



The relationship between cigarettes and electronic cigarettes: Evidence from household panel data[☆]



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ABSTRACT

We use the Nielsen Consumer Panel to investigate the impact of tobacco control policies on purchases of electronic cigarettes (e-cigarettes), cigarettes, and smoking cessation products. We measure product quantity, product type, nicotine content, and liquid volume of e-cigarettes, and product quantity and nicotine content of cigarettes. Higher cigarette excise taxes decrease both cigarette and e-cigarette purchases, suggesting that cigarettes and e-cigarettes are complements, and higher cigarette excise taxes reduce the aggregate amount of nicotine purchased from cigarettes and e-cigarettes. Cigarette smoke-free air laws decrease cigarette purchases, while e-cigarette smoke-free air laws do not affect cigarette or e-cigarette purchases.

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1. Introduction

Use of electronic cigarettes (e-cigarettes), handheld devices that users use to inhale an aerosol usually containing nicotine, has rapidly increased in the past few years. According to the CDC, in 2014 over 12% of adults had ever tried an e-cigarette and over 3.5% of adults currently used e-cigarettes. Compared to cigarettes, e-cigarettes release lower doses of carcinogens and nicotine, although public health officials are concerned that increased e-cigarette use may increase use of cigarettes (Goniewicz et al., 2014, 2012; Cahn and Siegel, 2011). Because of these concerns, a growing number of states and localities have restricted e-cigarette pur-

chases and use. However, little is known regarding the economic relationship between e-cigarettes and cigarettes, so the effects of e-cigarette restrictions on e-cigarette use and cigarettes, and the effects of traditional tobacco control policies on e-cigarette use remain uncertain.

It is possible and would be intuitive to assume that e-cigarettes and cigarettes are substitutes, as they both deliver nicotine in an inhaled form. Indeed, early research examining adolescents finds that states implementing restrictions on e-cigarette purchases saw increases in smoking among adolescents (Friedman, 2015; Pesko et al., 2016; Dave et al., 2017), although Abouk and Adams (2017) find that e-cigarette bans decrease smoking among adolescents, suggesting a complementary relationship. But the intuition that cigarettes and e-cigarettes are substitutes doesn't adequately account for nicotine's habit-forming potential; hence, the relationship may be different between adolescents and adults. Moreover, limitations in data availability on purchases and consumption of e-cigarettes have caused previous work to focus on the effects of policies targeting e-cigarettes on the use of cigarettes to infer the nature of the relationship. Finally, the early research on e-cigarettes and cigarettes does not examine the harmful ingredients in e-cigarettes, like the amount of nicotine or liquid in the e-cigarettes.

In this paper, we examine the economic relationship between e-cigarettes, cigarettes, and other smoking cessation products among adults. Specifically, we use the Nielsen Consumer Panel (NCP)

[☆] Researcher(s) own analyses calculated based in part on data from The Nielsen Company (US), LLC and marketing databases provided through the Nielsen Datasets at the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business. The conclusions drawn from the Nielsen data are those of the researchers and do not reflect the views of Nielsen. Nielsen is not responsible for, had no role in, and was not involved in analyzing and preparing the results reported herein. The authors thank participants at Montana State, the University of Colorado – Denver, and the 2017 iHEA World Congress for helpful comments. Author order is alphabetic and lead authorship is shared among all of the authors. There are no conflicts of interest.

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between the years of 2011 and 2015 to examine how cigarette, e-cigarette, and smoking cessation product purchases respond to increases in cigarette excise taxes and smoke-free air laws (SFA laws) that restrict both cigarettes and e-cigarettes. To our knowledge, we present the first estimates of how the demand for e-cigarettes responds to changes in tobacco control and e-cigarettes policies. The use of the NCP allows for a comprehensive evaluation of changes in purchases *within*-households *across* time in response to policy changes. Moreover, we use UPCs to match 90% of cigarette and 85% of e-cigarette products to detailed product characteristics, including product type, liquid volume, and nicotine content for e-cigarettes and nicotine content for cigarettes. These additional characteristics allow for an investigation of not just the product and cross-product effects on purchase quantity, but also a detailed understanding of the impacts on harmful ingredient consumption, both for cigarettes and e-cigarettes.

Our results indicate that increases in cigarette excise taxes reduce both cigarette and e-cigarette purchases, measured both by the counts of purchases and by the total amount of nicotine or volume of liquid purchased.¹ Intuitively, we also find some evidence that cigarette excise taxes increase smoking cessation product purchases. Results also indicate that SFA laws applying to cigarettes decrease cigarette purchases and may increase smoking cessation product purchases, but we do not find evidence they lead to statistically significant changes in e-cigarette purchases. Finally, the data do not indicate that SFA laws which target e-cigarette usage lead to statistically significant changes in tobacco purchases among adults. Broadly, our results provide causal evidence for a complementary relationship between traditional cigarettes and e-cigarettes among adults.

This study contributes to the literature in several ways. To our knowledge, we offer the first estimates of how *purchases* of e-cigarettes respond to tobacco control policies (including cigarette taxes or prices) and the first evidence of how e-cigarette SFA laws affect purchases of cigarettes, e-cigarettes, and smoking cessation products. Second, we leverage the detailed product information in the NCP to match cigarette purchases to the nicotine contents of the cigarettes using data from the National Health and Nutrition Examination Surveys (NHANES) and e-cigarette purchases to the product type, volume of liquid, and nicotine content using internet searches, correspondences with companies, and visits to retailers. The NCP household panel data also offer advantages over self-reported measures of tobacco use. Since we examine changes in smoking behavior within households across time in response to changes in tobacco control policies, using household fixed effects, we can determine whether estimated changes in the number of cigarettes, e-cigarettes, or smoking cessation products purchases represent changes in behavior or changes in the pool of purchasers. Finally, since our data represent scanned purchases, it likely suffers from less recall error than retrospective self-reported measures of consumption.

The rest of this paper is organized as follows. Section 2 provides background and a review of the literature surrounding e-cigarette use, Section 3 summarizes our data sources, Section 4 describes our methodology, Section 5 reviews the results, and Section 6 concludes.

2. Background

E-cigarettes are handheld devices that heat a liquid solution containing nicotine into an aerosol so it can be inhaled. In addition to nicotine, the solution includes flavorings, propylene glycol or

¹ The reductions in e-cigarette purchases are driven by e-cigarette cartridge refills and starter kits, products likely used more by regular e-cigarette users.

glycerin, and other additives (U.S. Food and Drug Administration, 2017). Most e-cigarettes consist of a battery, a vaporizer that heats the liquid solution, and a cartridge that holds the liquid solution. E-cigarettes may be disposable devices, which are marketed to last about as long as a pack of cigarettes, or more permanent devices consisting of a battery and vaporizer and a replaceable or reusable cartridge (Glasser et al., 2017).

Currently, the contents and labeling of e-cigarettes are not regulated by the U.S. Food & Drug Administration, and the labeling of e-cigarette packages varies across brands and manufacturers. Specifically, brands label the nicotine concentration of their liquids, often in terms of percent of nicotine per milliliter of fluid (e.g., 1.7% nicotine/ml) or in the total amount of nicotine in the liquid (e.g., 18 mg of nicotine). Laboratory tests suggest that the actual content of nicotine varies somewhat but is often consistent with product labels (Etter et al., 2013; Goniewicz et al., 2012). The amount of nicotine ingested by e-cigarette users is often less than would be ingested using cigarettes; however, the amount of nicotine ingested by the user may vary considerably, depending on the experience of the user (Farsalinos et al., 2014; Vansickel and Eissenberg, 2013; Etter, 2014).

In addition to nicotine, e-cigarette vapor contains other compounds including particulate matter and some of the same toxic chemicals in tobacco smoke. According to laboratory tests, the particulate matter is similar in size as particles released from cigarettes, but studies have not reached a consensus as to the amount of particulate matter released (Fuoco et al., 2014; Ingebrethsen et al., 2012; Long, 2014). Most studies have found that the toxic chemical concentrations are much less than measured in cigarettes (Farsalinos et al., 2015a; Goniewicz et al., 2014; Farsalinos et al., 2015b). There is a debate regarding the overall safety of e-cigarettes relative to cigarettes. Researchers who view e-cigarettes favorably point to the smaller amounts of toxins in e-cigarettes, while researchers who are more skeptical of e-cigarettes express concerns regarding a 're-normalization' of smoking, a lack of regulation in the e-cigarette market, and the rapid take-up of e-cigarettes by adolescents (Etter, 2012; Wagener et al., 2012b,a; Cobb et al., 2010; Fairchild et al., 2014; Dutra and Glantz, 2014).

E-cigarette use among both adolescents and adults has markedly increased over the past five years (Centers for Disease Control and Prevention, 2016; Regan et al., 2013). A growing literature examines the relationship between e-cigarette use and cigarettes, usually finding positive correlations between the two products. As an example, Dutra and Glantz (2014) examine the National Youth Tobacco Surveys and find that e-cigarette use is positively correlated with different measures of cigarette use among adolescents. Coleman et al. (2014) examine young adults who are not established smokers and find that use of e-cigarettes is correlated with openness to cigarette smoking. However, these studies do not use identification strategies which support a causal interpretation.

As a result of a lack of good data sources, early papers in the economics literature have focused on experiments to analyze the market for e-cigarettes. Marti et al. (2016) conduct an online experiment examining how various e-cigarette attributes affected demand for e-cigarettes. The authors find that adult smokers, in general, have a strong preference for cigarettes over e-cigarettes. Smokers value e-cigarettes as cessation devices, a *relatively* healthy alternative to cigarettes, and the ability to smoke e-cigarettes in public places. Pesko et al. (2016) also conduct an experiment to analyze the effects of e-cigarette regulations on the demand for e-cigarettes. They find that proposed taxes on e-cigarettes, warning labels, and restrictions on e-cigarette flavors would likely reduce the number of adult smokers who would switch to e-cigarettes.

Friedman (2015) examines the effects of adolescent e-cigarette restrictions on state-level smoking rates among adolescents, using

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