial incentive to use e-cigarettes. We explore the effect on both current and daily traditional cigarette use for all respondents and for subgroups defined by sex and age.

The traditional cigarette tax main effect captures traditional cigarette tax responsiveness in the absence of an e-cigarette tax. Summing the traditional cigarette tax coefficient and the interaction coefficient estimates reveals traditional cigarette tax responsiveness in the presence of an e-cigarette tax. If the interaction coefficient estimate is positive, this pattern of results can be interpreted to imply that a traditional cigarette tax hike reduces traditional cigarette use to a lesser degree than if the e-cigarette tax had not been adopted.

For current traditional cigarette use in table 9, the interaction term is positive for all groups, although it only reaches statistical significance for men. For everyday traditional cigarette use in table 10, the coefficient estimate on the interaction term is statistically significant and positive for all groups. These results collectively suggest that adoption of an e-cigarette tax dilutes traditional cigarette tax responsiveness. For example, the ratio of the traditional cigarette tax main effect coefficient estimate to the interaction term coefficient estimate, for daily smoking among all respondents, suggests that e-cigarette tax adoption reduces approximately two-thirds of the effect that traditional cigarette taxes would have on daily smoking absent an e-cigarette tax. However, the e-cigarette tax main effect is negative and roughly the same magnitude as the interaction coefficient. This finding suggests that only once the traditional cigarette excise tax exceeds $1.00 does an e-cigarette tax begin to reduce traditional cigarette tax responsiveness.

6. Discussion

In this paper, we provide the first evidence on the effects of traditional cigarette taxes on traditional cigarette use and e-cigarette use in a period when e-cigarettes were widely available in tobacco markets, and the effects of e-cigarette taxes on these outcomes. To do so, we combine data from two large-scale surveys, the BRFSS and the NHIS, and detailed information on state and county traditional cigarette and e-cigarette taxes with a difference-in-differences design. Overall, we observe that, as previous studies estimating traditional cigarette demand equations have documented, smoking declines when traditional cigarette tax rates increase. We also find evidence that adults are more likely to use e-cigarettes when traditional cigarette taxes rise, which mirrors evidence from retail sales data using variation in e-cigarette prices (Zheng et al. 2017; Stoklosa, Drope, and Chaloupka 2016). We observe some evidence that adoption of an e-cigarette tax reduces vaping, but this finding is somewhat sensitive to sample definition and sub-group. In particular, evidence gleaned from the BRFSS only suggests that e-cigarette use propensity declines post-e-cigarette tax adoption, but not in our combined data set or the NHIS in isolation. Regardless of the data source, we observe that men reduce their e-cigarette use following an e-cigarette tax adoption. Finally, traditional cigarette taxes appear to be less effective in reducing smoking when a locality has also adopted an e-cigarette tax.

The finding that e-cigarette adoption appears to dilute the effectiveness of traditional cigarette taxes, which are a standard policy lever to reduce smoking, is important from both an economic and a practical standpoint. We hypothesize that adoption of an e-cigarette tax increases the price of a potential smoking cessation device (Hajek et al. 2019), which dissuades some smokers from attempting to quit or reduce smoking by taking up vaping in response to a traditional cigarette tax increase. Indeed, traditional smoking cessation devices (e.g., Food and

Drug Administration-approved nicotine replacement therapies such as Zyban, Chantix, or Nicotrol) are expensive (Maclean, Pesko, and Hill 2019), particularly without insurance, and may not be feasible for smokers, who on average have lower incomes (Remler 2004). Moreover, e-cigarettes are perceived as effective smoking cessation devices, and more effective than traditional smoking cessation options among some groups of smokers (Glasser et al. 2017; Harrell et al. 2014). Therefore, when the price of e-cigarettes increases after a tax is adopted, smokers may be less likely to attempt to stop smoking (Saffer et al. 2018) or to reduce smoking. Overall, without speaking to specific pathways, this finding suggests that the combination of a traditional cigarette tax hike and an e-cigarette tax prevents smokers from quitting or switching to a less harmful product. Both actions would improve smokers' health by minimizing exposure to carcinogens and other toxins contained in traditional cigarettes.

From the policymaker's perspective, understanding policy interactions is important for developing effective strategies to achieve social goals. Previous economic studies have, for example, documented policy spillovers in the context of Medicaid (Burns and Dague 2017), minimum wages (Page, Spetz, and Millar 2005), workers compensation (McInerney and Simon 2012), and medical marijuana laws (Bradford and Bradford 2018). Failure to consider such potential spillovers can lead to suboptimal policies.

We suspect that our focus on (primarily) the extensive margins of traditional cigarette and e-cigarette use likely leads us to understate the tax effects. That is, following a traditional cigarette tax hike or the adoption of an e-cigarette tax, some individuals may reduce the quantity demanded on the intensive margin (e.g., the number of traditional cigarettes smoked or e-cigarettes vaped per day) but not quit completely. While we do examine daily smoking and vaping, we are unable to fully capture this margin given the information available in both data sources.

Our findings depart from those of a seminal and related study. Whereas we document that traditional cigarettes and e-cigarettes are substitutes, Cotti, Nesson, and Tefft (2018) provide evidence of complementarity between the two products. Our data do not allow us to fully explore differences in findings, but we can propose potential hypotheses.

First, our data set encompasses more recent changes. Cotti, Nesson, and Tefft (2018) use data from 2011 to 2015. Our data set includes 2016 and 2017, when nine additional localities—California, Connecticut, Delaware, Louisiana, Minnesota, Oregon, Pennsylvania, Rhode Island, and West Virginia—increased their traditional cigarette excise taxes. These localities are different from the localities that passed such taxes from 2011 to 2015. In particular, California is a treatment state in our study because its legislators enacted a cigarette tax increase in April 2017. But this populous state with a historically strong tobacco-control program was a control locality during the period investigated by Cotti, Nesson, and Tefft (2018).

Second, the studies have important differences in measures of e-cigarette use.[14] In the scanner data, Cotti, Nesson, and Tefft (2018) document that 9.5 percent of households report purchasing traditional cigarettes over the last quarter, compared to 15.8 percent that report currently smoking in our data. Thus, current reported smoking is 66 percent more common than the percent of households that report purchasing traditional cigarettes. One potential explanation for this difference is that smokers may cluster in the same households, which would understate the smoking rate. For example, Sterba et al. (2011) survey partnered smokers who called a quitline (a phone counseling service to help smokers quit); 54.1 percent of callers report that

[14] Differences exist but are much smaller across the data sources for traditional cigarette use.

their partner also smokes. Further, in the scanner data, 0.3 percent of households report purchasing e-cigarettes, while we find that 3.1 percent of respondents in our combined BRFSS and NHIS sample currently vape. Thus, our vaping rate is 10 times the rate implied by Cotti, Nesson, and Tefft (2018) and likely well outside the range that could be explained by a clustering of people that vape in the same household. We suspect that the particularly large difference between reported use and purchasing of e-cigarettes is driven by purchases without a UPC code, such as e-liquids from specialty mix shops. These purchases do not appear in the scanner data but are captured in our overall use measures. Individuals purchasing e-liquids without UPC codes may have different cross-tax elasticities than individuals purchasing e-liquids with UPC codes, and so including these individuals may account for differences between household scanner data and survey data.

Our study has limitations. First, because e-cigarette questions have only recently been added to large-scale health surveys, we have limited data on e-cigarette use. Second, while we can measure daily smoking and vaping, we cannot, with the information collected in our data sources, fully examine effects on the extensive margin of tobacco product use. As noted earlier, this data feature likely leads us to understate tax effects. Third, we rely on self-reported traditional cigarette and e-cigarette use, which may be measured with some error. Fourth, due to substantial heterogeneity in how localities have adopted e-cigarette taxes, and no obvious way to standardize these taxes, we include an indicator for a tax rather than a tax rate, as is common in economic analyses of traditional cigarettes.

Finally, we note that our data sources are not representative at the level of treatment for all traditional cigarette tax changes and e-cigarette tax adoptions that occurred during our study period. For example, some of the policy changes we leverage occurred at the sub-state level (city or county) and our data sources are not representative at that level, which can lead to empirical issues (Maclean, Tello-Trillo, and Webber 2019). We believe that our ability to combine two large data sources may mitigate this issue, but we acknowledge that ideally we would have access to data that are representative at the level of treatment for all included localities.

Our research contributes further evidence (from difference-in-differences methods) that regulating e-cigarettes has the unintended consequence of raising traditional cigarette use. While neither product is harmless, the clinical literature strongly suggests that e-cigarettes are the less harmful product. With few exceptions (Abouk and Adams 2017; Cotti, Nesson, and Tefft 2018), this finding has been documented for youth (Dave, Feng, and Pesko 2019; Pesko, Hughes, and Faisal 2016; Pesko and Currie 2019; Friedman 2015), pregnant women (Cooper and Pesko 2017; Pesko and Currie 2019), and now, for the first time, for adults. These results suggest caution in regulating e-cigarettes because e-cigarette regulations may have a harmful, unintended consequence: increased smoking of traditional cigarettes.

Table 1. Summary statistics among respondents in all localities, and localities that did and did not adopt an e-cigarette tax by 2017: Combined BRFSS and NHIS data, 2011–2017

Sample	**All localities**	**Adopting localities**	**Nonadopting localities**
Outcomes			
Smoking	0.158	0.158	0.159
Daily smoking	0.114	0.114	0.114
Vaping	0.031	0.031	0.029
Daily vaping	0.011	0.011	0.010
Traditional cigarette and e-cigarette taxes			
Traditional cigarette tax rate ($ per pack)	1.445 (0.925)	1.493 (0.949)	1.249 (0.791)
E-cigarette tax (any)	0.063	0.000	0.320
Area-level controls			
Restaurant smoking ban	0.684	0.694	0.643
Private workplace smoking ban	0.690	0.696	0.668
Bar smoking ban	0.573	0.574	0.569
Indoor vaping restrictions (% population)	0.137 (0.318)	0.137 (0.320)	0.138 (0.307)
Beer tax ($ per gallon)	0.236 (0.200)	0.253 (0.215)	0.170 (0.098)
Medical marijuana law	0.411	0.418	0.380
Marijuana decriminalized	0.333	0.356	0.241
Prescription drug monitoring program	0.949	0.946	0.961
ACA-Medicaid expansion	0.313	0.308	0.333
Unemployment rate (%)	6.027 (2.032)	5.923 (1.990)	6.455 (2.143)
Individual-level controls			
Female	0.587	0.590	0.574
Male	0.413	0.410	0.426
Less than high school	0.088	0.087	0.098
High school or GED	0.279	0.283	0.261
Some college	0.273	0.275	0.265
College degree or more	0.353	0.350	0.368
Education missing	0.006	0.006	0.007
White	0.828	0.834	0.801
African American	0.093	0.089	0.111
Asian	0.022	0.018	0.039
Native American or Alaskan	0.019	0.020	0.015
Other race	0.022	0.022	0.022
Race missing	0.016	0.018	0.011
Married	0.540	0.542	0.533
Divorced	0.138	0.140	0.131
Widowed	0.125	0.128	0.112
Separated	0.022	0.021	0.023
Never married	0.169	0.163	0.195
Marital status missing	0.006	0.006	0.006
Age (years)	55.08 (16.69)	55.46 (16.63)	53.52 (16.86)
Uninsured	0.099	0.098	0.105
Insured	0.897	0.898	0.891
Insurance missing	0.004	0.004	0.005
Income ($; missing values imputed)	42,975 (25,879)	43,075 (25,689)	42,564 (26,636)
Unemployed or not in labor force	0.482	0.488	0.456
Employed	0.511	0.504	0.536
Employment missing	0.007	0.007	0.008
Observations	3,637,821	2,921,762	716,059

Notes: Data are unweighted. The unit of observation is an individual in a county in a year. Standard deviations for continuous variables are reported in parentheses.

Table 2. Effects of traditional cigarette and e-cigarette taxes on smoking and vaping outcomes among adults using a difference-in-differences-style model: Combined BRFSS and NHIS data, 2011–2017

Outcome	Smoking	Daily smoking	Vaping	Daily vaping
Traditional cigarette tax rate	-0.003***	-0.004***	0.003**	0.001***
($ per 20 unit pack)	[-0.006,-0.001]	[-0.006,-0.002]	[0.001,0.006]	[0.000,0.002]
E-cigarette tax (any)	0.000	-0.001	-0.002	-0.000
	[-0.003,0.004]	[-0.004,0.002]	[-0.005,0.001]	[-0.002,0.001]
Observations	3,263,753	3,261,037	969,659	969,350
Proportion of outcome variable	0.158	0.114	0.031	0.011
Number of clusters	50	50	50	50

Notes: The unit of observation is an individual in a county in a year. Data are unweighted. Models are estimated with a linear probability model and control for area-level and individual-level variables reported in table 1, county fixed effects, and quarter-by-year fixed effects. 95% confidence intervals account for within-state correlations and are reported in square brackets.

***, **, and * = statistically different from zero at the 1%, 5%, and 10% level.

Table 3. Effects of traditional cigarette and e-cigarette taxes on smoking and vaping outcomes among adults using a difference-in-differences-style model: BRFSS data, 2011–2017

Outcome	Smoking	Daily smoking	Vaping	Daily vaping
Traditional cigarette tax rate	-0.003**	-0.003***	0.004***	0.001**
($ per 20-unit pack)	[-0.005,-0.000]	[-0.005,-0.002]	[0.002,0.006]	[0.000,0.002]
E-cigarette tax (any)	0.000	-0.001	-0.003**	-0.000
	[-0.003,0.004]	[-0.004,0.002]	[-0.005,-0.001]	[-0.001,0.000]
Observations	3,043,140	3,040,492	847,858	847,553
Proportion of outcome variable	0.157	0.112	0.031	0.011
Number of clusters	50	50	50	50

Notes: The unit of observation is an individual in a county in a year. Data are unweighted. Models are estimated with a linear probability model and control for area-level and individual-level variables reported in table 1, county fixed effects, and quarter-by-year fixed effects. 95% confidence intervals account for within-state correlations and are reported in square brackets.

***, **, and * = statistically different from zero at the 1%, 5%, and 10% level.

Table 4. Effects of traditional cigarette and e-cigarette taxes on smoking and vaping outcomes among adults using a difference-in-differences-style model: NHIS data, 2011–2017

Outcome	Smoking	Daily smoking	Vaping	Daily vaping
Traditional cigarette tax rate	-0.008**	-0.007**	0.001	0.001
($ per 20-unit pack)	[-0.015,-0.000]	[-0.013,-0.001]	[-0.004,0.006]	[-0.002,0.005]
E-cigarette tax (any)	0.004	0.005	-0.002	0.001
	[-0.008,0.016]	[-0.007,0.016]	[-0.010,0.006]	[-0.005,0.007]
Observations	220,613	220,545	121,801	121,797
Proportion of outcome variable	0.176	0.135	0.031	0.011
Number of clusters	50	50	50	50

Notes: The unit of observation is an individual in a county in a year. Data are unweighted. Models are estimated with a linear probability model and control for area-level and individual-level variables reported in table 1, county fixed effects, and quarter-by-year fixed effects. 95% confidence intervals account for within state correlations and are reported in square brackets.

***, **, and * = statistically different from zero at the 1%, 5%, and 10% level.

Table 5. Effects of traditional cigarette and e-cigarette taxes on smoking and vaping outcomes among adults using an event-study style model: Combined BRFSS and NHIS data, 2011–2017

Outcome	Smoking	Daily smoking	Vaping	Daily vaping
Large traditional cigarette tax indicators				
2+ years in advance of large tax increase	0.003	0.003	0.004	-0.003
	[-0.004,0.010]	[-0.002,0.008]	[-0.003,0.011]	[-0.007,0.002]
[2,1) years in advance of large tax increase	0.003	0.003	0.003	-0.002
	[-0.001,0.008]	[-0.004,0.009]	[-0.004,0.011]	[-0.007,0.004]
[1,0) years in advance of large tax increase	--	--	--	--
(reference)	--	--	--	--
Tax increase	-0.000	-0.003**	0.004**	0.001
	[-0.004,0.004]	[-0.006,-0.000]	[0.000,0.008]	[-0.002,0.004]
E-cigarette tax indicators				
2+ years in advance of tax adoption	-0.001	0.001	-0.004	-0.001
	[-0.007,0.004]	[-0.004,0.005]	[-0.010,0.002]	[-0.004,0.003]
[2,1) years in advance of tax adoption	-0.001	-0.000	-0.004	-0.002
	[-0.006,0.004]	[-0.005,0.005]	[-0.010,0.002]	[-0.006,0.002]
[1,0) years in advance of tax adoption	--	--	--	--
(reference)	--	--	--	--
Tax adoption	-0.002	-0.000	-0.003	-0.000
	[-0.006,0.002]	[-0.005,0.004]	[-0.006,0.001]	[-0.003,0.002]
Observations	3,016,967	3,014,425	906,116	905,826
Proportion of outcome variable	0.159	0.115	0.031	0.011
Number of clusters	47	47	47	47

Notes: The unit of observation is an individual in a county in a year. Data are unweighted. Models are estimated with a linear probability model and control for area-level and individual-level variables reported in table 1, county fixed effects, and quarter-by-year fixed effects. 95% confidence intervals account for within-state correlations and are reported in square brackets. The omitted category is the year prior to the policy adoption. A large traditional cigarette tax hike is defined as an increase of ≥$0.50. All nonadopting localities are coded as zero for all event-time indicators. Illinois, Massachusetts, and Minnesota are excluded; see text for details.
***, **, and * = statistically different from zero at the 1%, 5%, and 10% level.

Table 6. Effects of traditional cigarette and e-cigarette taxes on smoking and vaping outcomes among adults using a difference-in-differences-style model among males: Combined BRFSS and NHIS data, 2011–2017

Outcome	Smoking	Daily smoking	Vaping	Daily vaping
Traditional cigarette tax rate	-0.006***	-0.006***	0.005***	0.002**
($ per 20-unit pack)	[-0.010,-0.002]	[-0.008,-0.003]	[0.002,0.008]	[0.000,0.004]
E-cigarette tax (any)	0.000	-0.000	-0.005**	0.000
	[-0.005,0.006]	[-0.005,0.005]	[-0.009,-0.001]	[-0.002,0.002]
Observations	1,356,202	1,354,866	422,839	422,657
Proportion of outcome variable	0.175	0.126	0.036	0.013
Number of clusters	50	50	50	50

Notes: The unit of observation is an individual in a county in a year. Data are unweighted. Models are estimated with a linear probability model and control for area-level and individual-level variables reported in table 1, county fixed effects, and quarter-by-year fixed effects. 95% confidence intervals account for within-state correlations and are reported in square brackets.
***, **, and * = statistically different from zero at the 1%, 5%, and 10% level.

Table 7. Effects of traditional cigarette and e-cigarette taxes on smoking and vaping outcomes among adults using a difference-in-differences-style model among females: Combined BRFSS and NHIS data, 2011–2017

Outcome	Smoking	Daily smoking	Vaping	Daily vaping
Traditional cigarette tax rate	-0.001	-0.002	0.001	0.001
($ per 20-unit pack)	[-0.005,0.002]	[-0.005,0.001]	[-0.002,0.005]	[-0.001,0.002]
E-cigarette tax (any)	0.000	-0.001	-0.000	-0.001
	[-0.005,0.005]	[-0.004,0.002]	[-0.004,0.004]	[-0.002,0.000]
Observations	1,907,267	1,905,887	546,537	546,410
Proportion of outcome variable	0.147	0.105	0.027	0.009
Number of clusters	50	50	50	50

Notes: The unit of observation is an individual in a county in a year. Data are unweighted. Models are estimated with a linear probability model and control for area-level and individual-level variables reported in table 1, county fixed effects, and quarter-by-year fixed effects. 95% confidence intervals account for within-state correlations and are reported in square brackets.
***, **, and * = statistically different from zero at the 1%, 5%, and 10% level.

Table 8. Effects of traditional cigarette and e-cigarette taxes on smoking and vaping outcomes among adults using a difference-in-differences-style model among adults less than 35 years: Combined BRFSS and NHIS data 2011-2017

Outcome	Smoking	Daily smoking	Vaping	Daily vaping
Traditional cigarette tax rate	-0.005*	-0.006**	0.006**	0.002
($ per 20-unit pack)	[-0.010,0.000]	[-0.011,-0.001]	[0.000,0.011]	[-0.002,0.006]
E-cigarette tax (any)	-0.003	-0.003	-0.006	0.000
	[-0.012,0.006]	[-0.009,0.004]	[-0.013,0.002]	[-0.005,0.006]
Observations	495,401	495,147	156,489	156,395
Proportion of outcome variable	0.217	0.145	0.064	0.022
Number of clusters	50	50	50	50

Notes: The unit of observation is an individual in a county in a year. Data are unweighted. Models are estimated with a linear probability model and control for area-level and individual-level variables reported in table 1, county fixed effects, and quarter-by-year fixed effects. 95% confidence intervals account for within-state correlations and are reported in square brackets.
***, **, and * = statistically different from zero at the 1%, 5%, and 10% level.

Table 9. Effects of traditional cigarette and e-cigarette taxes on any smoking among adults using a difference-in-differences-style model including an interaction between the traditional cigarette tax rate and the indicator for an e-cigarette tax: Combined BRFSS and NHIS data, 2011–2017

Sample	Full sample	Males	Females	< 35 years
Traditional cigarette tax rate	-0.004***	-0.008***	-0.002	-0.007*
($ per 20-unit pack)	[-0.007,-0.001]	[-0.013,-0.003]	[-0.006,0.003]	[-0.013,0.000]
E-cigarette tax (any)	-0.002	-0.006	-0.000	-0.007
	[-0.007,0.004]	[-0.014,0.002]	[-0.009,0.009]	[-0.020,0.007]
Traditional cigarette tax rate ($)*	0.002	0.005*	0.000	0.003
E-cigarette tax (any)	[-0.001,0.005]	[-0.000,0.010]	[-0.005,0.005]	[-0.005,0.010]
Observations	3,263,753	1,356,202	1,907,267	495,401
Proportion of outcome variable	0.158	0.175	0.147	0.217
Number of clusters	50	50	50	50

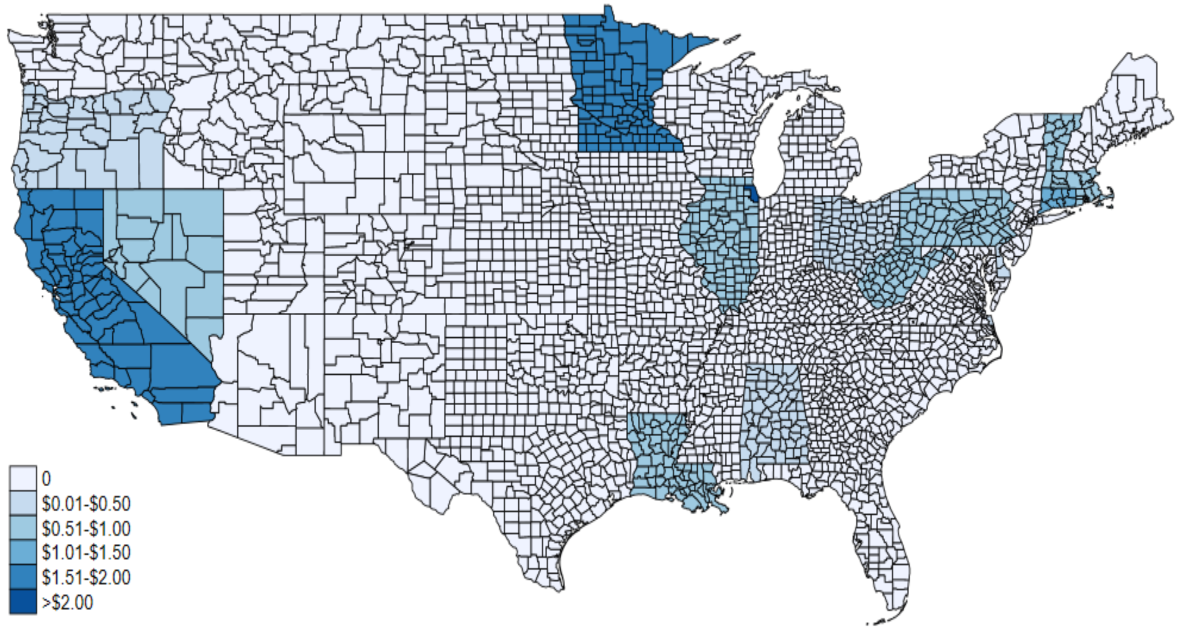
Notes: The unit of observation is an individual in a county in a year. Data are unweighted. Models are estimated with a linear probability model and control for area-level and individual-level variables reported in table 1, county fixed effects, and quarter-by-year fixed effects. 95% confidence intervals account for within-state correlations and are reported in square brackets.
***, **, and * = statistically different from zero at the 1%, 5%, and 10% level.

Table 10. Effects of traditional cigarette and e-cigarette taxes on daily smoking among adults using a difference-in-differences-style model including an interaction between the traditional cigarette tax rate and the indicator for an e-cigarette tax: Combined BRFSS and NHIS data, 2011–2017

Sample	Full sample	Males	Females	< 35 years
Traditional cigarette tax rate	-0.006***	-0.009***	-0.004*	-0.009***
($ per 20-unit pack)	[-0.008,-0.003]	[-0.013,-0.004]	[-0.008,0.000]	[-0.015,-0.003]
E-cigarette tax (any)	-0.005***	-0.006*	-0.005***	-0.010*
	[-0.008,-0.002]	[-0.014,0.001]	[-0.008,-0.002]	[-0.020,0.000]
Traditional cigarette tax rate ($ per 20	0.004***	0.005**	0.003*	0.006*
unit pack)*E-cigarette tax (any)	[0.001,0.006]	[0.001,0.009]	[-0.000,0.006]	[-0.001,0.012]
Observations	3,261,037	1,354,866	1,905,887	495,147
Proportion of outcome variable	0.114	0.126	0.105	0.145
Number of clusters	50	50	50	50

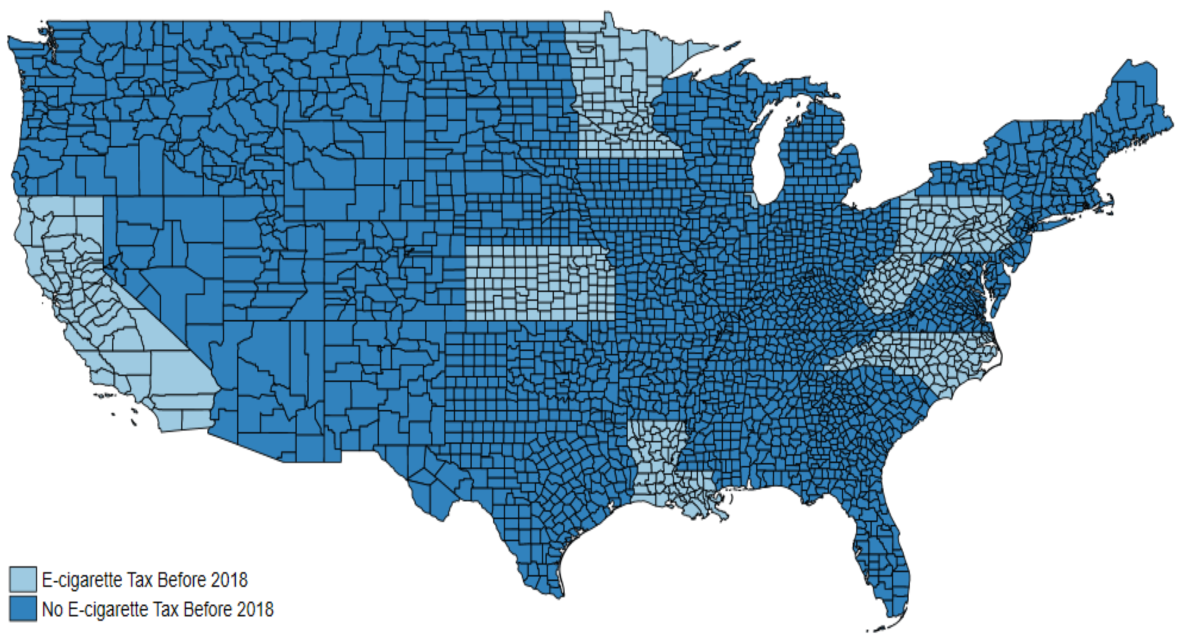
Notes: The unit of observation is an individual in a county in a year. Data are unweighted. Models are estimated with a linear probability model and control for area-level and individual-level variables reported in table 1, county fixed effects, and quarter-by-year fixed effects. 95% confidence intervals account for within-state correlations and are reported in square brackets.
***, **, and * = statistically different from zero at the 1%, 5%, and 10% level.

Figure 1. Geographic variation in locality traditional cigarette taxes, 2017



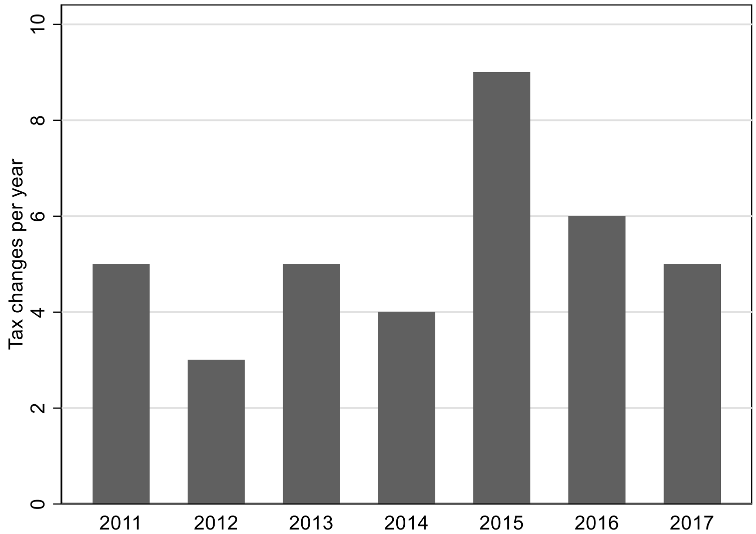
Note: See text for details.

Figure 2. Geographic variation in localities that adopted an e-cigarette tax by 2017



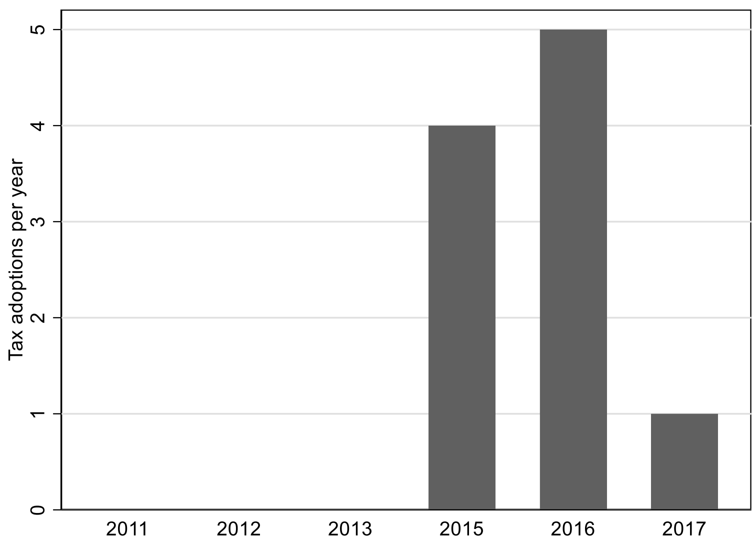
Note: See text for details.

Figure 3. Traditional cigarette tax changes in each year, 2011–2017



Notes: See text for details.

Figure 4. E-cigarette tax adoptions in each year 2011 to 2017



Note: See text for details.

Appendix table 1. Traditional cigarette tax changes, 2011–2017

Locality	**Effective date**	**Tax change amount***
State		
Alabama	10/2015	$0.25
California	4/2017	$2.00
Connecticut	7/2011, 10/2015, 7/2016, 12/2017	$0.40, $0.25, $0.25, $0.45
Delaware	9/2017	$0.50
Hawaii	7/2011	$0.20
Illinois	6/2012	$1.00
Kansas	7/2015	$0.50
Louisiana	7/2015, 4/2016	$0.50, $0.22
Massachusetts	7/2013	$1.00
Minnesota	7/2013, 1/2015, 1/2016, 1/2017	$1.60, $0.07, $0.10, $0.04
New Hampshire	7/2011, 8/2013	-$0.10, $0.10,
Ohio	7/2015	$0.35
Oregon	1/2014, 1/2016	$0.13, $0.01
Nevada	7/2015	$1.00
Pennsylvania	8/2016	$1.00
Rhode Island	7/2012, 8/2015, 8/2017	$0.04, $0.25, $0.50
West Virginia	7/2016	$0.65
Vermont	7/2011, 7/2014, 7/2015	$0.38, $0.13, $0.33
*County/City***		
Chicago, Illinois	1/2014	$0.50
Cook County, Illinois	3/2013	$1.00
Newport News, Virginia	7/2011, 7/2012	$0.10, $0.10
Philadelphia County, Pennsylvania	1/2014	$2.00
Virginia Beach, Virginia	7/2013	$0.05

Note: See text for full details.

* This number indicates the size of the change in the tax, not the level of the tax after accounting for the change.

** For locations with 100,000 people or more.

Appendix table 2. E-cigarette tax adoption through end of 2017

Locality	Effective date	Unit taxed	Tax amount
State			
District of Columbia	10/2015, 10/2016	Wholesale price	67.0%, 65.0%
California	4/2017, 7/2017	Wholesale price	27.3%, 65.1%
Kansas	7/2016, 7/2017	Per fluid milliliter	\$0.20, \$0.05
Louisiana	7/2015	Per fluid milliliter	\$0.05
Minnesota	8/2010, 7/2013	Wholesale price	35.0%, 95.0%
North Carolina	6/2015	Per fluid milliliter	\$0.05
Pennsylvania	7/2016	Purchase price	40.0%
West Virginia	7/2016	Per fluid milliliter	\$0.075
County/City			
Chicago, Illinois	1/2016	Per unit / per fluid milliliter	\$0.80 / \$0.55
Cook County, Illinois	5/2016	Per fluid milliliter	\$0.20
Montgomery County, Maryland	8/2015	Wholesale price	30.0%

Notes: See text for full details. Minnesota is a treated control for our study period. Delaware and New Jersey levied e-cigarette taxes after 2017 (details available on request). We do not incorporate these changes into our analysis.

Appendix table 3. Summary statistics among respondents in all localities, and localities that did and did not adopt an e-cigarette tax by 2017: BRFSS data, 2011–2017

Sample	All localities	Adopting localities	Non-adopting localities
Outcomes			
Smoking	0.157	0.157	0.160
Daily smoking	0.112	0.112	0.114
Vaping	0.031	0.031	0.030
Daily vaping	0.011	0.011	0.011
Traditional cigarette and e-cigarette taxes			
Traditional cigarette tax rate ($ per 20-unit pack)	1.449	1.490	1.273
	(0.922)	(0.943)	(0.802)
E-cigarette tax (any)	0.064	0.000	0.344
Area-level controls			
Restaurant smoking ban	0.700	0.702	0.688
Private workplace smoking ban	0.705	0.703	0.713
Bar smoking ban	0.590	0.585	0.609
Indoor vaping restrictions (% population coverage)	0.139	0.140	0.134
	(0.320)	(0.323)	(0.305)
Beer tax ($ per gallon)	0.237	0.252	0.169
	(0.201)	(0.214)	(0.102)
Medical marijuana law	0.408	0.425	0.333
Marijuana decriminalized	0.328	0.361	0.185
Prescription drug monitoring program	0.948	0.946	0.959
ACA-Medicaid expansion	0.312	0.311	0.315
Unemployment rate (%)	5.961	5.890	6.273
	(2.013)	(1.992)	(2.075)
Individual-level controls			
Female	0.597	0.599	0.584
Male	0.403	0.401	0.416
Less than high school	0.080	0.079	0.081
High school or GED	0.281	0.285	0.266
Some college	0.271	0.272	0.264
College degree or more	0.363	0.359	0.384
Education missing	0.005	0.005	0.005
White	0.836	0.840	0.819
African American	0.087	0.082	0.106
Asian	0.015	0.014	0.022
Native American or Alaskan	0.020	0.021	0.016
Other race	0.023	0.023	0.023
Race missing	0.019	0.020	0.014
Married	0.536	0.538	0.527
Divorced	0.142	0.142	0.138
Widowed	0.134	0.137	0.123
Separated	0.021	0.021	0.022
Never married	0.160	0.155	0.184
Marital status missing	0.007	0.007	0.006
Age (years)	56.12	56.42	54.83
	(16.42)	(16.38)	(16.63)
Uninsured	0.092	0.091	0.094
Insured	0.905	0.906	0.903
Insurance missing	0.003	0.003	0.003
Income ($; missing values imputed)	46,334	46,147	47,151
	(24,636)	(24,540)	(25,031)
Unemployed or not in labor force	0.499	0.504	0.475
Employed	0.494	0.488	0.517
Employment missing	0.008	0.008	0.008
Observations	3,140,962	2,555,342	585,620

Notes: Data are unweighted. The unit of observation is an individual in a county in a year. Standard deviations for continuous variables are reported in parentheses.

Appendix table 4. Summary statistics among respondents in all localities, and localities that did and did not adopt an e-cigarette tax by 2017: NHIS data, 2011–2017

Sample	All localities	Adopting localities	Non-adopting localities
Outcomes			
Smoking	0.176	0.182	0.158
Daily smoking	0.135	0.141	0.116
Vaping	0.031	0.032	0.026
Daily vaping	0.011	0.012	0.009
Traditional cigarette and e-cigarette taxes			
Cigarette excise tax	1.420	1.519	1.143
	(0.946)	(0.993)	(0.734)
Any tax on e-cigarettes	0.055	0.000	0.210
Area-level controls			
Restaurant smoking ban	0.586	0.637	0.444
Private workplace smoking ban	0.598	0.646	0.464
Bar smoking ban	0.468	0.496	0.390
Indoor vaping restrictions (% population	0.128	0.118	0.157
coverage)	(0.304)	(0.299)	(0.316)
Beer tax ($ per gallon)	0.233	0.253	0.175
	(0.194)	(0.217)	(0.076)
Medical marijuana law	0.429	0.370	0.593
Marijuana decriminalized	0.363	0.317	0.494
Prescription drug monitoring program	0.952	0.946	0.969
ACA-Medicaid expansion	0.322	0.290	0.412
Unemployment rate (%)	6.445	6.152	7.269
	(2.098)	(1.958)	(2.254)
Individual-level controls			
Female	0.528	0.528	0.528
Male	0.472	0.472	0.472
Less than high school	0.144	0.135	0.169
High school or GED	0.263	0.270	0.242
Some college	0.290	0.296	0.273
College degree or more	0.289	0.285	0.299
Education missing	0.015	0.014	0.018
White	0.775	0.795	0.721
African American	0.132	0.131	0.133
Asian	0.064	0.046	0.114
Native American or Alaskan	0.012	0.011	0.012
Other race	0.018	0.017	0.020
Race missing	0.000	0.000	0.000
Married	0.569	0.573	0.559
Divorced	0.115	0.120	0.101
Widowed	0.064	0.065	0.060
Separated	0.025	0.024	0.027
Never married	0.223	0.214	0.248
Marital status missing	0.004	0.003	0.004
Age (years)	48.50	48.81	47.65
	(16.75)	(16.79)	(16.59)
Uninsured	0.145	0.142	0.153
Insured	0.845	0.848	0.835
Insurance missing	0.010	0.010	0.013
Income ($; missing values imputed)	21,736	21,652	21,971
	(23,331)	(23,186)	(23,730)
Unemployed or not in labor force	0.375	0.376	0.373
Employed	0.618	0.618	0.618
Employment missing	0.007	0.006	0.009
Observations	496,859	366,420	130,439

Notes: Data are unweighted. The unit of observation is an individual in a county in a year. Standard deviations for continuous variables are reported in parentheses.

References

Abouk, R., and S. Adams. 2017. "Bans on Electronic Cigarette Sales to Minors and Smoking among High School Students." *Journal of Health Economics* 54: 17–24.

Ali, M. M., W. N. Dowd, T. Classen, R. Mutter, and S. P. Novak. 2017. "Prescription Drug Monitoring Programs, Nonmedical Use of Prescription Drugs, and Heroin Use: Evidence from the National Survey of Drug Use and Health." *Addictive Behaviors* 69: 65–77.

Altonji, J. G., L. B. Kahn, and J. D. Speer. 2016. "Cashier or Consultant? Entry Labor Market Conditions, Field of Study, and Career Success." *Journal of Labor Economics* 34 (S1): S361–S401.

Autor, D. H. 2003. "Outsourcing at Will: The Contribution of Unjust Dismissal Doctrine to the Growth of Employment Outsourcing." *Journal of Labor Economics* 21(1): 1–42.

Barbaresco, S., C. J. Courtemanche, and Y. Qi. 2015. "Impacts of the Affordable Care Act Dependent Coverage Provision on Health-Related Outcomes of Young Adults." *Journal of Health Economics* 40: 54–68.

Bertrand, M., E. Duflo, and S. Mullainathan. 2004. "How Much Should We Trust Differences-in-Differences Estimates?" *Quarterly Journal of Economics* 119(1): 249–275.

Besley, T., and A. Case. 2000. "Unnatural Experiments? Estimating the Incidence of Endogenous Policies." *The Economic Journal* 110(467): 672–694.

Bishop, J. M. 2018. "Does Cigarette Smuggling Prop up Smoking Rates?" *American Journal of Health Economics* 4(1): 80–104.

Bradford, A. C., and W. D. Bradford. 2018. "The Impact of Medical Cannabis Legalization on Prescription Medication Use and Costs under Medicare Part D." *The Journal of Law and Economics* 61(3): 461–487.

Burns, M., and L. Dague. 2017. "The Effect of Expanding Medicaid Eligibility on Supplemental Security Income Program Participation." *Journal of Public Economics* 149: 20–34.

Callison, K., and R. Kaestner. 2014. "Do Higher Tobacco Taxes Reduce Adult Smoking? New Evidence of the Effect of Recent Cigarette Tax Increases on Adult Smoking." *Economic Inquiry* 52(1): 155–172.

Cantrell, J., J. Huang, M. S. Greenberg, H. Xiao, E. C. Hair, and D. Vallone. 2019. "Impact of E-Cigarette and Cigarette Prices on Youth and Young Adult E-Cigarette and Cigarette Behaviour: Evidence from a National Longitudinal Cohort." *Tobacco Control*: http://dx.doi.org/10.1136/tobaccocontrol-2018-054764.

Carpenter, C., and P. J. Cook. 2008. "Cigarette Taxes and Youth Smoking: New Evidence from National, State, and Local Youth Risk Behavior Surveys." *Journal of Health Economics* 27(2): 287–299.

Centers for Disease Control and Prevention. 2019. CDC State System.

Chaloupka, F. J., and K. E. Warner. 2000. "The Economics of Smoking." In *Handbook of Health Economics,* edited by A. J. Culyer and J. P. Newhouse, 1539–1627. New York: Elsevier.

Community Preventive Services Task Force. 2014. Reducing Tobacco Use and Secondhand Smoke Exposure: Interventions to Increase the Unit Price for Tobacco Products.

Cooper, M. T., and M. F. Pesko. 2017. "The Effect of E-Cigarette Indoor Vaping Restrictions on Adult Prenatal Smoking and Birth Outcomes." *Journal of Health Economics* 56: 178–190.

Cotti, C., E. Nesson, and N. Tefft. 2016. "The Effects of Tobacco Control Policies on Tobacco Products, Tar, and Nicotine Purchases among Adults: Evidence from Household Panel Data." *American Economic Journal: Economic Policy* 8(4): 103–23.

Cotti, C., E. Nesson, and N. Tefft. 2018. “The Relationship between Cigarettes and Electronic Cigarettes: Evidence from Household Panel Data.” *Journal of Health Economics* 61: 205–219.
Courtemanche, C., and B. Feng. 2018. “Can Cigarette Taxes Still Reduce Youth Smoking?”
Dave, D., B. Feng, and M. F. Pesko. 2019. “The Effects of E-Cigarette Minimum Legal Sale Age Laws on Youth Substance Use.” *Health Economics* 28(3): 419–436.
DeCicca, P., D. Kenkel, and A. Mathios. 2002. “Putting out the Fires: Will Higher Taxes Reduce the Onset of Youth Smoking?” *Journal of Political Economy* 110(1): 144–169.
DeCicca, P., and L. McLeod. 2008. “Cigarette Taxes and Older Adult Smoking: Evidence from Recent Large Tax Increases.” *Journal of Health Economics* 27(4): 918–929.
Farber, H. S., D. Herbst, I. Kuziemko, and S. Naidu. 2018. “Unions and Inequality over the Twentieth Century: New Evidence from Survey Data.” National Bureau of Economic Research Working Paper No. 24587.
Friedman, A. S. 2015. “How Does Electronic Cigarette Access Affect Adolescent Smoking?” *Journal of Health Economics* 44 (December): 300–308.
Glasser, A. M., L. Collins, J. L. Pearson, H. Abudayyeh, R. S. Niaura, D. B. Abrams, and A. C. Villanti. 2017. “Overview of Electronic Nicotine Delivery Systems: A Systematic Review.” *American Journal of Preventive Medicine* 52(2): e33–e66.
Gostin, L. O. 2017. “2016: The Year of the Soda Tax.” *The Milbank Quarterly* 95(1): 19.
Gruber, J., and M. Frakes. 2006. “Does Falling Smoking Lead to Rising Obesity?” *Journal of Health Economics* 25(2): 183–197.
Gruber, J., and B. Köszegi. 2001. “Is Addiction ‘Rational’? Theory and Evidence.” *The Quarterly Journal of Economics* 116(4): 1261–1303.
Hajek, P., A. Phillips-Waller, D. Przulj, F. Pesola, K. Myers Smith, N. Bisal, J. Li, S. Parrott, P. Sasieni, and L. Dawkins. 2019. “A Randomized Trial of E-Cigarettes Versus Nicotine-Replacement Therapy.” *New England Journal of Medicine* 380 (7): 629–637.
Hansen, B., J. J. Sabia, and D. I. Rees. 2017. “Have Cigarette Taxes Lost Their Bite? New Estimates of the Relationship between Cigarette Taxes and Youth Smoking.” *American Journal of Health Economics* 3(1): 60–75.
Harrell, P. T., N. S. Marquinez, J. B. Correa, L. R. Meltzer, M. Unrod, S. K. Sutton, V. N. Simmons, and T. H. Brandon. 2014. “Expectancies for Cigarettes, E-Cigarettes, and Nicotine Replacement Therapies among E-Cigarette Users (Aka Vapers).” *Nicotine & Tobacco Research* 17(2): 193–200.
Horn, B. P., J. C. Maclean, and M. R. Strain. 2017. “Do Minimum Wage Increases Influence Worker Health?” *Economic Inquiry* 55(4): 1986–2007.
Huang, J., C. Gwarnicki, X. Xu, R. S. Caraballo, R. Wada, and F. J. Chaloupka. 2018. “A Comprehensive Examination of Own- and Cross-Price Elasticities of Tobacco and Nicotine Replacement Products in the US.” *Preventive Medicine* 117: 107–114.
Lovenheim, M. F. 2009. “The Effect of Teachers’ Unions on Education Production: Evidence from Union Election Certifications in Three Midwestern States.” *Journal of Labor Economics* 27(4): 525–587.
Maclean, J. C., A. S. Kessler, and D. S. Kenkel. 2016. “Cigarette Taxes and Older Adult Smoking: Evidence from the Health and Retirement Study.” *Health Economics* 25 (4): 424–438.
Maclean, J. C., M. Oney, J. Marti, and J. Sindelar. 2018. “What Factors Predict the Passage of State-Level E-Cigarette Regulations?” *Health Economics* 27(5): 897–907.

Maclean, J. C., M. F. Pesko, and S. C. Hill. 2019. "Public Insurance Expansions and Smoking Cessation Medications." *Economic Inquiry*. Accepted.

Maclean, J. C., D. S. Tello-Trillo, and D. Webber. 2019. "Losing Insurance and Behavioral Health Inpatient Care: Evidence from a Large-Scale Medicaid Disenrollment." Cambridge, MA: National Bureau of Economic Research Working Paper No. 25936.

Marti, J., J. Buckell, J. C. Maclean, and J. Sindelar. 2019. "To 'Vape' or Smoke? Experimental Evidence on Adult Smokers." *Economic Inquiry* 57(1): 705–725.

McInerney, M., and K. Simon. 2012. "The Effect of State Workers' Compensation Program Changes on the Use of Federal Social Security Disability Insurance." *Industrial Relations: A Journal of Economy and Society* 51(1): 57–88.

Miller, S. 2012. "The Effect of Insurance on Emergency Room Visits: An Analysis of the 2006 Massachusetts Health Reform." *Journal of Public Economics* 96(11–12): 893–908.

Miller, S., and L. R. Wherry. 2017. "Health and Access to Care During the First 2 Years of the ACA Medicaid Expansions." *New England Journal of Medicine* 376(10): 947–956.

National Institute on Alcohol Abuse and Alcoholism. 2019. Alcohol Policy Information System (Apis): Beer Taxes.

Nesson, E. 2017. "Heterogeneity in Smokers' Responses to Tobacco Control Policies." *Health Economics* 26(2): 206–225.

Orzechowski, W., and R. Walker. 2018. The Tax Burden on Tobacco 2017: Historical Compilation. Arlington, VA.

Pacula, R. L., J. F. Chriqui, and J. King. 2003. "Marijuana Decriminalization: What Does It Mean in the United States?" In *National Bureau of Economic Research Working Paper Series*. Cambridge, MA: National Bureau of Economic Research.

Page, M. E., J. Spetz, and J. Millar. 2005. "Does the Minimum Wage Affect Welfare Caseloads?" *Journal of Policy Analysis and Management* 24(2): 273–295.

Pei, Z., J.-S. Pischke, and H. Schwandt. 2018. "Poorly Measured Confounders Are More Useful on the Left Than on the Right." *Journal of Business & Economic Statistics*: 1–12.

Pesko, M. F. 2014. "Stress and Smoking: Associations with Terrorism and Causal Impact." *Contemporary Economic Policy* 32(2): 351–371.

Pesko, M. F., and J. M. Currie. 2019. "E-Cigarette Minimum Legal Sale Age Laws and Traditional Cigarette Use among Rural Pregnant Teenagers." *Journal of Health Economics* 66(July): 71–90.

Pesko, M. F., J. Huang, L. D. Johnston, and F. J. Chaloupka. 2018. "E-Cigarette Price Sensitivity among Middle- and High-School Students: Evidence from Monitoring the Future." *Addiction* 113(5): 896–906.

Pesko, M. F., J. M. Hughes, and F. S. Faisal. 2016. "The Influence of Electronic Cigarette Age Purchasing Restrictions on Adolescent Tobacco and Marijuana Use." *Preventive Medicine* 87: 207–12.

Pesko, M. F., D. S. Kenkel, H. Wang, and J. M. Hughes. 2016. "The Effect of Potential Electronic Nicotine Delivery System Regulations on Nicotine Product Selection." *Addiction* 111(4): 734–744.

Pesko, M. F., and C. Warman. 2017. "The Effect of Prices on Youth Cigarette and E-Cigarette Use: Economic Substitutes or Complements?" Social Science Research Network.

Remler, D. K. 2004. "Poor Smokers, Poor Quitters, and Cigarette Tax Regressivity." *American Journal of Public Health* 94(2): 225–229.

Sabia, J. J., and T. T. Nguyen. 2018. "The Effect of Medical Marijuana Laws on Labor Market Outcomes." *The Journal of Law and Economics* 61(3): 361–396.

Saffer, H., D. Dench, D. Dave, and M. Grossman. 2018. "E-Cigarettes and Adult Smoking." National Bureau of Economic Research Working Paper, Cambridge, MA.

Sterba, K. R., V. Rabius, M. J. Carpenter, P. Villars, D. Wiatrek, and A. McAlister. 2011. "Dyadic Efficacy for Smoking Cessation: Preliminary Assessment of a New Instrument." *Nicotine & Tobacco Research* 13(3): 194–201.

Stoklosa, M., J. Drope, and F. J. Chaloupka. 2016. "Prices and E-Cigarette Demand: Evidence from the European Union." *Nicotine & Tobacco Research* 18(10): 1973–1980.

US Department of Health and Human Services. 2016. *E-Cigarette Use among Youth and Young Adults: A Report of the Surgeon General*. Rockville, MD: US Department of Health and Human Services.

University of Kentucky Center for Poverty Research. 2019. UKCPR National Welfare Data, 1980–2017. Lexington, KY: Gatton College of Business and Economics, University of Kentucky.

Vapor Products Tax. 2018. Tax Data Center.

Wang, T. W., K. Asman, A. S. Gentzke, K. A. Cullen, E. Holder-Hayes, C. Reyes-Guzman, A. Jamal, L. Neff, and B. A. King. 2018. "Tobacco Product Use among Adults—United States, 2017." *Morbidity and Mortality Weekly Report* 67(44): 1225.

Webber, D. A. 2016. "Are College Costs Worth It? How Ability, Major, and Debt Affect the Returns to Schooling." *Economics of Education Review* 53: 296–310.

Winickoff, J. P., M. Gottlieb, and M. M. Mello. 2014. "Tobacco 21—an Idea Whose Time Has Come." *New England Journal of Medicine* 370(4): 295–297.

Zheng, Y., C. Zhen, D. Dench, and J. M. Nonnemaker. 2017. "US Demand for Tobacco Products in a System Framework." *Health Economics* 26(8): 1067–1086.