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Brief Report
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Brief Report

Using Experimental Auctions to Examine Demand for E-Cigarettes

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Abstract

Background: E-cigarettes are the latest in a line of potentially reduced exposure products that have garnered interest among smokers.
Methods: In this paper, we use experimental auctions to estimate smokers' demand for e-cigarettes and to assess the impact of advertisements on willingness to pay. These are actual auctions, with winners and losers, which means hypothetical biases often seen in surveys are minimized.
Results: We find smokers have positive demand for e-cigarettes, and that the print advertisements used in our study had greater effectiveness than video ads ($b = 2.00$, $p < .05$) in terms of increasing demand for disposable e-cigarettes. Demand was greater for reusable versus disposable e-cigarettes. In multivariate models, demand for e-cigarettes was higher among non-white participants and among smokers willing to pay more for cigarettes.
Conclusions: Our findings suggest that cigarette smokers are interested in e-cigarettes as alternatives to traditional products, particularly for reusable forms, and that this demand can be influenced by messaging/advertising.
Implications: Given these reduced harm products are appealing, if smokers are able to switch completely to e-cigarettes, there is a good chance for accrual of significant harm reduction.

Introduction

The constantly evolving tobacco market presents opportunities and challenges for public health. This includes how to handle electronic cigarettes (or e-cigarettes), which have emerged as a potentially reduced health risk product for smokers. E-cigarettes are a broad class of products, ranging from disposable cigarette-like units to large "tank" systems that are refilled with nicotine-containing liquids by the user. Research is needed to examine the extent to which broader adoption of products such as e-cigarettes could impact the health of millions of Americans, including smokers' adoption of e-cigarettes. This is a particularly crucial question, as significant public health benefits could be achieved if smokers could be induced to switch to a less hazardous alternative.

Several existing studies focus on how access to e-cigarettes affects demand for conventional cigarettes. Friedman[1] compares cigarette use among 12- to 17-year olds in states that ban e-cigarettes sales to minors and states that do not. She finds that a sales ban leads to a 0.9 percentage point increase in cigarette use among 12- to 17-year olds. Based on the results of an online survey, Doyle et al.[2] find that 63% of smokers view e-cigarettes as a substitute for cigarettes, suggesting that e-cigarette use can reduce cigarette demand. Marti et al.[3] use a hypothetical choice experiment to divide smokers into three categories: "smokers" who prefer cigarettes, "vapers" who prefer e-cigarettes, and "dual users" who use both products. They find that health-related concerns are the most important driver of demand for e-cigarettes. They conclude that regulations reducing health concerns associated with e-cigarettes could reduce cigarette demand, particularly among dual users. In this paper, we use experimental auctions to determine how much smokers are willing to pay for cigarettes and e-cigarettes and how

willingness to pay is influenced by television and print advertising for e-cigarettes. Quantifying willingness to pay, using a direct rather than hypothetical method, is crucial to understanding the proportion of smokers who might actually adopt e-cigarettes, as opposed to those merely open to the idea.

Methods

Subjects participated in an experimental auction, which has become an increasingly popular way to estimate the demand for products.[4–13] Lusk and Shogren[4] cite 113 academic publications that use experimental auctions to estimate consumers' willingness to pay for products or product traits. What differentiates experimental auctions from hypothetical surveys is that experimental auction participants face real, immediate financial consequences for their actions. The highest bidders actually purchased the e-cigarettes or cigarettes for sale in our auction. This purchase element helped to avoid "hypothetical bias," or the tendency for participants to submit more generous valuations when they know they will never be expected to actually pay for a product. List and Gallet[14] conduct a meta-analysis of 29 studies that collect both real and hypothetical valuations for different products. The authors find that hypothetical value estimates overstate real value estimates by a factor of three on average.

Participant Recruitment and Sample Size

The study protocol was approved by the institutional review boards at the Roswell Park Cancer Institute and Susquehanna University. Participants were recruited by newspaper ads and flyers in Buffalo, New York, and Selinsgrove, Pennsylvania. These sites were chosen because they differed from one another in terms of racial diversity and urbanicity. Eligible study participants were 18 and older, currently smoked, were not currently using e-cigarettes, and had no major medical issues that would warrant exclusion. Participants were paid $80 for their participation, and sessions usually lasted about 70 minutes. Auctions were conducted with 6 to 17 participants at a time, and a total of 432 smokers participated between March 2014 and November 2014.

The Products

Participants bid on two types of e-cigarettes: a Blu e-cigarette starter kit and a Blu e-cigarette single use pack. Winning participants were allowed the option of choosing either "classic" tobacco-flavored or menthol-flavored e-cigarettes if they won the auction. Participants placed a bid on single-use e-cigarettes and a separate bid on a refillable e-cigarette starter kit. According to the manufacturer, the single-use e-cigarette is equivalent to two packs of conventional cigarettes. Participants also bid on a pack of Camel brand cigarettes, either the regular, blue, menthol, or menthol blue variety, depending on their individual preference. This setup allowed for a comparison of bids for cigarettes to e-cigarettes. We chose Camel because we wanted to use a premium cigarette brand that was still advertised in print media and was available in both 'light' and menthol varieties.

Experimental Conditions

We sought to assess demand for the three products, relative to cigarettes, under alternative conditions. Condition assignment was at the group level—all participants at a given auction session received the same condition to facilitate the auction protocol. The conditions were as follows:

1. Participants saw no advertisements for e-cigarettes (N = 90)
2. Participants saw a print ad for e-cigarettes (N = 110)
3. Participants saw a TV commercial for e-cigarettes (N = 110)
4. Participants saw both a print ad and a TV commercial for e-cigarettes (N = 99)

The print and TV ads were actual ads used by the company. The TV ad primarily focused on the features and benefits of Blu relative to traditional smoking, while the print ad featured a celebrity endorser and focused on images and themes of freedom. For the print ad, participants were asked to read the information provided in silence, to allow each participant to process the information with minimal influence from other study participants. For the TV ad, participants were asked to watch in silence. After the ads, the auction began.

Experimental Design

We used the random nth price auction mechanism to collect data.[15,16] Bidders in the random nth price auction have an incentive to bid truthfully regardless of the number of people they are bidding against. In fact, Shogren et al.[16] find that the random nth price auction does a particularly good job of motivating bidders with low or moderate values to bid truthfully. As with other experimental auctions,[11] participants are initially given enough money to compensate for their time and to provide them with more than enough money to pay the "clearing" price for the product of interest. The optimal amount of money to pay auction participants is an open research question. Loureiro et al.[17] find that larger payments lead to higher bids in a second-price auction, while Depositario et al.[18] find that larger payments lead to lower bids in an nth price auction.

Participants were told, both with written instructions and with an oral description, that this auction was different from other auctions in that they could only bid once (on a product) and it was in their best interest to submit a bid equal to the full price they would personally pay for the product. To minimize experimenter demand effects and ensure that all groups received the same instructions, participants watched a video explaining the details of the auction. Participants also received written instructions. The appendix (https://goo.gl/24TUwG) presents the packet participants received, including all written instructions participants received on the auction mechanism. The key feature of the auction is that it is "demand revealing": it is in a participant's best interest to bid his or her true value (demand) for the product because the amount the auction winners pay is determined by another subject's bid, not their bid.

Procedures

After participants arrived and signed a consent form, they filled out a brief survey on smoking behavior (Step 1). Next (Step 2), participants received a detailed explanation of the auction mechanism (both orally and in writing), with an emphasis that it was in their best interest to bid their true value for the products. Next, participants participated in a practice auction for two candy bars (Step 3) that demonstrated the real auction procedures by having participants place bids for different candy bars in different rounds. In Step 4, participants received their randomly assigned condition (no information, print ad, TV ad, or both ads). Then (Step 5), participants placed separate, private bids on each of the three products. This has become standard in experimental auctions studies. In early studies using experimental auctions to estimate the value of products

or product traits, subjects bid in repeated rounds with the understanding that only the transactions from one randomly chosen round would be carried out.[19] The standard practice in these repeated-round auctions used to be posting the winning bidders' ID numbers and the selling price after each round.[20] But Corrigan and Rousu[21] and Corrigan et al.[22] find that posted prices from earlier rounds can affect bids submitted in later rounds. With this in mind, we follow the lead of more recent studies such as Alphonce and Aflnes[23] and have participants bid in just one round.

After all three bids were submitted, a random draw was conducted to determine which product was the binding product, followed by a random draw to determine the *n*th price (Step 6). This determined who won products, which product, and how much the winners would pay. Finally (Step 7), participants filled out a post-auction questionnaire, winners exchanged money for their product, and the experiment ended.

Analysis

To examine the possible impact of e-cigarette advertisements and participant characteristics on demand for e-cigarettes, we first compare demographic and background characteristics across experimental groups to make sure that the groups do not differ systematically. Next, we compare average bids for each type of e-cigarette to that for the conventional cigarettes for each experimental group. Finally, we estimate censored regression models using SAS. Our censored regressions correct for the fact that participants were constrained to a minimum bid of zero (between 6.7% and 8.9% of participants bid zero, depending on the product). All models include ad condition, self-rated health, age, sex, education, race (white/black/other), study site, and body mass index as independent variables, with e-cigarette bids as the dependent variable. Additionally, we modeled the effects of participant worry pertaining to smoking's effects and whether the participant had ever used e-cigarettes.

Results

Unconditional results are presented in Table 1. For most demographic and background characteristics, we find no statistically significant differences across treatment groups. The only exceptions are the differences in education level between the control group and print-only ad group and the differences in the percent earning between $30 000 and $60 000 in the control group and the video only and the print and video groups. Overall, average bids for conventional cigarettes, single-use e-cigarettes, and the e-cigarette starter kit were $3.80, $4.22, and $10.31. The $0.42 difference between bids for conventional cigarettes and single-use e-cigarettes is not statistically significant ($t = 1.52$). It is worth noting that the single-use e-cigarettes claim they are approximately the equivalent of two packs of cigarettes, so the "per-cigarette" demand is lower for single-use e-cigarettes. The $6.51 difference between bids for conventional cigarettes and the e-cigarette kit is statistically significant at the 1% level ($t = 10.15$). We find a similar ranking of average bids in each of the four experimental groups.

Table 2 shows the regression results for the bids for the e-cigarettes. Note that these coefficient estimates show how changes in a dependent variable would be expected to affect the unobserved latent variable (ie, participants' uncensored willingness to pay for each product). While there are other ways of measuring marginal effects in a Tobit model, we feel this is the best approach given that the participant might conceivably place a negative value on e-cigarettes, but the auction setting censors these participants' bids at zero.

Table 1. Bids, Demographic Characteristics, and Background Characteristics

	Overall ($N = 409$)	Control group ($N = 90$)	Print ad only ($N = 110$)	Video ad only ($N = 110$)	Print and video ad ($N = 99$)
Bid for cigarettes	$3.80 (2.8)	$3.98 (2.9)	$3.85 (2.8)	$3.34 (2.6)	$4.10 (3.1)
Bid for single-use e-cigarette	$4.22 (6.0)	$4.22 (4.3)	$4.74 (8.5)	$3.38 (3.5)	$4.56 (6.2)
Bid for e-cigarette starter kit	$10.31 (14.0)	$9.09 (9.8)	$11.17 (16.5)	$9.31 (10.4)	$11.58 (17.5)
Age	41.1 (14.3)	39.4 (14.5)	41.9 (14.6)	40.9 (14.1)	42.0 (14.0)
Participant's BMI	28.2 (6.9)	27.8 (5.9)	29.2 (7.3)	27.5 (6.7)	28.1 (7.6)
Self-rated health (1 = excellent through 5 = poor)	2.66 (0.90)	2.55 (0.99)	2.69 (0.92)	2.60 (0.85)	2.80 (0.83)
Education level (0 = no HS degree, 1 = HS degree/GED, 2 = some college, 3 = associates degree, 4 = bachelor's degree, 5 = graduate degree)	1.60 (1.12)	1.43[a] (1.04)	1.75 (1.23)	1.65 (1.15)	1.54 (1.05)
Percent white	0.60	0.59	0.63	0.52	0.66
Percent black	0.33	0.34	0.31	0.37	0.30
Percent race—other	0.07	0.07	0.06	0.11	0.04
Percent female	0.43	0.36	0.49	0.48	0.38
Percent with income < 30K	0.52	0.51	0.59	0.49	0.47
Percent with income between 30K and 60K	0.15	0.20[b]	0.12	0.20	0.18
Percent with income over 60K	0.06	0.06	0.05	0.06	0.08
Percent income—declined to answer	0.27	0.33	0.24	0.25	0.27
Percent in Buffalo, NY	0.52	0.61	0.48	0.52	0.48
Percent in Selinsgrove, PA	0.48	0.39	0.52	0.48	0.52
Percent that used e-cigarettes at some point	0.52	0.52	0.58	0.45	0.50
Percent that are moderately or very worried about the future	0.57	0.61	0.52	0.59	0.58
Percent that have completed at least some college	0.45	0.36	0.49	0.52	0.43
Percent that smoke a pack or more of cigarettes daily	0.26	0.21	0.32	0.23	0.27

BMI = body mass index; GED = General Education Diploma; HS = high school. Except where noted above, there were no statistically significant differences between the control group and any treatment group. *SD*s in parentheses.

[a]The difference in education level in the control group and the print-only group is statistically significant at the 5% level.

[b]The difference in the percent with incomes between $30 000 and $60 000 in the control group and the print-only group and the print and video group is statistically significant at the 5% level.

Table 2. Censored Regression Model Regressing Bid for E-Cigarette

	Dependent variable = bid for single-use e-cigarette		Dependent variable = bid for e-cigarette kit	
	Model 1	Model 2	Model 3	Model 4
Intercept[a]	5.47** (1.82)	4.59** (1.78)	10.57* (4.04)	7.90* (3.85)
Participant received only video information (relative to control), *N* = 110 (27%)	−1.28 (0.93)	−1.44 (0.88)	0.25 (2.15)	−0.09 (1.89)
Participant received only print information (relative to TV only), *N* = 110 (27%)	0.79[b] (0.93)	0.49[b] (0.89)	3.26 (2.15)	2.39 (1.91)
Participant received both print ad and TV ad (relative to TV only), *N* = 99 (24%)	0.80[b] (0.94)	0.10 (0.89)	3.89 (2.16)	1.85 (1.91)
Self-rated health (mean = 2.66, *SD* = 0.90)	−0.62 (0.37)	−0.41 (0.35)	−1.80* (0.85)	−1.27 (0.76)
Age (mean = 41.1, *SD* = 14.3)	0.00 (0.02)	0.01 (0.02)	0.05 (0.05)	0.08 (0.05)
Female, *N* = 175 (43%)	0.12 (0.67)	0.38 (0.64)	−0.55 (1.54)	0.30 (1.37)
Income—below $30 000, *N* = 212 (52%)	0.37 (0.71)	0.41 (0.67)	1.67 (1.63)	1.80 (1.45)
Income—between $30 000 and $60 000, *N* = 57 (15%)	0.76 (1.03)	−0.11 (0.97)	3.69 (2.34)	1.05 (2.07)
Education level (mean = 1.60, *SD* = 1.12)	0.29 (0.29)	0.40 (0.27)	0.92 (0.66)	1.35* (0.59)
Race_black, *N* = 136 (33%)	0.50 (0.82)	0.81 (0.78)	−1.73 (1.88)	−1.15 (1.68)
Race_other, *N* = 29 (7%)	3.62** (1.36)	4.14** (1.29)	0.98 (3.12)	1.65 (2.78)
Participant is from Buffalo, *N* = 213 (52%)	1.24 (0.78)	0.84 (0.75)	5.22** (1.79)	4.05* (1.61)
BMI (mean = 28.2, *SD* = 6.9)	−0.11* (0.05)	−0.12** (0.05)	−0.17 (0.11)	−0.19* (0.10)
Participant is worried quality of life may be lower because of smoking, *N* = 234 (57%)		−0.29 (0.62)		−0.81 (1.33)
Participant has ever used an e-cigarette, *N* = 209 (52%)		0.72 (0.63)		2.12 (1.34)
Log likelihood	−1220	−1162	−1550	−1464

BMI = body mass index. *SE* in parentheses. *N* = 409.

[a]Auctions conducted from March to November 2014. *N* = 409.

[b]Coefficient for those who saw print ad only is different from the coefficient for those who saw video ad only and that difference is statistically significant at the 5% level.

*$p < .05$; **$p < .01$.

None of the coefficients for the advertisement treatment groups are statistically different from zero. However, the results from Model 1 indicate that participants who received only the print ad bid significantly more for the single-use e-cigarette than those who received only the TV ad. Specifically, according to Model 1 participants who only received the TV ad bid $1.28 less than those who received no ad, while participants who only received the print ad bid $0.79 more than those who received no ad. This $2.07 (= $1.28 + $0.79) difference is statistically significant at the 5% level. Participants who saw both the TV and print ad bid more for the single-use e-cigarettes than those who received the TV ad only, although the difference between those coefficients was only statistically significant in Model 1. The coefficient for self-rated health was negative but only statistically significant in one of the models for the e-cigarette kit. The negative coefficient for self-rated health indicated those who rated their health as poorer (stronger) bid less (more) for the e-cigarette kit. Those who considered themselves as non-white and non-black bid between $3.62 and $4.14 more for single-use e-cigarettes than white participants, but not the e-cigarette kits. The coefficient indicating the participant was from Buffalo was positive and statistically significant in all models for the e-cigarette kit. The coefficient for a participant's body mass index was negative and statistically significant in both models for single-use e-cigarettes and one of the two models for the e-cigarette kits. Note that for these nested models, the likelihood-ratio test shows statistically significant impacts ($p < .01$) of adding each set of variables.

Discussion

We found that smokers were willing to pay a positive amount for e-cigarettes. The average bid for e-cigarettes exceeded the bids for cigarettes, regardless of the condition group. Caution should be used before reading too much into this finding, however, as the single-use e-cigarette is approximately equivalent to two packs. We also found that the auction location played a significant role—Buffalo participants almost universally bid more for the e-cigarette kit and for cigarettes, though not necessarily for the disposable e-cigarette. This may be because higher tobacco prices in New York cause those from Buffalo to have higher demand for the kit—which is a better monetary value (in the long run).

We found evidence that those who saw a print advert for Blu bid more for the product than those in the TV-ad group for single-use e-cigarettes. There are a number of explanations for this. First, the TV ad was primarily focused on the features and benefits of Blu relative to smoking, while the print ad featured a celebrity endorser and was focused on image and themes of freedom. So, the two ads engaged different routes of persuasion.[24,25] This suggests that messages targeting smoker self-image may be more effective in encouraging e-cigarette use than messages about relative health risk. While it is well established that advertising can increase demand for products,[26] only limited research has examined e-cigarette advertising. Villanti et al.[27] found that exposure to e-cigarette ads could increase trials from those who had never tried e-cigarettes. Farrelly et al.[28] found that adolescents in a treatment group that saw TV advertisements for e-cigarettes stated that they were more likely to use e-cigarettes in the future.

We saw a persistent effect of self-rated health on bids for e-cigarettes among smokers—those who self-rated themselves as healthier bid more. This may provide evidence that health-concerned smokers may seek a product that is perceived or promoted as less hazardous. It is also possible that self-rated health is a proxy for other unobservable aspects of socioeconomic status, though our analysis does control for income, education, and race. Relatedly, we find that those

with higher body mass index levels had lower demand for e-cigarettes. This is sensible insomuch as self-rated health tends to be lower among the overweight/obese.[29] We also found modest evidence that education increased demand for e-cigarettes. This may provide evidence that those who are better educated are looking to reduce their harm from tobacco intake and is consistent with literature that says e-cigarette users tend to have more education than smokers.[30]

A limitation in our work is that we focused on demand among current smokers. There is significant concern that e-cigarettes can appeal to nonusers, particularly youth. While most e-cigarette use is among cigarette smokers as an alternative and/or cessation aide, there has been nontrivial uptake among adolescent nonsmokers.[31,32] Our data cannot address this aspect of the public health balance, and auction approaches are not well suited to estimate demand in this context. One potential shortcoming of this and other experimental auctions is that because the stakes are low, the financial penalty for participants who over- or understate what they are truly willing to pay for a product is small. The laboratory environment and the experimental auction itself were both new to the participants, which may have affected the bids they submitted.

In sum, the data from this study suggest that cigarette smokers are interested in e-cigarettes as alternatives to traditional products and that this demand can be influenced by messaging/advertising. However, significant interindividual variability exists, with younger smokers and those with better self-rated health showing relatively greater demand for e-cigarettes. If such reduced harm products are appealing to this group and they are able to switch completely to e-cigarettes, there is a good chance for accrual of significant harm reduction.

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Declaration of Interests

None declared.

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