APPENDIX

Appendix A: Sample characteristics(n=2031)

Variable	%
<u>Sociodemographic variables</u>	
Age <26	11.6
Age 26-54	68.2
Old (age > 54)	20.2
Female	54.2
Male	45.8
White	86.6
Black	9.0
Asian	2.5
American Indian	2.0
Other race	2.0
Non-Hispanic	91.8
Hispanic	8.2
Higher education (obtained a university degree)	47.8
Non-higher education	52.2
Income > mean income ($55,000)	39.9
Income < mean income ($55,000)	60.1
Household size > 2	55.5
Household size < 3	44.5
Self-reported health < 3	36.1
Self-reported health > 2	63.9
<u>Smoking-related variables</u>	
One or more attempt(s) to quit in the past year	58.1
No quit attempts	41.9
Cigarette only user	51.1
Use both cigarettes and e-cigarettes (dual user)	30.5
E-cigarette only user (vaper)	7.3
Recent Quitter	11.1
N	**2,031**

Notes: "recent quitter" is an individual that reported no current use of either product

Appendix B: Product Type Choice Model

Respondents were asked to select their preferred product type in choice scenarios, so they are assumed to be maximizing their utility when making choices (Louviere et al., 2000). We defined a general product type utility function that relates individuals' choices to their preferences for product types and attributes:

$$Utility(product) = f(product\ type, flavor, price, nicotine, health\ risk) \quad (1).$$

This utility function serves as the basis for the empirical model. From (1), we can build an econometric model to put numerical values on individuals' ordinal preferences (Hensher et al., 2015). Here, *utility* comprises an observed and unobserved component, V_{ijc} and ε_{ijc}, respectively. We then defined the observed component in terms of the attributes and product types,

$$U_{ijc}(product) = V_{ijc} + \varepsilon_{ijc}$$
$$= \beta_{flavor}.Flavor_{jc} + \beta_{price}.Price_{jc} + \beta_{nicotine}.Nicotine_{jc} + \beta_{Health\ risk}.Health\ Risk_{jc}$$
$$+ ECIG + None - of - these$$
$$+ \varepsilon_{ijc} \quad (2),$$

where V_{ijc} is the utility that respondent *i* derives from product type *j* in choice scenario *c*.

The utility is related to the product attributes, namely flavor ($Flavor$), price ($Price$), level of nicotine ($Nicotine$), and health risk ($Health\ Risk$); β_{price} are the preferences for the attributes to be estimated. Next, individuals' underlying preferences were estimated for e-cigarettes ($ECIG$) and the "none of these" option ($None - of - these$). The omitted product type is cigarettes, and thus these coefficients show the preference for these options relative to a cigarette. ε_{ijc} is an error term that is assumed to follow a type-I extreme value distribution to facilitate estimation.

As noted above, we are interested in the impact of flavored product ban alternatives. Thus, we redefined the choice model (2) to capture preferences for flavored products directly,

rather than for product types and flavors separately. To do this, we redefined V_{ijc} using (a) flavored product constant terms (which are combinations of flavors and product type constant terms); and (b) combined fruit/sweet flavors[1]. We therefore estimate parameters separately for the set of product type and flavor pairs as indicated below, with cigarettes as the omitted category. The flavored product type utility function is defined as

$$\begin{aligned} U_{ijc}(flavored\ product) &= V_{ijc} + \varepsilon_{ijc} \\ &= Men\_Ccig + Tob\_Ecig + Men\_Ecig + Fru\_Ecig + None - of - these \\ &+ \beta_{price}.Price_{jc} + \beta_{nicotine}.Nicotine_{jc} + \beta_{Health\ risk}.Health\ Risk_{jc} \\ &+ \varepsilon_{ijc} \end{aligned} \quad (3).$$

The four flavored products constants each represent the preference for a flavored product type relative to unflavored cigarettes (the omitted category). These constants are: Men_Ccig, which captures the relative preference for menthol cigarettes, and Tob_Ecig, Men_Ecig, and Fru_Ecig, which capture relative preference for, respectively, tobacco, menthol, and fruit/sweet flavored e-cigarettes. Further, the preference for not choosing any of the flavored products was captured by $None - of - these$. The terms $\beta_{price}, \beta_{nicotine,}$and $\beta_{health\ risk}$ capture preferences for the attributes of price, nicotine content, and health risk, respectively.

In specification (3), preferences are estimated at the sample level. In addition to this basic model, we introduced heterogeneity across personal characteristics. Specifically, we interact sociodemographic and smoking behavior variables with the flavored product constants in the utility function. The full list of items that are interacted with the flavored product constants are given in Table 3 and results are presented in Table 4, panel B. We used estimates of these interaction terms to make the policy predictions.

Finally, we define the choice model which gives the probability of choice as a function of the relative utilities (which are, as above, a function of flavored product and attribute

[1] We combine the categories of sweet and fruit because: together they incorporate many of the flavors of e-cigarettes available; historically they have been regulated differentially from menthol; and this is consistent with previous literature (Bonhomme et al., 2016; Huang et al., 2016; Pepper et al., 2016). We also test for the validity of pooling them as explained below.

preferences). Because respondents make two sequential choices without replacement, we use the exploded, or rank order, logit model (Luce and Suppes, 1965; Yoo and Doiron, 2013),

$$P_{ijc}(rank\ 1{,}2) = \frac{e^{V_{ijc}}}{\sum_{j=1}^{J} e^{V_{ijc}}} \cdot \frac{e^{V_{ijc}}}{\sum_{j=2}^{J} e^{V_{ijc}}} \quad (4),$$

where P_{ijc} is the probability that individual *i* ranks product type *j* first or second in choice scenario *c*. The first term is the probability that product type *j* is ranked first (which is akin to the multinomial logit model for a single choice). The second term is the probability that product type *j* is ranked second when the first choice has been removed from the options.

Appendix C: Testing and Robustness

In addition to the data quality measures that were used, statistical testing for model specification, and correspondence of our findings to the literature, further statistical tests and empirical robustness analyses were conducted and our findings were confirmed. First, alternative model structures were estimated, including the multinomial logit based only on respondents' first choice and the exploded logit with an adjustment for scaling differences between the first and second choices (Yoo and Doiron, 2013). We further estimated a model with random parameters to allow for unobserved heterogeneity. In addition, we estimated a model that discarded the recent quitters. In all cases, we find the results (available upon request) to be very similar to those presented.

In addition, our specification of the paired flavored products was tested (rather than flavors as attributes and product types separately). We use pairwise testing of all flavored product constants and find that we can reject the null that the two coefficients are equal per pair in every test (at the one percent level). We observe an improvement in model fit when moving from a model with flavors as attributes and product types separately to the model in Table 3 (although it is not statistically significant). We also test our categories of flavors. In preliminary modeling, we find no differences between preferences for fruit and sweet flavors.

Using a Wald test, we are unable to reject the null that the two coefficients were equal. In addition, we find that preferences for fruit/sweet were statistically distinct from menthol. These tests support the categorization of sweet and fruit together that we use. In summary, our treatment of flavors is in line with policymakers' options, but also consistent with the literature and is statistically supported.

Several internal validity checks supported our results. First, we used a series of follow-up questions to check for consistency between choice task responses—e.g. health is self-reported by our sample as one of the leading reasons for using e-cigarettes. Second, we checked that our estimated coefficients are in line with theoretical a priori expectations, that is, price coefficients are negative, respondents preferred healthier cigarettes and that those who report using e-cigarettes prefer e-cigarettes to combustible cigarettes.

Appendix D: Pre-experiment information for respondents

SCREEN 1

We would like you to choose between two types of cigarettes:

1. Traditional tobacco cigarettes.

2. Electronic or e-cigarettes. E-cigarettes are battery operated and vaporize a liquid containing, which may contain nicotine.

We would like you to imagine that you can easily buy both types of cigarettes where you usually buy your cigarettes; for example, in your local grocery store, convenience store, gas station, bodega, or on the internet.

SCREEN 2

While there are several specific types of e-cigarettes, **we would like you to think of the e-cigarettes as a broad group in this survey.** We display some of the specific e-cigarettes types in the table below. All of these types of e-cigarettes should be considered as one group.

The survey will now pause to give you time to review the types of cigarette you will be able to choose.

Broad cigarette types	**Specific types within each group**
Traditional tobacco cigarettes	
E-cigarettes	  

SCREEN 3

Each of these two broad cigarette types can be described by **several characteristics.** Below we describe four characteristics. For each we vary the characteristic by providing different 'levels'. We would like you to focus on these characteristics and levels when you make your choices.

1. Nicotine. Nicotine is a stimulant and it is addictive. Nicotine occurs naturally in tobacco leaves so it is found in traditional tobacco cigarette. While nicotine is the addictive part of traditional tobacco cigarettes, it is the tar and carcinogens that can give a smoker lung cancer and heart disease. The average level of nicotine in traditional tobacco cigarettes is around 0.3 mg per cigarette. Nicotine is often, but not always, added to e-cigarettes.

2. Flavors. The only flavor that is allowed by the government for traditional tobacco cigarettes is menthol. In contrast, e-cigarettes are sold in a variety of flavors including tobacco, menthol, fruit, sweet, and other flavors.

Examples of fruit flavors: strawberry, watermelon, peach, black cherry, blueberry, grape, banana, green apple.

Examples of sweet flavors: candy, desserts, chocolate, vanilla, cinnamon.

3. Impact of using cigarettes on your life-expectancy. It is well-known that the tar and carcinogens in traditional tobacco cigarettes harms your health and can reduce your life-expectancy. Medical experts tend to think that e-cigarettes are less harmful to health than traditional tobacco cigarettes, but this is not known with certainty. You will therefore see the following: Regular cigarette users will **die earlier by: 2 years, 5 years, 10 years and 'unknown'**.

4. Price. To make it easy for you to compare prices across cigarette types, we have calculated the price of each cigarette type to be the same amount as 20 traditional tobacco cigarettes. The prices that you see in this survey may not be the prices that you pay for your own cigarettes. This is ok; please use the prices that we provide when you consider the cigarettes, even if they are very different than the price you pay for your own cigarettes.

For the purposes of your choices, please do not consider the price of buying the startup kit for reusable e-cigarettes.

Bottom line: the price for each cigarette type you see is the full price we would like you to consider in making your choice.

SCREEN 4

The survey will now pause to give you time to review the characteristics and the values they can take in the various options you will be asked to choose from.

Characteristic	**Levels or options relating to each characteristic. You will be presented with sets of alternatives of these.**
Nicotine	None, Low (0.1mg per cigarette), Medium (0.3mg per cigarette), High (0.6mg per cigarette)
Flavor	For traditional tobacco cigarettes: tobacco, menthol For e-cigarettes: tobacco, menthol, fruit, sweet
Regular users will die earlier by	2 years, 5 years, 10 years, unknown
Price for the equivalent of 20 traditional **tobacco cigarettes**	$4.99, $7.99, $10.99, $13.99

SCREEN 5

Please read. **Below, you will be asked to choose cigarette types 12 different times**. Note that:

- The cigarette types will have different combinations of characteristic levels in each question.
- You do not have to choose the same cigarette type in each question.
- Choose the cigarette type you like best based on its characteristic levels, **even if you chose a different cigarette type in another question**.
- Please look at the example question on the next page.

SCREEN 6

EXAMPLE OF CHOICE QUESTION

The table below is an example of a choice question in which a person has to choose two options. They must indicate their first and second choice between the e-cigarettes and traditional tobacco cigarettes in the choice question. We will ask you to make first and second choices 12 times.

In this choice question, this person chose an e-cigarette (e-cigarette 2) as their first choice and a pack of traditional tobacco cigarettes (tobacco cigarette 2) as their second choice. In other choice questions, this same person may choose different cigarettes because the characteristics will differ each time. The survey will now pause to give you time to look at the example of the choice question.

As in the example here, we would like you to choose your two most preferred options from the choices and the order in which you prefer them. The idea is to pick your most preferred option – 'first preferred' and then your next preferred option – 'second preferred'.

If you would not purchase any of the options, you may pick 'I would not purchase any of these products' twice.

Tobacco Cigarette 1	Tobacco Cigarette 2
 • Flavor: **Tobacco** • Nicotine level: **Low** • Die earlier: **10 years**	 • Flavor: **Menthol** • Nicotine level: **Medium** • Die earlier: **10 years**
$13.99	$10.99
E-cigarette 1	**E-cigarette 2**
 • Flavor: **Sweet** • Nicotine level: **Medium** • Die earlier: **Unknown**	 • Flavor: **Fruit** • Nicotine level: **High** • Die earlier: **2 years**
$4.99	$7.99

First preference		Second preference
○	Tobacco Cigarette 1	●
○	Tobacco Cigarette 2	○
○	E-cigarette 1	○
●	E-cigarette 2	○
○	None of these	○
○	None of these	○

SCREEN 7

Next, you will be asked to make **12 choices**. In each choice question there are four cigarette options and we would like you to choose which two specific cigarettes you would most like to buy and indicate which you prefer most and then second. You may indicate for your first and/or second choice that you would not want to choose a cigarette. Note that:

- The characteristics of each cigarette will be different in each question.
- Please think about all characteristics when you make your choice.
- The order of your responses is important.
- **There are no right or wrong answers.**

Your choices will provide very useful information for a research study. Thank you for your time and effort.