HHS Public Access

Author manuscript

Drug Alcohol Depend. Author manuscript; available in PMC 2022 January 01.

Published in final edited form as:

Drug Alcohol Depend. 2021 January 01; 218: 108406. doi:10.1016/j.drugalcdep.2020.108406.

Estimating the Price Elasticity of Demand for JUUL E-cigarettes among Teens

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Abstract

Background: The widespread popularity of e-cigarettes, particularly JUUL, has led to an alarming increase in teen nicotine use, reversing a 40-year trend. One key question is how sensitive teens' demand for JUUL is to changes in price.

Methods: We estimate the price elasticity of demand using results from an experimental auction where teen nicotine users and nonusers bid on a JUUL kit.

Results: We find that a 10% increase in price leads to as much as a 24% reduction in JUUL demand among teens using nicotine, and as much as a 45% reduction among teens not currently using nicotine. The teens in our study were more price sensitive than older adults who took part in a similar earlier study.

Conclusions: From a public health standpoint, these are promising results. High e-cigarette taxes may dissuade relatively few older adult cigarette smokers from switching to e-cigarettes, but at the same time be highly effective at preventing teens from becoming e-cigarette users in the first place.

Keywords

E-cigarettes; JUUL; teens; price elasticity of demand

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All authors contributed materially to the research presented in this paper.

The authors have no conflicts of interest or financial disclosures.

1. Introduction

Between 1976 and 2018, cigarette use among U.S. high-school seniors fell by 87% (Johnston, et al. 2019). This is a landmark achievement in a country where smoking remains the leading cause of preventable death (U.S. Department of Health and Human Services 2014). But while smoking has dropped, youth e-cigarette use has surged, particularly since 2017 (Cullen et al. 2018). Much of this increase appears due to the overwhelming popularity of the JUUL brand (Cullen et al. 2019).

At the same time, e-cigarettes appear safer than conventional cigarettes (National Academies of Sciences, Engineering, and Medicine 2018; McNeill et al. 2020), and while the evidence is mixed (Halpern et al. 2018), there is some reason to believe e-cigarettes may help cigarette smokers quit (Hajek et al. 2019). If older adult smokers could use e-cigarettes to transition off of all nicotine products or, short of that, switch completely to e-cigarettes, that would be a public health victory. But it may not be a victory worth winning if it comes at the cost of a large increase in nicotine addiction among the next generation.

A carefully calibrated e-cigarette tax may allow policymakers to navigate this narrow channel, assuming, that is, the tax could be set high enough to dissuade teens from using e-cigarettes, but not so high that it keeps adult cigarette smokers from switching. This depends critically on how sensitive e-cigarette demand is to an increase in price, what economists call the price elasticity of demand (PED).

To estimate the PED among young adults, we report results from an experimental auction where 18- and 19-year-olds bid on 11 different nicotine products, including a JUUL kit.

2. Methods

2.1. Study design

The Institutional Review Board at the University of South Carolina approved this study. We recruited 300 18- and 19-year-olds from Susquehanna University (N = 112) and the University of South Carolina (N = 188) between October 2018 and March 2019. One hundred seventy-five (58%) of these participants were current nicotine users, meaning they had used cigarettes or e-cigarettes within the last 30 days. Among these users, 117 used only e-cigarettes, 5 used only cigarettes, and 53 were dual users. The remaining 125 were nonusers. Each participant received $20 for taking part in the 20-minute study.

Participants bid on 10 tobacco products that varied in terms of product type (i.e., e-cigarette, conventional cigarette, heated tobacco product), flavor, brand, and nicotine level.[1] In addition, all participants evaluated a Starbucks gift card and a JUUL starter kit, which included a device and 4 flavored “pods” (i.e., mint, crème brulee, tobacco, mango).

The auction experiment had six steps.

[1]While the 10 products varied between participants, the overarching goal was for 40% of products to come from the baseline product in a category (e.g., tobacco flavor in the case of flavorings) and 30% to come from each alternative category (e.g., cherry and menthol flavors). Brands were the exception, where 30% of products were Marlboro, 30% were Freedom, 30% were Blu, and 10% were Horizon branded.

Step 1: Screening

Participants confirmed they were 18 or 19 years old by showing the experimenter their driver's license or other form of identification. The experimenter then determined whether participants were current nicotine users.

Step 2: Use and perceptions survey

Participants completed a survey about their smoking habits and attitudes toward and knowledge of conventional cigarettes, e-cigarettes, and non-combusted cigarettes (i.e., heat-not-burn devices).

Step 3: Auction instructions

The experimenter explained that the participant would bid on several products but that only one randomly determined product would be sold. For each product, the participant would bid in a Becker-DeGroot-Marschak (BDM) mechanism (Becker, DeGroot and Marschak 1964). The Participant would choose a bid between $0 and $10 in $0.10 increments. The experimenter would compare this bid to a price drawn at random from a uniform distribution over the [$0, $10] interval. If the participant's bid was greater than or equal to the random price for the selected item, they would win the product and pay the random price. If their bid was less than the random price, they would not win the product. The BDM mechanism is "demand revealing," meaning a participant could do no better than to submit a bid equal to what they were truly willing to pay for a product. This is because the participant's bid could not influence the price they would pay if they won the auction, meaning there was no incentive to submit a low bid in the hope of getting a better deal.

Step 4: Practice auction

The participant first bid in a hypothetical practice auction for a six-month subscription to each of three popular magazines. This allowed the participant to see how the auction would work, and reinforced that, while they would bid on several products, only one randomly chosen product would be sold.

Step 5: Real auction

The participant bid on 11 nicotine products and a Starbucks gift card. All participants bid on the JUUL kit in round 12. After a participant had bid on all 12 products, the experimenter determined the product to be sold.[2] The experimenter then chose the random price for that product, compared that price to the participant's bid, and determined whether the participant won the product.

Step 6: Demographic survey

Participants indicated their age, gender, student status, race, and ethnicity.

[2]Because some of the nicotine products were not actually available (e.g., non-combusted cigarettes), the product sold at Susquehanna University was either a pack of conventional cigarettes or a Starbucks gift card, with the choice made at random. Because USC is a tobacco-free campus, the product sold there was always a gift card.

2.2. Data analysis

Price elasticity of demand (PED) measures how sensitive demand is to changes in price. Specifically, PED measures the percent decrease in quantity demanded associated with a one percent increase in price. Because the increase in teen nicotine use has been driven by e-cigarettes, and the majority of teen e-cigarette users use JUUL (Cullen, Gentzke, et al. 2019), we focus on PED for the JUUL kit. To estimate demand, we Follow Lusk and Schroeder (2004), who construct "inverse cumulative density functions of WTP," which they observe "can be interpreted as demand curves assuming each individual only consumes one unit." Analyzing the data in 2020, we constructed separate demand curves for JUUL among current nicotine users and nonusers by assuming that for any given price, the quantity demanded is equal to the number of auction participants who submitted a bid greater than or equal to that price. Because we asked participants to submit bids between $0 and $10, we estimated (inverse) demand using linear and quadratic tobit models that take into account bid censoring from above at $10 and below at $0:

$$P_j = \beta_0 + \beta_1 Q_j + \varepsilon_j, \tag{1}$$

$$P_j = \gamma_0 + \gamma_1 Q_j + \gamma_2 Q_j^2 + \varepsilon_j, \tag{2}$$

where P_j represents the jth-highest price in the [$0, $10] range subjects could indicate they were willing to pay, Q_j is the quantity demanded measured as the percentage of subjects willing to pay at least price j, and ε_j is a zero-mean error term. We estimated PED at a given price-quantity combination for the linear model as

$$PED_j = \frac{1}{\hat{\beta}_1}\frac{P_j}{Q_j}, \tag{3}$$

and for the quadratic model as

$$PED_j = \frac{1}{\hat{\gamma}_1 + 2\hat{\gamma}_2 Q_j}\frac{P_j}{Q_j}, \tag{4}$$

where $\hat{\beta}$ and $\hat{\gamma}$ represent coefficient estimates from equations (1) and (2).

3. Results

Figure 1 shows the demand curves for a JUUL kit among nicotine users and nonusers along with the fitted demand curves from the linear and quadratic tobit models. Tobit results for users are as follows, where t-statistics are in parentheses:

$$\begin{aligned} P_j &= 16.37 - 0.18 Q_j, \\ &(115.29)\ (-82.13) \end{aligned} \tag{5}$$

$$P_j = \underset{(35.77)}{13.02} - \underset{(-4.94)}{0.06}Q_j - \underset{(-9.11)}{0.00}Q_j^2. \quad (6)$$

Tobit results for nonusers are as follows:

$$P_j = \underset{(90.44)}{12.14} - \underset{(-58.25)}{0.22}Q_j, \quad (7)$$

$$P_j = \underset{(45.39)}{11.66} - \underset{(-10.32)}{0.19}Q_j - \underset{(-2.02)}{0.00}Q_j^2. \quad (8)$$

Because PED varies with price and quantity, Table 1 presents PED estimates and confidence intervals for several price-quantity combinations.

We find that a 10% increase in price leads to as much as a 24% reduction in e-cigarette demand among teens currently using nicotine, and as much as a 45% reduction among teens who are not currently using nicotine.[3],[4]

4. Discussion

At every price in Table 1, PED is larger in absolute value for nonusers than for users, implying nonusers' demand is more price sensitive. As expected, for both users and nonusers, PED estimates rise in absolute value as the price rises. This means that teens become more price sensitive as the price of e-cigarettes increases.[5] At higher prices, e-cigarette demand is especially price sensitive among nonusers. At a price of $10, for example, nonusers' demand for e-cigarettes is more price sensitive than demand for goods such as restaurant meals (−1.6), leisure travel (−2.4), or fresh vegetables (−3.7) (Mateer and Coppock 2021).

Using a similar experimental auction, Corrigan et al. (2020) estimated PED for a single-use Blu e-cigarette among a sample of cigarette smokers who were not current e-cigarette users and were, on average, 42 years old.[6] The authors reported that PED among auction winners was −0.56 (95% CI [−0.60, −0.53]). They calculated this value at a price of $7.15, which was the average bid submitted by auction winners. For comparison, linear PED at that price for our teen sample was −0.78 (95% CI [−0.80, −0.76]) among users and −1.49 (95% CI

[3]As a sensitivity test, we also estimated PED for users, excluding the five cigarette-only users. These results were not statistically significantly different from those for the larger sample of users.

[4]Mean bids were significantly lower at Susquehanna University than at the University of South Carolina ($4.10 vs. $5.38, p=0.01 in a two-sided t-test assuming unequal variance). As a result, PED estimates differed across sites. For example, linear PED among users at a price of $10 was −2.42 at Susquehanna and −1.34 at USC.

[5]This is necessarily true for linear demand curves. A $1 price increase represents a smaller percentage change at higher price levels, but leads to the same decrease in quantity demanded.

[6]Participants were cigarette smokers in Selinsgrove, PA, and Buffalo, NY, who were at least 18 years old, did not have major health concerns, and were not regular e-cigarette users. As in the current study, Corrigan et al. used the BDM mechanism. While those authors did not place an upper bound on auction bids, 91% of bids were less than or equal to $10.

[−1.54, −1.44]) among nonusers. These results suggest that teen nonusers are dramatically more price sensitive than teen nicotine users, who are, in turn, somewhat more price sensitive than adult smokers who are not current e-cigarette users. From a public health standpoint, these are promising results. High e-cigarette taxes may dissuade relatively few older adult cigarette smokers from switching to e-cigarettes, but at the same time be highly effective at preventing teens from becoming e-cigarette users in the first place.[7]

One limitation of this study is that participants' bids were restricted to the [$0, $10] interval at a time when a JUUL starter kit had a retail price of $39.99. This does not appear to have had a major impact on bids given that 68% of users and 89% of nonusers chose to submit bids of less than $10 (with the rest bidding $10). For nonusers, this may indicate a lack of interest in the JUUL kit. For users, this may be the result of participants already owning a JUUL device and, therefore, placing relatively little value on a second device. Insomuch as bid censoring was an issue, we accounted for it econometrically by using tobit analysis to control for censoring from above at $10 and below at $0. Future research should examine whether biding behavior is different with no upper bound on bids. Future studies should also use identical method with teens and adults to allow for a more direct comparison of teen and adult PED.

Role of Funding Source

This work was supported by a grant from the National Institutes of Health (1P01CA200512-01). This organization had no role in the study design, collection, analysis or interpretation of the data, writing the manuscript, or the decision to submit the paper for publication.

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[7]A drawback of this approach is that higher e-cigarette taxes may dissuade low-income older adult cigarette smokers from switching. Policymakers can mitigate this problem by setting taxes on the two goods so that the price of e-cigarettes remains lower than cigarettes on a cost-per-pack basis.

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Highlights

- E-cigarettes have increased teen nicotine use but may help some adult smokers quit
- We estimate teens' price elasticity of demand for JUUL e-cigarettes using auction bids
- We find teens' demand for JUUL e-cigarettes is relatively sensitive to price changes
- E-cigarette taxes may be highly effective at preventing teens from becoming users

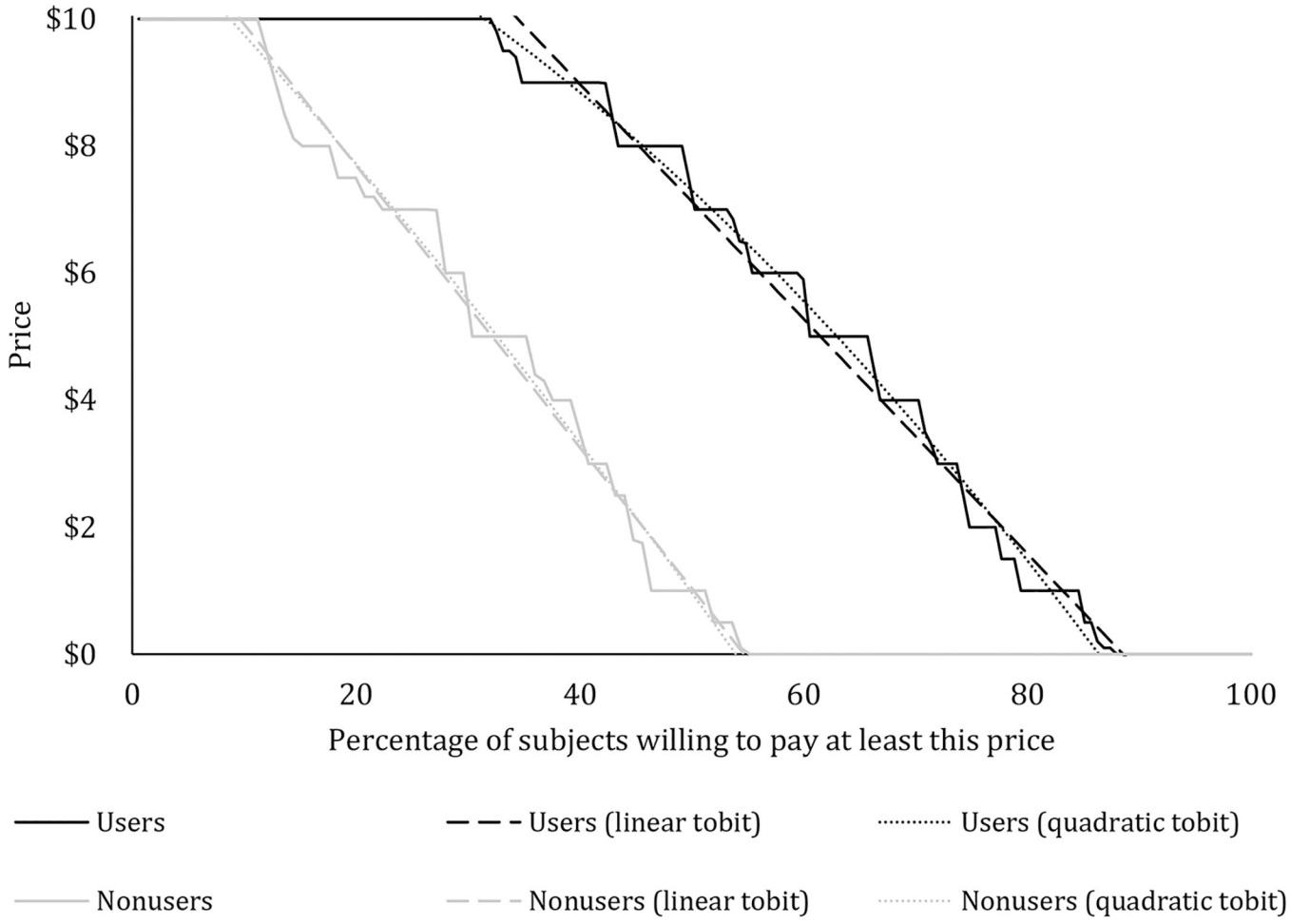

Figure 1.
Demand curves for a JUUL kit among teen nicotine users and nonusers

Table 1.

Price elasticity of demand for a JUUL kit among teen nicotine users and nonusers

	PED among nicotine users (*N* = 175)		PED among nonusers (*N* = 125)	
Price	**Linear model**	**Quadratic model**	**Linear model**	**Quadratic model**
$10.00	−1.69 [−1.73, −1.65]	−2.44 [−2.66, −2.21]	−4.02 [−4.15, −3.89]	−4.50 [−5.03, −3.97]
$7.50	−0.82 [−0.84, −0.80]	−0.92 [−0.95, −0.89]	−1.69 [−1.74, −1.63]	−1.80 [−1.93, −1.67]
$5.00	−0.41 [−0.42, −0.40]	−0.39 [−0.40, −0.38]	−0.64 [−0.66, −0.62]	−0.63 [−0.65, −0.61]
$2.50	−0.18 [−0.19, −0.18]	−0.16 [−0.16, −0.15]	−0.26 [−0.26, −0.25]	−0.24 [−0.26, −0.23]

Note: 95% confidence intervals in brackets.