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Fear or Knowledge The Impact of Graphic Cigarette Warnings on Tobacco Product Choices
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ABSTRACT

Requiring graphic warning labels (GWLs) on cigarette packaging has become a highly contentious unresolved legal battle. The constitutionality depends, in part, on the likely impact of GWLs on smoking decisions, and whether they generate knowledge as opposed to emotional reactions against smoking. Using an online discrete choice stated preference experiment we compare tobacco choices (cigarettes, e-cigarettes, quitting) for those presented with a GWL versus the currently existing label. We find the fraction of individuals choosing cigarettes to be lower and quitting higher for the GWL group. Our findings reveal that the differences between groups were primarily driven by the evocation of fear and disgust rather than an improvement in health knowledge related to the GWL. The discrete choice experiment also provides new evidence on how cigarette prices, e-cigarette prices, and policy-manipulable e-cigarette attributes such as e-cigarette warning labels, and flavor availability influence tobacco product choices.

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I. INTRODUCTION

Disseminating information to consumers about the health risks of smoking has been a focus of public policy for over fifty years. The steady decline in the percentage of Americans who smoke cigarettes began, in part, with successful information campaigns like the 1964 Surgeon General's report and the anti-smoking publicity that followed (Warner 1977). Although smoking rates have continued to fall, smoking is still the leading preventable cause of death in the U.S. with hundreds of thousands of deaths per year linked to combustible cigarettes (FDA 2022). The executive and legislative branches of the federal government remain focused on information dissemination as a key strategy to prevent smoking onset and encourage smoking cessation. An important step was the passage of the Family Smoking Prevention and Tobacco Control Act of 2009. The Tobacco Control Act gave the Food and Drug Administration (FDA) regulatory authority over tobacco products and mandated that cigarette packages include graphic warning labels about the health consequences of smoking. After two attempts by FDA to develop graphic warning labels, as of July 2023 they remain in litigation.

In 2012 the federal district courts ruled against FDA's first attempt to require graphic warning labels on cigarette packages. The courts found that that the proposed graphic warning labels were unconstitutional and violated the free speech rights of cigarette manufacturers. This ruling focused, in part, on the finding that the government was not simply attempting to inform consumers about the risks of smoking but instead the government was trying to emotionally persuade consumers not to smoke - and thus had over-reached its constitutional authority (RJ Reynolds Tobacco Co. v. US Food and Drug Administration, 2012).[1] In response, FDA reconsidered and in 2020 proposed a new set of 11 graphic warnings designed with a narrower

[1] R.J. Reynolds Tobacco Company Versus Food and Drug Administration, 696 F.3d 1205, 1214 (DC Cir 2012).

goal to inform consumers of some of the lesser-known but serious health risks of smoking. As discussed in Section II below, the legal battle continues. In this paper, we bring empirical evidence to bear on some of the central issues of the litigation.

How graphic warning labels affect consumers' tobacco product choices are at the core of the legal dispute between cigarette manufacturers and the FDA. Our study combines an online experiment about graphic warning labels with a discrete choice experiment about consumers' stated preferences between cigarettes, e-cigarettes, and quitting. In the graphic warnings experiment, half of the subjects were shown one of the new labels while the other half made up the control group and were shown one of the current Surgeon General's text warning labels. By embedding the graphic warnings experiment in a discrete choice experiment, we study the impact of graphic warning labels on cigarette purchases in a hypothetical but semi-realistic market context. Discrete choice experiments are commonly used in marketing research and economics to provide predictions of consumer demand in policy-relevant scenarios; research on their external validity reaches a consensus that subjects' stated preferences can provide valuable information and predict actual choices in markets (Carson 2014, McFadden 2017). In section III below we provide more discussion on the findings of prior research, the challenges of quasi-experimental research in this context, and the external validity of discrete choice experiments. Because of the gaps in prior research and the inherent challenges to identify the effects of graphic warning labels in market data, we believe our evidence from the discrete choice experiment makes useful contributions both to the research base and to the legal debate.

Our first contribution is to evaluate the impact on tobacco product choices of replacing the current Surgeon General's text warning with the new graphic warnings proposed by the FDA. By comparing the stated preferences of adult smokers in the experimental and control

groups, we estimate the impact of graphic warnings on tobacco product immediate choices and on six-months-from-now choices. We find that compared to the control group, in the group shown the graphic warnings the fraction of immediate choices to purchase cigarettes fell by 5.4 percentage points and the fraction of 6-months-from-now choices to purchase cigarettes fell by 6.8 percentage points. The fractions of immediate and 6-months-from-now choices to quit tobacco use increased by 2.8 percentage points and 5.5 percentage points, respectively.

Our second contribution is to analyze the mechanisms through which graphic warning labels affect tobacco product choices. Although the FDA's stated goal of the new warning labels was to provide information about lesser-known risks of smoking, we find little evidence that subjects who saw the graphic warnings were much better informed about the specific health risk featured on the label. We find strong evidence that the graphic warning label evoked the negative emotional responses of fear/disgust. In further analysis of the mechanisms, we find that the difference in fear/disgust accounts for 17 percent of the total estimated impact of graphic warnings on smokers' choices, while the difference in knowledge of the specific health risk accounts for only 3 percent. In a follow-up discrete choice experiment, we showed subjects another one of the 11 new warning labels, which we *a priori* judged to feature a less provocative image. We find little evidence that the other image was associated with better information or more fear/disgust, and we estimate smaller effects of the graphic warning label on tobacco product choices.

Our third contribution is to study how graphic warning labels on cigarette packages affect tobacco product choices and quitting when e-cigarettes are also available. To our knowledge, we are the first study to do so. Other countries that require graphic warning labels implemented them before the broad use of modern e-cigarettes. If the new U.S. graphic warning

labels survive the legal challenges, they will enter a vastly different market for tobacco products than existed when they were first required by the 2009 Tobacco Control Act. In 2009, e-cigarettes were a very new product. However, during the 2010's youth and adult use of e-cigarettes rose rapidly. In 2016 the FDA extended its tobacco regulatory authority to include electronic nicotine delivery systems including e-cigarettes. A central question that has not been addressed in prior research is whether graphic warnings on cigarette packages encourage or discourage e-cigarette use. On the one hand, the information conveyed by graphic warnings might be generalized to all tobacco products thereby reducing demand for both cigarettes and e-cigarettes. On the other hand, graphic warnings might increase the perceived risk of cigarettes relative to e-cigarettes thereby decreasing the demand for cigarettes and increasing the demand for e-cigarettes. Our empirical estimates suggest that on net, graphic warnings on cigarette packages have a small and statistically insignificant impact to increase the probability of choosing e-cigarettes.

Our fourth contribution is to estimate how cigarette taxes, e-cigarette taxes, and policy-manipulable e-cigarette attributes influence tobacco product choices. These results are interesting in their own right, especially in light of the small (albeit rapidly growing) body of research on e-cigarette regulation (DeCicca, Kenkel, and Lovenheim 2022). The results also allow us to compare the effects of graphic warning labels on tobacco product choices relative to other regulatory options. For example, based on our estimates, either the graphic warning label or a cigarette tax hike of $3.00 decreases the probability of choosing cigarettes by 5.4 percentage points. However, our results suggest that recent policy trends towards tighter regulation of e-cigarettes might work in the opposite direction of graphic warning labels on cigarette packages. A number of states have begun to tax e-cigarettes, and some have banned popular flavors in e-

cigarettes. We estimate that the combination of a $2 e-cigarette tax and a ban on popular e-cigarette flavors increases the probability of choosing cigarettes by 5.4 percentage points, enough to offset the estimated decrease due to graphic warning labels.

II. LEGAL DEVELOPMENTS ON GRAPHIC WARNING LABELS

The Tobacco Control Act required the FDA to develop nine full-color graphic warnings to appear on the top half of all cigarette packs sold in the United States. Five cigarette manufacturers challenged this requirement in federal district court, on the grounds that the FDA, in implementing the legislative requirement that graphic images appear on cigarette packages, would violate the tobacco companies' right to commercial free speech. When the district court ruled in favor of the cigarette manufacturers, the FDA appealed the decision to the federal appeals court, which issued a summary judgment also in favor of the cigarette manufacturers (R.J. Reynolds Tobacco Company vs. Food and Drug Administration, 2012).[2] The FDA declined to appeal this ruling to the Supreme Court. Instead, in March 2020 the FDA finalized a rule which established a new set of 11graphic warning labels. This action was again challenged by RJ Reynolds and other cigarette manufacturers in a lawsuit filed on April 3, 2020, within the U.S District Court for the Eastern District of Texas (USDCT). Due to the new legal challenge the implementation of the new graphic warnings was postponed. On December 7th the courts again ruled against the FDA and granted the plaintiffs motion for summary judgment on their first amendment claim. In February 2023 FDA appealed that decision.

The Final Rule for the Original Proposed Images

To understand the decades-long legal dispute and its bearing on our empirical work, it is useful to examine the original proposed rule developed by FDA as well as the final rule issued

[2] Ibid.

after public comment (Federal Register, 2010; Federal Register, 2011). The FDA developed its nine graphic warning labels based on its own empirical research, a review of the relative academic literature, and in response to thousands of comments submitted to FDA (Federal Register, 2011). While the FDA claimed that its own study could not firmly establish the real-world, long-term effect of the proposed images, the agency argued that there was a significant research base demonstrating that graphic images are more effective than the text-only warnings currently used in the United States. The FDA characterized this as a "strong worldwide consensus".[3] Consequently, the FDA claimed that by communicating the negative health consequences of smoking the graphic images would deter youth onset into smoking and encourage current smokers to quit.[4]

The Scrutiny Standard Used by the Courts

The cigarette manufacturers did not dispute the government's constitutional authority to require health warnings on cigarette packages nor did they contest the language contained in the text portion of the graphic warning labels.[5] They argued, in part, that the graphic images proposed in the final rule shame and repulse smokers and suggest smoking is an antisocial act. The cigarette manufacturers claimed that rather than informing consumers about the health risks of smoking, through the new graphic warnings the FDA requires the manufacturers to promote an ideological message that individuals should not smoke. At its core, this case questions whether FDA can force the cigarette manufacturers to make commercial disclosures beyond purely factual and accurate disclosures and, instead, work against their own economic interest.

[3] See Federal Register (2010) at p. 69,525
[4] See Federal Register (2010) at p. 69,526
[5] R.J. Reynolds Tobacco Company Versus Food and Drug Administration 696 F.3d 1205, 1214 (DC Cir 2012).

The right to refrain from speaking or express certain views are protected by the First Amendment of the constitution and attempts by government to compel individuals to express certain views is subject to strict scrutiny by the courts (see Wooley vs. Manyard, 1977).[6] These rights can also apply to commercial speech; however, courts consider intermediate levels of scrutiny in commercial speech cases. The legal question in the FDA litigation, as described in the summary judgement was "how much leeway should this Court grant the government when it seeks to compel a product's manufacturer to convey the state's subjective - and perhaps even ideological view–that consumers should reject this otherwise legal, disfavored product?"[7]

While strict scrutiny requires a compelling government interest and a narrowly tailored law to achieve that interest, intermediate scrutiny requires a lower threshold for government action. One measure of intermediate scrutiny is in Zauderer v. Office of Disciplinary Counsel. The Zauderer precedent established that the government can force commercial entities to engage in speech if the information is factual and uncontroversial, reasonably related to the government's interest in preventing consumer deception, and not unduly burdensome (Zauderer v. Office of Disciplinary Counsel, 1985).[8] Central Hudson establishes an another form of intermediate scrutiny where, in general, commercial speech should be subject to less stringent review than other types of speech (Central Hudson Gas and Electric Company v. Public Service Commission, 1980).[9] Despite only an intermediate level of scrutiny, the Central Hudson standard presents a high bar for government being able to force specific speech. The government must prove that its interest is substantial, that the required speech directly and materially advances that interest while also being narrowly tailored and not more expansive than necessary.

[6] Wooley Versus Manyard (1977), 705, 714, 97 S. Ct. 1428 51 L.Ed.2nd 752
[7] See R.J. Reynolds Tobacco Company Versus Food and Drug Administration (2012), page 6.
[8] Zauderer v. Office of Disciplinary Counsel (1985), 471 U.S. 626, 105 S. Ct. 2265.
[9] Central Hudson Gas and Electric Company v. Public Service Commission (1980). 447 U.S. 557 100, S. Ct. 2343.

This is considered a more difficult hurdle for the government relative to the consumer deception standard in Zauderer.

The district court concluded that the graphic warnings were not purely factual and non-controversial and so the Zauderer standard was not applied. The court found that the graphic images were in part designed to evoke an emotional response rather than just provide factual information.[10] Consequently, the Central Hudson standard of intermediate scrutiny was used by the courts to determine the constitutionality of the graphic warning labels. In applying the Central Hudson standard, the court determined that the government stated interest was to "both discourage non-smokers from initiating cigarette use and to encourage current smokers to consider quitting." [11] The court then determined that the FDA did not have sufficient evidence that graphic images would materially advance their interests of reduced smoking rates. Instead, the court notes that most of the evidence FDA presented demonstrates that the graphic images affect the antecedents of behavioral change rather than change itself. In surprisingly harsh language the appellate court states that "The FDA has not provided a shred of evidence – much less the substantial evidence required by the APA – showing that the graphic warnings will directly advance its interest in reducing the number of Americans who smoke."[12]

The Revision of the Graphic Images

Rather than appeal the decision, the FDA proposed new graphic warning labels and articulated a clearer, more specific government interest statement (Federal Register 2019, 2020).[13] This statement is: "FDA is proposing to take this action to promote greater public

[10] See R.J. Reynolds Tobacco Company Versus Food and Drug Administration (2012), page 10.
[11] See Federal Register (2011) at page 36,630.
[12] See RJ Reynolds Tobacco Company Versus Food and Drug Administration (2012) at page 12.
[13] See Federal Register (2019) at 42,734 for the proposed rule and Federal Register (2020) at 15,638 for the final rule.

understanding of the negative health consequences of cigarette smoking."[14] In response to the court's failure to find substantial evidence that graphic warning labels would reduce smoking, the FDA's new stated interest avoids claiming that the goal of the government action is to reduce smoking rates. Instead, throughout the proposed rule the focus is on communicating the health consequences of smoking. Given the more narrowly defined interest, the FDA argues that the new proposed graphic warning labels are factual, accurate, advance the government interest, and are not unduly burdensome. The FDA believes that the warnings now should pass a First Amendment analysis under either Zauderer or Central Hudson.

In arguing that the new proposed graphic warning labels promote greater public knowledge the FDA relies on three key issues. First, FDA claims the current Surgeon General's warning is inadequate because it has not changed since 1984, does not attract attention, is not remembered, does not prompt thoughts about the risks of smoking, and there remain significant gaps in public understanding of the negative health consequences of cigarette smoking.[15] Second, cigarette health warnings that are noticeable, lead to learning, and increase knowledge will promote public understanding of the negative health consequences of smoking. FDA argues that pictorial/graphic images are more likely to be effective, relative to the current text warning, on these dimensions.[16]

Finally, FDA argues that because the current warnings have not been updated since 1984, their content has not kept up with current research. The updated graphic warning labels present an opportunity to better educate the public about lesser-known health risks where there is low awareness and public understanding. The 11 new labels include images and statements about

[14] See Federal Register (2019) at page 42,754.
[15] See Federal Register (2019) pages 42,759-42,762.
[16] See Federal Register (2019) pages 42,779-42,765.

bladder cancer, cataracts, chronic obstructive pulmonary disease, erectile dysfunction, fatal lung disease in non-smokers, harm to children, head and neck cancer, heart disease and stroke resulting from clogged arteries, reduced blood flow and amputation, stunted fetal growth, and type 2 diabetes.

FDA directly argues that these new proposed warnings are constitutional. FDA notes that the scientific literature demonstrates that smokers and nonsmokers alike have misperceptions about the health risks associated with cigarette smoking and are largely unaware of risks not mentioned in the text warnings. FDA contends that the proposed warnings educate consumers about lesser-known health risks and thus the Zauderer standard is appropriate. FDA also indicates that the new warnings can satisfy the Central Hudson criteria as well in case they are used by the courts.

The cigarette manufacturers have challenged the new proposed warnings, largely on the same basic premise of their 2010 challenge.[17] They allege that, as with the originally proposed graphic warning labels, the new graphic warning labels are designed to evoke negative emotions. The cigarette manufacturers also argue there are less intrusive ways to convey information about the health risks of smoking. In a summary of their constitutional concerns, they state "The Rule requires the use of eleven new textual warnings, accompanied by eleven graphic images—such as images of a specimen cup filled with bloody urine and a pair of diseased feet with several amputated toes—that are designed to frighten, shock, and disgust adult cigarette consumers. In addition, these "warnings" must occupy the top 50% of the front *and* back of cigarette packages and the top 20% of cigarette advertising. These requirements cross the line into governmental anti-smoking advocacy."[18]

[17] See R.J. Reynolds Tobacco Company vs. FDA, No. 6:20-cv 00176.
[18] See R.J. Reynolds Tobacco Company vs. FDA, No. 6:20-cv 00176, Page 1.

The courts once again ruled in favor of the cigarette manufacturers. The court concluded that "the label statements required by the FDA rule do not qualify for First Amendment scrutiny under Zauderer because they are not purely factual and uncontroversial. The court then concludes that the compelled labels do not survive scrutiny under Central Hudson's tests for commercial speech regulations generally." [19] In February 2023, the FDA appealed this decision.

Empirical Results that Can Shed Light on Constitutionality of New Graphic Images

Our study directly addresses questions raised in the litigation. We use a graphic warning labels experiment embedded in a discrete choice experiment to directly compare smoking cessation decisions when individuals are faced with the current text warnings or one of the graphic warnings proposed by FDA. Since the graphic warnings have not yet appeared on packages, the hypothetical choices provide useful evidence on the likely impact of the new graphic warning labels, and evidence on which legal arguments have empirical support.

In the first round of litigation, the cigarette manufacturers argued that FDA did not present enough evidence that the graphic warning labels would have an impact on actual smoking decisions. Our empirical work directly estimates this impact using stated preference data and explores the mechanisms through which the graphic warning impacts choice. FDA contends that the new warnings address lesser-known health risks and exposure to the graphic warnings will improve consumer knowledge of specific health risks. Our study directly tests this by measuring whether those exposed to a graphic warning label have greater knowledge of the health risk featured in the warning compared with those exposed to the Surgeon General text warning currently on cigarette packages. Increased knowledge of lesser-known health risks is one of the key arguments justifying the legality of the graphic warnings.

[19] See R.J. Reynolds Tobacco Company vs. FDA, No. 6:20-cv 00176 Opinion and Order, Page 23.

Our work also estimates the degree to which the graphic warnings generate emotional responses such as fear and disgust. The cigarette manufacturers argue that it is unconstitutional for them to be required to send messages that generate emotive negative responses to their product. In addition to respondents' risk knowledge and fear/disgust, we also investigate other mechanisms by focusing on how exposure to the graphic warning labels changes other perceptions including the expected life years lost from smoking cigarettes, expected life years lost from vaping e-cigarettes, the relative harm of e-cigarettes relative to cigarettes, the belief that nicotine in cigarettes is the substance that causes most of the cancer caused by smoking, and the belief that nicotine, on its own, can harm the developing brain of youth and young adults.

Our empirical analysis also explores the roles cigarette taxes, e-cigarette taxes, and policy-manipulable e-cigarette attributes play in tobacco product choices. Under the FDA's original 2010 rationale that graphic warning labels could reduce smoking, this part of our analysis is relevant to whether there is a less burdensome alternative to achieve the government's interest, a standard relevant under Central Hudson scrutiny. Our analysis is far from the first to study the extent to which smokers respond to cigarette taxes (DeCicca, Kenkel, and Lovenheim 2022). However, prior research on the role of e-cigarette taxes and policy-manipulable e-cigarette attributes is more limited. Under the 2009 Tobacco Control Act and the 2016 Deeming Rule FDA has direct authority to regulate e-cigarette attributes including required warnings and the availability of popular flavors and nicotine levels. Our empirical results shed light on whether FDA's actions towards e-cigarettes promote or hinder the goal of reducing smoking. However, we note that under the FDA's 2019 stated interest in promoting greater understanding of the health consequences of smoking, FDA's authority to regulate attributes of e-cigarettes and the

government's authority to tax cigarettes are not relevant to whether there are less burdensome alternatives to the proposed graphic warning labels on cigarette packages.

III. OVERVIEW OF LITERATURE

Graphic Warning Labels

There is a large base of prior research evaluating the impact of graphic cigarette warning labels on consumer attitudes and behaviors. Because this research is so large, our discussion focuses on prior research reviews and a few notable studies. Noar *et. al* (2016) conducted a meta-analysis of studies that use an experimental protocol to compare pictorial and text-only warnings. In a typical experimental protocol, subjects in a laboratory are shown different warnings and asked about their reactions. Noar et al. (2016) identified 37 studies spanning 48 independent samples. The 37 studies covered 16 different countries, with the largest number focused on the U.S., followed by Germany and Canada. Compared to text warnings, graphic warnings were found to be more effective in attracting and holding attention, eliciting cognitive and emotional reactions, driving negative attitudes toward smoking, and generating intentions not to smoke. Noar et al. (2016) note, however, that after culling through hundreds of studies to generate the 37 included in the meta-analysis, almost all the included studies focus on the precursors to behavioral change rather than smoking outcomes. Similarly, in the systematic review by Francis et al. (2017) of measures used to evaluate cigarette warning labels, emotional reactions, risk perceptions, and perceived effectiveness were the most common outcomes measured; only four studies in their review assessed actual smoking behavior.

Another set of studies evaluate changes in smoking attitudes and/or behavior after the introduction of required graphic warning labels in other countries, especially Canada and Australia. In Canada, research by Hammond (2003, 2004, 2004a, 2007, 2011) concluded that

after graphic warning labels were required, consumers were more likely to notice the labels, think about quitting, and were more knowledgeable about the health consequences of smoking. In Australia, Miller et al. (2009) examine consumer responses after introduction of graphic warning labels. Initial responses indicated about 36 percent of respondents felt disgust and about half reported that the new warnings increased their own risk perception of dying of a smoking related illness. As with the experimental studies covered by Noar et al. (2016), most of the studies on Canada and Australia focused on the impact of GWLs on the precursors of tobacco use rather than on actual smoking behavior.

Monárrez-Espino et al. (2014) conducted a systematic review of studies of graphic warning labels that focus directly on smoking outcomes. Studies with outcomes not related to behavior change, such as those looking at perceptions, attitudes, reactions, knowledge, or motivation and intention to quit were excluded from their sample. Among the 2,500 published studies, 21 articles met the criteria for their meta-analysis. Based on the 21 studies, Monárrez-Espino et al. (2014) conclude that the empirical evidence for or against graphic warning labels is insufficient and that any impact would be modest. They note a large proportion of the studies show null results for cessation, smoking reduction, and attempts to quit smoking.

In contrast to the large body of public health research on graphic warning labels, to our knowledge research using quasi-experimental research designs from modern applied econometrics is very limited. The inherent challenges of quasi-experimental research to identify the causal effect of graphic warning labels on smoking outcomes might explain why econometric research is so limited. Requirements for health warnings on cigarette packages are set at the national level in the U.S. and other countries. As a result, the difference-in-difference approach and related quasi-experimental research designs are impossible within the U.S. and problematic

to apply internationally due to differences across countries in levels and trends of smoking. An additional challenge is that graphic warning labels are often adopted simultaneously with other tobacco control policies such as cigarette tax hikes. Three studies use the difference-in-difference method to estimate the impact of Canada's 2000 implementation of graphic warning labels, using the U.S. as a control group. The courts found the FDA's (2011) difference-in-difference study of Canadian versus U.S. smoking rates unconvincing because at the same time Canada implemented graphic warning labels it also increased the cigarette excise tax.[20] Huang, Chaloupka, and Fong (2014) conducted a similar difference-in-difference study of the 2000 Canadian graphic warning labels; Usidame et al. (2022) replicated the analysis with individual-level data. Beleche et al. (2018) provide a detailed critique of Huang, Chaloupka, and Fong (2014). Beleche et al. (2018) point out an important challenge that also applies to the study by Usidame et al. (2022): prior to the implementation of graphic warning labels in Canada in 2000, the trends in smoking rates were different in the U.S. and Canada. In the pre-graphic warning labels period from 1995 to 2000 smoking prevalence dropped by almost six percentage points in Canada, compared to only 1.5 percentage points in the U.S. The violation of the parallel trends assumption casts doubt on the validity of the difference-in-difference estimates of the impact of graphic warning labels in Canada.

Discrete Choice Experiments and External Validity of Experiments in Health Settings

Discrete choice experiments are a common and accepted method for estimating market impacts in various hypothetical market situations including electricity markets (Blass, Lach, and Manski, 2010), health insurance markets (Kesternich, Hiess, McFadden, and Winter, 2013), labor markets (Mas, Alexandre and Pallais, 2017; Maestas et al. 2023), and tobacco product

[20] See RJ Reynolds Tobacco Company versus Food and Drug Administration (2012) at page 26.

markets (Kenkel, Peng, Pesko, and Wang, 2020). Given the wide use of discrete choice experiments there is a significant research base that examines their external validity – whether stated preferences in these experiments predict actual choices.

We will limit our discussion here to research on the external validity of discrete choice experiments about health choices. From their systematic review and meta-analysis, Quaife et al (2018) conclude that on the whole, discrete choice experiments produce moderate levels of external validity in terms of matching actual health choices. For example, de Bekker-Grobet al. (2020) find that when measured at the individual level, stated preferences about vaccinations predict 91 percent of actual choices. Telser and Zweifel (2007) examine the external validity of a DCE focused on decisions about protectors to prevent hip fractures. They compare the willingness to pay for risk reduction derived from the experiment to other measures of willingness to pay derived from market data. The comparison supports a high level of convergent validity. Mohammadi et al (2017) use a discrete choice experiment and estimate a mixed logit based on the hypothetical choices with respect to type of tuberculosis treatment (or none) in response to each treatment having six treatment attributes. They compare these choices with actual choices and find strong external validity and the degree of accuracy depends on the distributional assumptions used in the mixed logit models with some models. Kesternich et al (2013) implement a discrete choice experiment to analyze Medicare part D choices and compare these results to those that emerge from analysis of actual choices. They conclude that hypothetical choice experiments are useful in studying insurance choices as hypothetical behavior is related to actual behavior. They find that the coefficients that emerge in the discrete choice experiment are of the same sign as the coefficients that are estimated from market behavior. They note that the magnitudes of the coefficients are quite similar and do not find

significant differences between hypothetical and real choices between different attributes of the insurance scenarios. They do find a higher willingness to pay for insurance in the hypothetical market and thus higher insurance take-up rates but attribute this to the nature of the default option in the experiment.

IV. CONCEPTUAL AND EMPIRICAL FRAMEWORK

Our empirical analysis is linked to the economic theory of random utility maximization. The consumer is assumed to choose between three alternatives: cigarettes, e-cigarettes, or quitting and not using either cigarettes or e-cigarettes. The consumer chooses the alternative that provides the highest utility. The consumer's utility from each alternative can be decomposed into the representative utility explained by observed product attributes and an unobservable random component. The observed product attributes in our model include whether the cigarette has a graphic warning label (versus a text warning label), the price of the cigarette, the price of the e-cigarette, the warning message on the e-cigarette, the availability of flavored e-cigarettes, and the availability of varying nicotine levels in the e-cigarette.

The econometric specification of the equations for the probabilities that an alternative is chosen depends on the assumed distribution of the random component of utility. A widely used assumption is that the random component is i.i.d. Type 1 extreme value distributed across all alternatives and consumers, which leads to a convenient closed form conditional logit specification of the choice probabilities. For ease of interpretation, we report linear probability models of the choice probabilities. However, we have verified that the results from our linear probability models are robust and consistent with the estimates derived from the conditional logit model and a more sophisticated mixed logit model. The general form of the estimated linear probability models is:

(1) $\text{Choice}_i = \beta_0 + \beta_1 \text{ Graphic Warning}_i + \beta_2 \text{ Price of Cigarette}_i + \beta_3 \text{ Price of E-Cigarette}_i + \beta_4$ E-Cig Warning$_i$ + β_5 Flavor Availability$_i$ + β_6 Nicotine Content$_i$ + Controls +ε_i

We estimate six versions of equation (1). In the first three versions, the dependent variables are binary indicators of whether the subject's immediate choice was to purchase a cigarette, to purchase an e-cigarette, or to quit. In the next three versions, the dependent variables measure the subject's stated choice for six months in the future. Each equation is estimated separately, and we do not impose any cross-equation restrictions. However, because the three choices are mutually exclusive and exhaustive, empirically the parameter estimates in the first three immediate choice equations and the next three six-months-from-now equations sum to zero. For example, if the graphic warning label is estimated to decrease the probability of choosing cigarettes, there will be an equal and opposite increase in the probability of choosing e-cigarettes and/or quitting. In equation (1) the parameters β_1 provide reduced-form estimates of the total impact of the graphic warning label on the probability of choosing cigarettes, e-cigarettes, or quitting.

Although we do not fully specify a structural model of consumer utility, in our approach we conceptualize the graphic warning label's impact on utility as being through the mechanisms of fear/disgust and knowledge, which we observe in our data, as well as unobserved mechanisms. To understand the mechanisms, we estimate models of the impact of the graphic warning label on the observed antecedents of choice. In equation (2) we examine how the graphic warning label influences emotions such as fear and disgust, and in equation (3) how the graphic warning label influences knowledge of the health risk of smoking featured in the label:

(2) $\text{Fear/Disgust}_i = \alpha_{fo} + \alpha_{f1}\ \text{Graphic Warning}_i + \text{Controls} + \varepsilon_i$

(3) $\text{Knowledge}_i = \alpha_{ko} + \alpha_{k1}\ \text{Graphic Warning}_i + \text{Controls} + \varepsilon_i$

We then re-estimate the choice equations given by (1), but we drop the Graphic Warning indicator and replace it with the Fear/Disgust and Knowledge variables:

(4) $\text{Choice}_i = \beta_0 + \beta_{f1a}\ \text{Fear/Disgust}_i + \beta_{k1b}\ \text{Knowledge}_i + \beta_2\ \text{Price of Cigarette}_i + \beta_3\ \text{Price of E-Cigarette}_i + \beta_4\ \text{E-Cigarette Warning}_i + \beta_5\ \text{Flavor Availability}_i + \beta_6\ \text{Nicotine Content}_i + \text{Controls} + \varepsilon_i$

The estimates α_{f1} and α_{k1} from equations (2) and (3) show the impacts of the graphic warning label on the subject's fear/disgust and knowledge, respectively; the estimates β_{f1a} and β_{k1b} from equation (4) show the impact of fear/disgust and knowledge on the choice probabilities. Combining these estimates provides estimates of the impacts of the graphic warning labels on choices through the mechanisms of fear/disgust and knowledge: $\delta_1 = \beta_{f1a} \times \alpha_{f1}$ and $\delta_2 = \beta_{k1b} \times \alpha_{k1.}$ The shares of the total impact of the graphic warning labels on choices accounted for by each of the mechanisms are given by δ_1/β_1 and δ_2/β_1.

In addition to fear/disgust and knowledge we also examine other possible mechanisms, including how graphic warning label influence perceptions of the relative risk of e-cigarettes and cigarettes, how the graphic warning influences expected years of life lost from smoking and vaping, and how the graphic warning influences perceptions of the harm of nicotine.

V. EMPIRICAL METHODS

The Discrete Choice Experiment and Product Attributes

We utilize a discrete choice experiment to generate data on the relationship between policy relevant product attributes and tobacco choices by adult smokers (cigarette, e-cigarette, quit). Our experimental design consisted of a 3 (cigarette price) X 3 (e-cigarette price) X 3 (nicotine levels) X 3 (flavor availability) X 4 (e-cigarette warning) design, for a total of 324 possible attribute combinations that could be presented to respondents. Each respondent was presented with 12 of the 324 possible scenarios. The assignment of scenarios to individual respondents were designed to maximize statistical efficiency to identify the parameters of interest.

A cigarette graphic warning label experiment was embedded into the discrete choice experiment. The graphic warning label did not vary across the scenarios in the discrete choice experiment. Instead, half of the sample was randomly assigned one of the graphic warning labels and the other half was shown one of the Surgeon General's text warnings currently required on cigarette packages. In this way, the estimated impact of the graphic warning label on a choice in one scenario is not contaminated by whether the respondent had seen or not seen the graphic warning in a prior scenario. Similarly, we can cleanly identify the impact of the graphic warning labels on our measures of fear/disgust and knowledge – which were collected later in the survey after the discrete choice experiment. The discrete choice experiment allows us to study the impact of graphic warnings in a semi-realistic market context. Discrete choice experiments tend to be more reliable when the subjects are familiar with the products and have experience making choices between them (McFadden 2017). Asking smokers to make choices about tobacco products is an almost ideal application of the discrete choice experimental method, because smokers have experience making tobacco product choices on a frequent basis.

In addition to the graphic warning label on cigarettes, the discrete choice experimental manipulations of other product attributes were also designed to shed light on policy questions. Cigarette and e-cigarette prices are influenced by government tax policies and there is continued discussion at both the state and federal level on the appropriate levels for taxes on these products. There are also policy discussions focused on limiting the nicotine content of e-cigarettes; some countries, such as the UK, already have such limitations. The FDA continues to deny marketing approval to e-cigarettes with flavors other than tobacco, so understanding how consumers respond to the lack of availability of flavors is important.

When presented with a scenario each respondent was asked about which tobacco choice they would make. After that choice, the identical scenario reappears, and the subject is asked which choice they would make if choosing 6 months from now. This process is repeated 12 times (with a new scenario that has a different combination of product attributes), so that we collect 24 choices per individual. In terms of identifying the impact of the graphic warning label on choices we have half the sample exposed to the graphic image 24 times prior to making choices and half the sample exposed to the currently required text warning prior to making choices. For the sample assigned the text-based warning they see one of the current rotating Surgeon General warnings (SGW) required on cigarette packages. We used the text warning; "Smoking causes Lung Cancer, Heart Disease, Emphysema, and may Complicate Pregnancy." For the sample assigned one of the new FDA graphic warning labels we used the image of amputated toes with accompanying message "Smoking Reduces Blood Flow to the Limbs, Which May Require Amputation". This label was chosen based on our judgement that it is among the most visually provocative of the new warnings proposed by FDA. Figures 1a and 1b provide an illustration of the text warning and graphic warning presented to respondents.

Between the immediate choice scenario and the 6-months-from-now scenarios, over the course of the experiment each respondent was exposed to either the text warning or the graphic warning 24 times.

The Survey Instrument and the Sample

Our sample consisted of 1,202 observations of adult smokers (aged 18 and above), each of whom was exposed to 12 scenarios and asked to report, after each of the scenarios, on which of the three options they would select for their immediate choice and the choice they would make 6 months from now. Several observations were dropped from the analysis because the reported price they last paid for 20 cigarettes was outside any reasonable range. Our estimation sample consists of responses from 1,171 subjects each of whom contributes 12 choice outcomes for a total of 14,052 observations for each of the equations.

We utilized the survey firm SSRS to implement our survey and assign scenarios to maximize efficiency.[21] The survey consisted of three sections. The first section included questions focused on age, cigarette and e-cigarette use, addiction measures, how the products were purchased, intention to quit in the next 6 months, whether they attempted to quit and methods they intend to use to quit. The questions about the products being purchased enabled us to compute the price they last paid for cigarettes. These included questions regarding whether they purchased a pack, a carton, 'loosies' as well as what they paid for these products. We then standardized their purchase into the price each respondent paid for 20 cigarettes, which was used

[21] Survey respondents were obtained using the SSRS Probability Panel. SSRS Opinion Panel members are recruited randomly based on nationally representative ABS (Address Based Sample) design (including Hawaii and Alaska). ABS respondents are randomly sampled by MSG through the U.S. Postal Service's Computerized Delivery Sequence (CDS), a regularly-updated listing of all known addresses in the U.S. For the SSRS Opinion Panel, known business addresses are excluded from the sample frame. Additionally, the SSRS Opinion Panel recruit hard-to-reach demographic groups via the SSRS Omnibus survey platform. The SSRS Omnibus completes more than 50,000 surveys annually with 80% cell allocation.

in the discrete choice experimental manipulations. The scenarios could include the price they paid, half the price, or twice the price.

The second section of the survey consisted of the discrete choice experiment, where respondents were presented with scenarios and choice tasks. To set the context we used the following language prior to the presentation of the scenarios:

> *We are interested in smokers' choices between cigarettes and e-cigarettes. We want you to imagine that you can easily buy both cigarettes and e-cigarettes where you usually buy your cigarettes; for example, in your local grocery store, convenience store, gas station, bodega, vape shops or on the internet. Each of the cigarette and e-cigarette options on the next page can be described by several characteristics. You will see different scenarios each with different combinations of the price of your cigarette brand, the price of an e-cigarette, along with other e-cigarette product attributes (health messaging, nicotine content, flavors). Although e-cigarettes are sold in various quantities with different types of devices, we will be asking you about e-cigarette packages that are equivalent to one pack of your brand of cigarettes. For the purposes of your choices, please do not consider the price of buying the startup kit for reusable e-cigarette. For the purpose of this survey, when seeing a health-related message assume that it is a legal message in that the government has either pre-approved it or it has been determined by the regulatory authorities to be truthful and non-misleading.*

The third section of the survey includes questions focused on whether the respondent noticed which product attributes were changing across the scenarios, their risk perceptions of cigarettes relative to e-cigarettes, their assessments of life expectancy loss from smoking and vaping, the level of fear/disgust when asked to recall the cigarette pack warning, knowledge of

the risk featured in the graphic cigarette warning, perceptions of the harm of nicotine, and demographic variables.

Table 1 provides the descriptive statistics for the sample for the different sections of our survey. The first set of descriptive statistics verifies the balanced design of the graphic warnings label experiment (50 percent in each condition) and the balanced assignment of the e-cigarette flavor, nicotine, and warning conditions in the discrete choice experiment. The e-cigarette price condition assignment was also balanced, but because the price conditions were $2, $4, or $8, the mean e-cigarette price is higher than $4. The average cigarette price was $8.77. As explained above, the cigarette price manipulation was based on the price the respondent reported paying for a pack of cigarettes.

The second set of descriptive statistics are for variables that measure aspects of smoking behavior. Fifty-nine percent of smokers smoke every day with 40 percent smoking menthol cigarettes. Sixty-three percent of the sample report having ever used an e-cigarette and just over half have tried to quit smoking in the last 12 months with 66 percent intending to quit in the next 6 months. The third set of descriptive statistics provide the demographic makeup of the sample and the post discrete choice experiment perceptions of harm. The sample is 57 percent female, 77 percent white, and is on average 45 years old.

VI. RESULTS: CIGARETTE GRAPHIC IMAGE WARNING VERSUS TEXT WARNING

Mean Differences

Table 2 provides the mean differences in choices for the control group shown the text warning versus the experimental group shown the graphic warning label. Given the experimental design, the mean differences are likely to closely mirror the differences that will be found in a

multivariate regression model.[22] Among the subjects in the experimental group shown the graphic warning label, 55 percent of choices were cigarettes, 25 percent of choices were e-cigarettes, and 20 percent of choices were to quit and not use cigarettes or e-cigarettes. Among the subjects in the control group shown the text warning, 61 percent of the choices were cigarettes, 22 percent of the choices were e-cigarettes and 17 percent of the choices were to quit. The difference in means between the experimental and control groups are statistically significant. The differences in the fraction of cigarette choices and choices to quit are more pronounced between the groups when respondents were asked about what they would choose in 6 months.

Linear Probability Model Results for Cigarette Graphic Image Versus Text Cigarette Warning

Table 3 presents linear probability regression models given by equation (1) for both the immediate choices and the six-months-from-now choices. The table only presents the coefficients of the experimentally manipulated variables (the notes in each table list the control variables controlled for in the regression).

Of key interest is the coefficient on the graphic warning label (GWL) variable in the various equations. For the immediate choice, the probability of choosing a cigarette is 5.4 percentage points lower when faced with the graphic warning label compared to the text warning. The coefficients on the graphic warning variable for the e-cigarette and the quit choices indicate that the movement away from cigarettes generated by the graphic warning label was about equally distributed to increase e-cigarette choices by 2.7 percentage points and to increase choices to quit by 2.8 percentage points.

[22] While we include other right hand side variables in the regression results in Table 3, an F-test indicates that taken together these variables do not add statistically significant explanatory power. This is not surprising given the randomization of the experimental manipulations across respondents.

The last three columns in Table 3 present the results for the choice respondents would make in 6 months. Compared to the estimated impacts on immediate choices, the estimates show a larger movement away from cigarettes (a drop of 7.8 percentage points) and towards quitting (an increase of 5.5 percentage points) in the six-months-from-now choices. The estimated impacts to increase e-cigarette immediate choices and six-months-from-now choices are about the same. These patterns provide a hint that some subjects might intend to use e-cigarettes in the immediate term in order to quit all tobacco products in the future.

VII. RESULTS FOR THE MECHASIMS THROUGH WHICH CIGARETTE GRAPHIC IMAGE WARNINGS INFLUENCE CHOICES

To investigate the mechanisms through which the graphic warning labels affect choices, we focus on whether the graphic images matter because they generate emotions such as fear and disgust or whether they matter because they generate greater knowledge of health risks. We first examine equations relating exposure to the graphic warning label to measures of fear/disgust and to measures of knowledge of the health risk in the warning (reduced blood flow to the limbs). We then estimate the effect that levels of fear/disgust and knowledge have on decisions to choose cigarettes, e-cigarettes, and quitting. The total effect of each mechanism is determined by the product of these effects. We also allow for other possible mechanisms through which the graphic warning could influence choice. These include how the graphic warning influences the perception of the harm of e-cigarettes relative to cigarettes, influences the belief that nicotine in cigarettes is the substance that causes most of the cancer caused by smoking, the perceived life expectancy loss from smoking, the perceived life expectancy loss from vaping, and the belief that nicotine on its own, can harm the developing brain of youth and young adults. Tables 4 and 5 present the results for the fear/disgust and knowledge mechanisms because of the legal

relevance of this distinction for the constitutionality arguments raised by the federal district court and the FDA. Table 6 presents the fraction of the total impact of the graphic warning on choices accounted for by each mechanism measured in our experiment.

The Effect of the Graphic Warning on Fear/Disgust and Knowledge of Risk

Tables 4 present the results for the regressions corresponding to equations (2) and (3). The Fear/Disgust variable is measured based on the answer to the following question: *Think back to the scenarios that you were shown earlier in this study. In each of the scenarios, there was a warning label about smoking cigarettes. To what extent, if at all, did you feel disgust/fear as a result of the labels*? Possible answers were in a Likert scale: To a Great Extent, Somewhat, Verry Little, Not at All. The Likert scale question was asked immediately after the discrete choice experiment, where across the various scenarios subjects were shown either the graphic warning or the text warning a total of 24 times.

The results in Table 4 indicate that the impact of the graphic warning label on responses about fear/disgust are statistically significant at both ends of the Likert scale. The fraction responding "Not at All" is seven percentage points lower among subjects shown the graphic warning, while the fraction responding "To a Great Extent" is 4.2 percentage points higher. The signs and the magnitudes of the coefficients on "Very Little" and "Somewhat" are consistent with the ends of the Likert scale, with "Very Little" being negative and "Somewhat" being positive.

The bottom part of Table 4 presents the results where knowledge of the health risk is the dependent variable. The knowledge variables are constructed based on the answer to the following question. *To what extent do you agree or disagree with the following statement – Smoking cigarettes reduces blood flow to the lower limbs.* Possible answers were again on a

Likert scale: Strongly agree, Somewhat agree, Neither agree nor disagree, Somewhat disagree, Strongly disagree, or I don't know. The coefficient on the graphic warning variable is marginally significant in only one of the categories and this coefficient is relatively small in magnitude. Despite the fact that the text warning does not mention blood flow to the outer limbs while the graphic warning directly describes this risk, repeated exposures to the graphic warning is not associated with different levels of knowledge. Given that most subjects in both the experimental and control groups agreed that smoking causes this risk, we speculate that many subjects are pre-disposed to agree with many statements about the risks of smoking.

The Impact of Fear/Disgust and Knowledge on Choices

Table 5 presents the regressions that correspond to equation (4), where the graphic warning label variable is replaced by the mechanism variables. In terms of immediate choices, subjects who report they feel a great deal of fear/disgust are 18.1 percentage points less likely to choose cigarettes, 8.1 percentage points more likely to choose e-cigarettes, and 10 percentage points more likely to quit. Subjects who report they "somewhat" feel fear/disgust are 10 percentage points less likely to choose cigarettes, 8.1 percentage points more likely to choose e-cigarettes, and 1.9 percentage points more likely to quit. In contrast to the results for the fear/disgust variable, the coefficients on the variables measuring knowledge of the risks associated with reduced blood flow are small and mainly not statistically significant.

The Share of the Total Impact of the Graphic Warning Accounted for by the Mechanisms

Table 6 shows the share of the total impact of the graphic warning on choices. The impact of graphic warning labels on fear/disgust accounts for approximately 17 percent of the total impact of the labels on cigarette choices. The impact of graphic warning labels on knowledge of the specific health risk mentioned in the label accounts for approximately 3

percent of the total impact on cigarette choices. In general, the effects of the other changes in knowledge are also small. With respect to the e-cigarettes, the results suggest that the cigarette graphic warning labels' effects on both fear/disgust and perceptions of the relative risks of cigarettes versus e-cigarettes both play an important role to increase e-cigarette choices.

Results from a Follow-up Discrete Choice Experiment with an Alternative Graphic Warning Label

Our results suggest that fear/disgust is the main mechanism through which one of the new graphic warning labels influences stated preferences for cigarettes. We estimate that improvements in knowledge about the specific risk featured in the label – the risks that smoking plays in reducing blood flow to the limbs – play a minimal role. A limitation to our graphic warnings label experiment is that we only considered one of the eleven warning labels proposed in the FDA rulemaking process. We chose the amputation/blood flow warning as it was considered one of the more provocative warnings. The tobacco companies pointed to this image and alleged that this was designed to elicit fear.[23] Given how central the question of fear versus knowledge is in the legal dispute, we undertook a follow-up discrete choice experiment to explore whether the results would carry over to an alternative warning label that, *ex-ante*, we believed was significantly less provocative. Figure 1C shows the original graphic warning label used in our experiment and the alternative graphic warning label used in the follow-up. The alternative label features the face of a man with cloudy eyes and the accompanying text "Smoking causes cataracts, which can lead to blindness."

All subjects in the follow-up discrete choice experiment were shown the cataract label. The data from the new subjects were then pooled with the control group from the original

[23] See R.J. Reynolds Tobacco Company vs. FDA, No. 6:20-cv 00176, Page 1.

experiment who were shown the text warning. All other elements of the survey and discrete choice experiment were identical with one exception. A question was added after the choice tasks inquiring whether the respondent has knowledge about the link between smoking, cataracts, and blindness (i.e. the health risk featured in the text accompanying the graphic image of cataracts).

The follow-up discrete choice experiment was conducted about a year after the original study and should not be considered truly randomized compared to the original control group. We used a joint test of orthogonality and found a lack of balance between the new experimental group and the original control group in some observable characteristics. The estimated models use a rich set of control variables that includes these characteristics, but the results should still be interpreted with caution.

Tables 7, 8 and 9 summarize the key findings from the follow-up discrete choice experiment. Compared to the amputation/blood flow label, in the immediate choice equations in Table 7 we no longer find that those exposed to the cataract warning made statistically significantly different choices about cigarettes or quitting. The Table 7 estimated effects of the cataract graphic warning label are always substantially smaller than the Table 3 estimates of the effects of the amputation/blood flow label. The results provide some suggestive evidence that the cataracts label might lead to some movement from cigarettes to e-cigarettes.

The results in Table 8 demonstrate that the cataract warning label did not generate fear/disgust. The coefficients on the GWL cataracts variable are small and none is significantly related to levels of fear/disgust. The results in Table 9 suggest that fear/disgust continues to be strongly associated with tobacco product choices, but knowledge of the risk of cataracts is not. Taken together, the results from the follow-up discrete choice experiment with the cataract label

suggest that the cataract label did not have a significant overall impact because it did not induce fear/disgust.

VIII. RESULTS FOR OTHER PRODUCT ATTRIBUTES

The results from our discrete choice experiment provide new evidence on how cigarette prices, e-cigarette prices, and policy-manipulable e-cigarette attributes influence tobacco product choices. The results are interesting in their own right and also allow us to compare the effects of graphic warning labels on cigarettes to other regulatory options.

The coefficients on the cigarette price variable are statistically significant in each of the six linear probability models reported in Table 3. For the own-price effect, a $1 increase in the price of cigarettes results in a 1.8 percentage point decrease in the probability of choosing cigarettes (immediate choice). At the sample means, the results imply that the own-price elasticity of the probability of choosing cigarettes is -0.27, which is consistent with prior research on the own-price elasticity of cigarette demand (DeCicca, Kenkel, and Lovenheim 2022). Put differently, a $3 per pack tax hike that is passed through to consumer prices would decrease immediate cigarette choices by as much as we estimate would result from the graphic warning labels. A $5.20 per pack tax hike that is passed through to consumer prices would increase 6-months-from-now quitting by as much as we estimate would result from the graphic warning labels. For context, current state excise taxes range from $0.17 to $4.35 per pack, plus the $1.01 per pack federal excise tax.

The Table 3 results also provide additional evidence that cigarettes and e-cigarettes are economic substitutes. In terms of immediate choices, a $1 increase in the price of cigarettes increases the probability of choosing e-cigarettes by one percentage point, while a $1 increase in the price of e-cigarettes increases the probability of choosing cigarettes by 1.7 percentage points.

The estimated positive cross-price elasticities contribute to the growing body of evidence that cigarettes and e-cigarettes are economic substitutes (DeCicca, Kenkel, and Lovenheim 2022).

The results from our discrete choice experiment also suggest that e-cigarette choices are responsive to the availability of flavored e-cigarettes and to the warnings on e-cigarette packages. Our results imply that in terms of immediate cigarette choices, restricting the availability of e-cigarette flavors to menthol and tobacco is equivalent to an $0.81 e-cigarette excise tax. Compared to no warning or a warning label that states that e-cigarettes pose less risk than cigarettes, the current FDA-required warning label reduces immediate e-cigarette choices by 3.2 percentage points, equivalent to a $1.89 e-cigarette excise tax. Our estimates imply that, unfortunately, FDA's 2016 required e-cigarette warning labels and marketing denial orders against flavored e-cigarettes, as well as recent State e-cigarette taxes, are working to increase cigarette use and might offset any potential decrease from future graphic warnings on cigarette packages.

IX. DISCUSSTION

Using stated preference data, we find that the primary mechanism through which graphic warning labels on cigarette packages influence tobacco choices is through fear/disgust rather than changes in knowledge of the health risks. Our results pose a dilemma for the FDA. In the first round of litigation on the FDA-proposed graphic warning labels, the courts ruled against FDA arguing that FDA did not present a 'shred of evidence' on the direct impact of graphic images on smoking rates. Although the analysis in our study is based on stated preferences and not market data, we find statistically significant results that the impact of the graphic warning labels will be to reduce cigarette use and increase the use of e-cigarettes and quitting. However, we find that graphic cigarette warnings influence choice only because they generate fear/disgust.

Yet there are significant first amendment legal issues that FDA faces if fear and disgust are the mechanisms through which graphic images operate. We note that our results are consistent with results from a meta-analysis of the experimental literature on cigarette pack graphic warnings. Noar et al. (2020) conclude that, across many studies included in the meta-analysis, graphic images impact fear and cognitive elaboration but do little to impact health risk beliefs. Our results support this conclusion, by demonstrating that the primary path through which the graphic warnings influence tobacco product choices in a semi-realistic market situation is through fear rather than knowledge.

Our results also shed new light on discussions on the costs and benefits of tobacco regulation, and on the costs of so-called "nudge" policies more generally. Anti-smoking information campaigns that nudge consumers to better decisions in their own self-interest improve social welfare (Jin et al. 2015). However, required graphic warning labels are not nudges if consumers actively dislike the labels (List et al. 2023). Our results that warning labels mainly work through fear/disgust rather than knowledge suggest that the labels impose important costs that should be balanced against the public health benefits of reduced smoking.

Our study includes other policy-relevant findings. The effects of cigarette prices and e-cigarette prices on tobacco choices show strong own and cross-price elasticities of demand. Especially relevant are the results regarding the impact of e-cigarette prices on cigarette demand. There is emerging evidence that e-cigarettes and cigarettes are economic substitutes. Our results imply that that when faced with higher e-cigarettes prices, the probability of choosing cigarettes rises significantly. These results suggest that there can be important unintended consequences of taxing e-cigarettes, especially given our results that higher e-cigarettes price do not increase the probability of quitting. Instead, when respondents are presented with higher e-cigarette prices,

we see complete substitution away from e-cigarettes toward cigarettes. Another policy relevant result can be seen by examining the results regarding cigarette prices. Higher cigarette prices lower the probability of choosing a cigarette and raises the probability of choosing both an e-cigarette and quitting. This again suggests some level of cross-price elasticity between cigarettes and e-cigarettes.

Our findings on e-cigarette flavor availability also have direct policy relevance. The FDA has now consistently denied marketing authorization to e-cigarettes, except for tobacco-flavored e-cigarettes. The denials are based on the determination that they are not appropriate for public health, based on the tradeoff between youth vaping initiation and adult smoking cessation. Results from our discrete choice experiment suggest that limiting e-cigarette flavors to only tobacco is likely to increase the probability that adult smokers will choose cigarettes instead of e-cigarettes and does not increase quitting. FDA is concerned that flavored e-cigarettes will generate youth onset into e-cigarettes. While we do not study youth behavior, we do present the consequences on adult smokers. These estimates can be used to further evaluate and weigh the benefits and costs of eliminating flavored e-cigarettes from the market.

Our results on e-cigarette warnings suggest another possible unintended consequence of current e-cigarette regulatory policies. The current FDA warning on e-cigarettes is shown to result in a decreased probability of choosing e-cigarettes. This is as intended. However, we estimate that the decrease in the probability of choosing an e-cigarette does not result in a probability of quitting tobacco use, but instead increases the probability of choosing cigarettes. The unintended consequence is to move tobacco users from less harmful to more harmful forms of tobacco.

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Table 1. Descriptive statistics of DCE attributes, respondents' smoking history, demographics and post DCE perceptions (N = 1171)

DCE attributes of DCE # 1	Mean	SD	Min	Max
Cigarette pictorial warning (Amputation)	0.50	0.50	0	1
Price				
Cigarette price	8.77	6.10	0.50	40
E-cigarette price	4.67	2.49	2	8
E-cigarette available flavor				
Tobacco, menthol, fruit/sweet/candy	0.33	0.47	0	1
Tobacco and menthol	0.33	0.47	0	1
Tobacco only	0.33	0.47	0	1
E-cigarette available nicotine level				
Up to 5mg	0.33	0.47	0	1
Up to 20mg	0.33	0.47	0	1
Up to 50 mg	0.33	0.47	0	1
E-cigarette warning				
No warning	0.25	0.43	0	1
Are not completely risk free	0.25	0.43	0	1
Contain nicotine, which is addictive	0.25	0.43	0	1
May expose users to chemicals and toxins	0.25	0.43	0	1
Smoking history				
Smoke everyday	0.59	0.49	0	1
Age of smoking initiation	18.32	6.27	7	76
Heavy smoker	0.37	0.48	0	1
Cigarette flavor: menthol	0.40	0.49	0	1
Cigarette flavor: non-menthol	0.55	0.50	0	1
Cigarette flavor: other flavor	0.02	0.14	0	1
Cigarette flavor: no usual type	0.03	0.17	0	1
Ever used e-cigarette	0.63	0.48	0	1
Tried to quit during last 12 months	0.50	0.50	0	1
Intend to quit in next 6 months	0.66	0.48	0	1
Demographics				
Male	0.42	0.49	0	1
Female	0.57	0.50	0	1
Age	45.16	13.54	18	83
Age group (18-24)	0.04	0.19	0	1
Age group (25-39)	0.37	0.48	0	1
Age group (40-64)	0.49	0.50	0	1
Age group (65+)	0.10	0.30	0	1
Household size	2.80	1.69	1	19
Grade school/some high school	0.07	0.25	0	1
Completed high school	0.25	0.43	0	1

Technical school or community college	0.18	0.38	0	1
Some university, no degree	0.24	0.43	0	1
Bachelor's degree	0.18	0.38	0	1
Post-graduate degree	0.08	0.27	0	1
Household annual income above 50000 USD	0.46	0.50	0	1
Full-time employed	0.48	0.50	0	1
White	0.77	0.42	0	1
Post DCE perceptions				
Comparing to cigarettes, e-cigarettes are				
Less harmful	0.26	0.44	0	1
Just as harmful	0.39	0.49	0	1
More harmful	0.18	0.38	0	1
Do not know	0.17	0.38	0	1
Feel disgust/fear as a result of the pictorial warning				
To a great extent	0.15	0.35	0	1
somewhat	0.37	0.48	0	1
very little	0.27	0.44	0	1
Not at all	0.22	0.41	0	1
Believe that Smoking Cigarettes Reduces Blood Flow to the Lower Limbs				
Agree	0.66	0.47	0	1
Neither agree nor disagree	0.16	0.36	0	1
Disagree	0.04	0.20	0	1
Do not know	0.14	0.35	0	1
How much would you willing to pay for a case to carry cigarettes				
Willing to pay for a $5 case	0.12	0.33	0	1
Willing to pay for a $10 case	0.10	0.30	0	1
Willing to pay for a $20 case	0.05	0.23	0	1

Table 2. Descriptive statistics of DCE Choices by Type of Warning

Variables	Mean			Mean
	All	GWL	text warning	difference
Immediate choice today				
Cigarette	0.581	0.548	0.615	-0.0677***
E-cigarette	0.234	0.248	0.220	0.0281***
Quit	0.184	0.204	0.165	0.0396***
Choice of 6 months from now				
Cigarette	0.431	0.385	0.477	-0.0917***
E-cigarette	0.224	0.235	0.213	0.0221**
Quit	0.345	0.380	0.310	0.0697***
Respondents	1171	587	584	

Notes: Each respondent is presented 12 scenarios and makes one choice in each scenario. *** p<0.01, ** p<0.05, * p<0.1.

Table 3. Estimation results of the main effects from linear probability models

Variables		Immediate choice today			Choice of 6 months from now		
		Cigarette	E-cigarette	Quit	Cigarette	E-cigarette	Quit
Cigarette warning	GWL amputation	-0.054***	0.027	0.028*	-0.078***	0.024	0.055***
		(0.019)	(0.017)	(0.016)	(0.019)	(0.018)	(0.021)
Price	Cigarette price	-0.018***	0.010***	0.008***	-0.015***	0.007***	0.008***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	E-cigarette price	0.017***	-0.017***	-0.000	0.013***	-0.014***	0.002
		(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
E-cigarette available flavor	Tobacco, menthol, fruit/sweet/candy	-0.022***	0.027***	-0.005	-0.027***	0.036***	-0.009
		(0.008)	(0.007)	(0.006)	(0.007)	(0.007)	(0.006)
	Tobacco and menthol	-0.026***	0.010	0.016**	-0.023***	0.019***	0.003
		(0.008)	(0.007)	(0.006)	(0.007)	(0.006)	(0.006)
E-cigarette available nicotine level	Up to 20mg	-0.004	0.003	0.002	-0.004	-0.001	0.006
		(0.006)	(0.006)	(0.005)	(0.006)	(0.006)	(0.005)
	Up to 50mg	0.012*	-0.009	-0.003	-0.000	-0.001	0.001
		(0.007)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
E-cigarette warning	Are not completely risk free	0.005	-0.002	-0.003	0.002	0.003	-0.005
		(0.008)	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)
	Contain nicotine, which is addictive	0.032***	-0.017**	-0.015**	0.018*	-0.005	-0.013
		(0.009)	(0.008)	(0.008)	(0.009)	(0.009)	(0.009)
	May expose users to chemicals and toxins	0.012	-0.018**	0.005	0.005	-0.011	0.007
		(0.009)	(0.008)	(0.007)	(0.008)	(0.008)	(0.008)
	Constant	0.628***	0.214***	0.158**	0.731***	0.193***	0.075
		(0.074)	(0.061)	(0.068)	(0.078)	(0.066)	(0.087)
Observations		14,052	14,052	14,052	14,052	14,052	14,052
Adjusted R-squared		0.208	0.144	0.098	0.239	0.099	0.169

Notes: Additional control variables include smoking status (being every day smoker), age of smoking initiation, heavy smokers (heavy smoker index >= 3), vaping status (ever used e-cigarette), quitting effort (tried to quit during last 12 months), quit intention (intend to quit in the next 6 months), gender (being male), age, household size, education (reference category is grade school/some high school), household income above 50k, full-time employed, white. The reference category of e-cigarette available flavor "tobacco only", the reference category of e-cigarette available nicotine level is "up to 5mg", the reference category of e-cigarette warning is "no warning". Standard errors clustered at respondent level are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4 The effect of GWL on mechanism variables

(A)	Feel disgust/fear as a result of the cigarettes warning label			
	Not at all	Very little	Somewhat	To a great extent
GWL amputation	-0.070***	-0.009	0.036	0.042**
	(0.023)	(0.026)	(0.028)	(0.021)
Constant	0.042	0.216*	0.646***	0.096
	(0.102)	(0.110)	(0.128)	(0.102)
Observations	1,171	1,171	1,171	1,171
Adjusted R-squared	0.038	0.013	0.036	0.019

(B)	Smoking cigarettes reduces blood flow to the lower limbs				
	Strongly disagree	Somewhat disagree	Neither disagree nor agree/I do not know	Somewhat agree	Strongly agree
GWL amputation	-0.013*	-0.008	-0.007	-0.017	0.045
	(0.007)	(0.009)	(0.026)	(0.028)	(0.027)
Constant	-0.008	0.088**	0.574***	0.121	0.224*
	(0.040)	(0.039)	(0.121)	(0.123)	(0.121)
Observations	1,171	1,171	1,171	1,171	1,171
Adjusted R-squared	0.003	0.017	0.036	0.015	0.030

Notes: Heteroskedastic-robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Other controls include e-cigarette DCE attributes (proportion of each warning), smoking history (smoking status, age of smoking initiation, heavy smoker, vaping status, quitting effort, quitting intention), and demographics (gender, age, household size, education, income, full-time employment status, race).

Table 5 Mechanism analysis

Variables		Immediate choice today			Choice of 6 months from now		
		Cigarette	E-cigarette	Quit	Cigarette	E-cigarette	Quit
Price	Cigarette price	-0.019***	0.010***	0.009***	-0.015***	0.007***	0.008***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	E-cigarette price	0.017***	-0.017***	0.000	0.013***	-0.014***	0.001
		(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
Feel disgust/fear about the cigarette warning label	Very little	-0.033	0.046**	-0.013	-0.025	0.026	-0.000
		(0.024)	(0.021)	(0.022)	(0.028)	(0.023)	(0.029)
	Somewhat	-0.100***	0.081***	0.019	-0.119***	0.061***	0.058**
		(0.024)	(0.021)	(0.022)	(0.028)	(0.024)	(0.029)
	To a great extent	-0.181***	0.081***	0.100***	-0.164***	0.042	0.122***
		(0.032)	(0.027)	(0.029)	(0.036)	(0.029)	(0.038)
Smoking cigarettes reduces blood flow to the lower limbs	Strongly disagree	0.035	-0.038	0.003	0.163**	0.025	-0.189**
		(0.068)	(0.054)	(0.077)	(0.076)	(0.061)	(0.085)
	Somewhat disagree	-0.002	-0.013	0.015	0.029	-0.002	-0.027
		(0.048)	(0.049)	(0.051)	(0.056)	(0.051)	(0.064)
	Somewhat agree	0.046*	-0.028	-0.017	0.046*	-0.011	-0.036
		(0.024)	(0.021)	(0.022)	(0.025)	(0.022)	(0.027)
	Strongly agree	-0.021	-0.016	0.036	0.018	-0.005	-0.013
		(0.027)	(0.024)	(0.024)	(0.027)	(0.025)	(0.030)
	Constant	0.647***	0.211***	0.142*	0.768***	0.187***	0.046
		(0.080)	(0.063)	(0.075)	(0.089)	(0.071)	(0.098)
Observations		14,040	14,040	14,040	14,040	14,040	14,040
Adjusted R-squared		0.257	0.208	0.138	0.269	0.159	0.197

Notes: Standard errors clustered at respondent level are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The reference category of variable disgust/fear about graphic image is "Not at all", the reference category of variable knowledge of blood flow is "Neither disagree nor agree/I do not know". Other controls include e-cigarette DCE attributes (flavor, nicotine level, warning), potential mechanism variables (relative harm perception, belief of nicotine, perceived life expectancy loss from smoking/vaping), smoking history (smoking status, age of smoking initiation, heavy smoker, vaping status, quitting effort, quitting intention), and demographics (gender, age, household size, education, income, full-time employment status, race).

Table 6. Mechanism explained impacts

DCE # 1	Percent of Total Impact of The Pictorial Warning on Choice δ/β					
	Immediate Choice Today			Choice of 6 months from now		
	Cigarette	E-cigarette	Quit	Cigarette	E-cigarette	Quit
Feel Disgust/Fear as a Result of seeing Cigarette Warning Label	16.62%	21.80%	12.96%	12.21%	17.46%	10.55%
Perceived Harm of E-cigarettes Relative to Cigarettes	8.97%	31.34%	-6.82%	3.99%	35.34%	-5.88%
Believe that "I smoke more than I should"	-2.87%	0.57%	-5.29%	0.29%	-1.79%	0.95%
Believe that Nicotine in Cigarettes is the Substance that Causes Most of the Cancer Caused by Smoking	4.70%	3.03%	5.88%	0.19%	7.31%	-2.06%
Nicotine, on Its Own, Can Harm the Developing Brain of Youth and Young Adults	-0.05%	0.77%	-0.63%	-0.60%	-1.72%	-0.25%
Believe that Smoking Cigarettes Reduces Blood Flow to the Lower Limbs	3.19%	1.35%	4.50%	2.51%	-1.61%	3.81%
Life Expectancy Loss from Smoking	0.11%	-2.08%	1.66%	-0.16%	-7.23%	2.06%
Life Expectancy Loss from Vaping	0.13%	6.78%	-4.56%	-0.19%	6.55%	-2.31%

Table 7. The effect of graphic warning label on choices (Cataract GWL Versus Text)

Variables		Immediate choice today			Choice of 6 months from now		
		Cigarette	E-cigarette	Quit	Cigarette	E-cigarette	Quit
Cigarette warning	GWL cataracts	-0.031	0.030*	0.001	-0.033*	0.036**	-0.003
		(0.019)	(0.017)	(0.017)	(0.020)	(0.018)	(0.021)
Price	Cigarette price	-0.018***	0.008***	0.009***	-0.015***	0.007***	0.008***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	E-cigarette price	0.014***	-0.018***	0.004***	0.010***	-0.014***	0.004***
		(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)
E-cigarette available flavor	Tobacco, menthol, fruit/sweet/candy	-0.019**	0.027***	-0.008	-0.028***	0.036***	-0.008
		(0.008)	(0.007)	(0.006)	(0.007)	(0.007)	(0.006)
	Tobacco and menthol	-0.018**	0.012*	0.005	-0.019***	0.015**	0.004
		(0.008)	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)
E-cigarette available nicotine level	Up to 20mg	-0.002	-0.003	0.005	-0.007	0.003	0.004
		(0.006)	(0.006)	(0.005)	(0.006)	(0.006)	(0.005)
	Up to 50mg	0.005	-0.000	-0.005	-0.004	0.002	0.002
		(0.007)	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)
E-cigarette warning	Are not completely risk free	-0.005	0.005	-0.000	-0.010	0.007	0.004
		(0.008)	(0.007)	(0.007)	(0.008)	(0.007)	(0.008)
	Contain nicotine, which is addictive	0.022**	-0.015*	-0.007	0.012	-0.007	-0.005
		(0.009)	(0.008)	(0.007)	(0.009)	(0.009)	(0.009)
	May expose users to chemicals and toxins	0.007	-0.008	0.001	-0.003	-0.009	0.012
		(0.008)	(0.008)	(0.007)	(0.008)	(0.008)	(0.008)
	Constant	0.625***	0.294***	0.081	0.730***	0.199***	0.071
		(0.076)	(0.063)	(0.073)	(0.080)	(0.068)	(0.089)
Observations		13,980	13,980	13,980	13,980	13,980	13,980
Adjusted R-squared		0.212	0.168	0.093	0.242	0.134	0.156

Notes: Additional control variables include smoking status (being every day smoker), age of smoking initiation, heavy smokers (heavy smoker index >= 3), vaping status (ever used e-cigarette), quitting effort (tried to quit during last 12 months), quit intention (intend to quit in the next 6 months), gender (being male), age, household size, education (reference category is grade school/some high school), household income above 50k, full-time employed, white. The reference category of e-cigarette available flavor "tobacco only", the reference category of e-cigarette available nicotine level is "up to 5mg", the reference category of e-cigarette warning is "no warning". Standard errors clustered at respondent level are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 8: The effect of pictorial warning on mechanism variables (DCE # 2)

	Feel disgust/fear as a result of the cigarettes warning label			
	Not at all	Very little	Somewhat	To a great extent
GWL cataracts	-0.004	0.008	0.014	-0.018
	(0.026)	(0.027)	(0.029)	(0.021)
Constant	0.125	0.149	0.552***	0.174*
	(0.105)	(0.110)	(0.125)	(0.091)
Observations	1,146	1,146	1,146	1,146
Adjusted R-squared	0.041	0.011	0.037	0.024

	Smoking cigarettes reduces blood flow to the lower limbs				
	Strongly disagree	Somewhat disagree	Neither disagree nor agree/I do not know	Somewhat agree	Strongly agree
GWL cataracts	-0.008	-0.002	0.041	0.030	-0.060**
	(0.008)	(0.011)	(0.028)	(0.030)	(0.027)
Constant	0.002	0.077**	0.619***	0.302**	-0.001
	(0.044)	(0.032)	(0.121)	(0.121)	(0.113)
Observations	1,146	1,146	1,146	1,146	1,146
Adjusted R-squared	0.001	0.003	0.051	0.012	0.028

Notes: Heteroskedastic-robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Other controls include e-cigarette DCE attributes (proportion of each warning), smoking history (smoking status, age of smoking initiation, heavy smoker, vaping status, quitting effort, quitting intention), and demographics (gender, age, household size, education, income, full-time employment status, race).

Table 9 Mechanism analysis omitting Cataract GWL

Variables		**Immediate choice today**			**Choice of 6 months from now**		
		Cigarette	E-cigarette	Quit	Cigarette	E-cigarette	Quit
Price	Cigarette price	-0.017***	0.008***	0.010***	-0.015***	0.007***	0.008***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	E-cigarette price	0.014***	-0.018***	0.004***	0.010***	-0.014***	0.004**
		(0.002)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)
Feel disgust/fear about the cigarette warning label	Very little	-0.063**	0.037*	0.026	0.002	0.029	-0.031
		(0.025)	(0.021)	(0.021)	(0.028)	(0.023)	(0.029)
	Somewhat	-0.083***	0.042**	0.041**	-0.069**	0.040*	0.029
		(0.024)	(0.021)	(0.021)	(0.027)	(0.023)	(0.029)
	To a great extent	-0.126***	0.051*	0.075**	-0.080**	0.037	0.043
		(0.033)	(0.028)	(0.031)	(0.036)	(0.029)	(0.039)
Smoking cigarettes	Strongly disagree	0.038	0.084*	-0.122**	0.100	0.145**	-0.245***
		(0.062)	(0.050)	(0.055)	(0.077)	(0.058)	(0.065)

reduces blood flow to the lower limbs	Somewhat disagree	-0.018	0.012	0.006	-0.020	0.027	-0.007
		(0.053)	(0.046)	(0.049)	(0.053)	(0.044)	(0.060)
	Somewhat agree	0.031	-0.025	-0.006	-0.000	-0.027	0.027
		(0.023)	(0.021)	(0.020)	(0.024)	(0.021)	(0.026)
	Strongly agree	-0.016	-0.008	0.024	-0.003	-0.011	0.015
		(0.026)	(0.023)	(0.023)	(0.027)	(0.024)	(0.030)
	Constant	0.637***	0.307***	0.057	0.802***	0.173**	0.025
		(0.086)	(0.068)	(0.077)	(0.089)	(0.072)	(0.092)
Observations		13,968	13,968	13,968	13,968	13,968	13,968
Adjusted R-squared		0.250	0.226	0.121	0.271	0.203	0.183

Notes: Standard errors clustered at respondent level are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The reference category of variable disgust/fear about graphic image is "Not at all", the reference category of variable knowledge of blood flow is "Neither disagree nor agree/I do not know". Other controls include e-cigarette DCE attributes (flavor, nicotine level, warning), potential mechanism variables (relative harm perception, belief of nicotine, perceived life expectancy loss from smoking/vaping), smoking history (smoking status, age of smoking initiation, heavy smoker, vaping status, quitting effort, quitting intention), and demographics (gender, age, household size, education, income, full-time employment status, race).

Figure 1A: One of the Scenario Presentations to Respondents Who Are Randomly Assigned to the Surgeon General Cigarette Warning Label (SGWL).

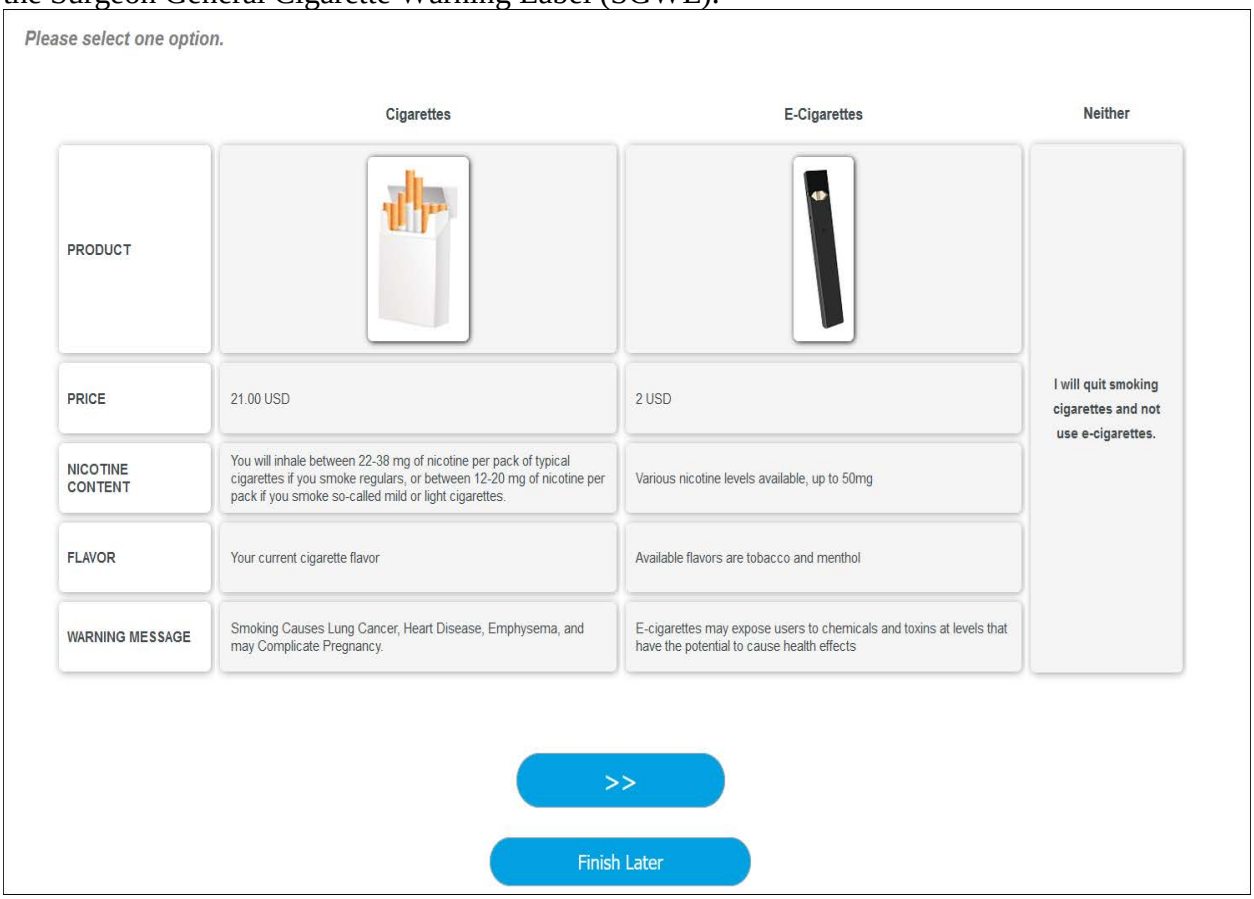

Figure 1B: One of the Scenario Presentations to Respondents Randomly Assigned to the FDA Graphic Warning Label (FDAGWL).

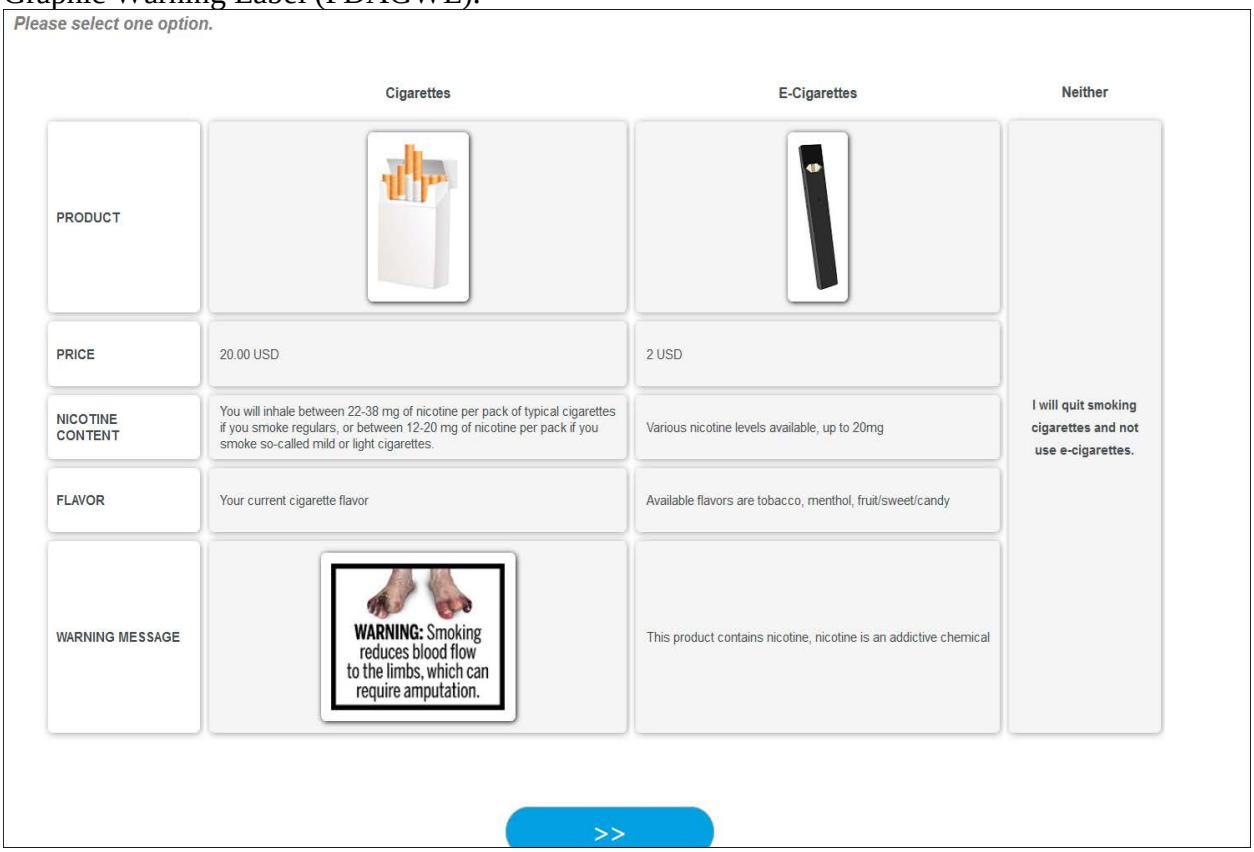

Figure 1C: Graphic Warning Label Used in Second DCE Experiment.

Replace

With