Consumer Preferences for Cigarettes and Heated Tobacco Products in Japan: Evidence from a Discrete Choice Experiment

Don Kenkel, PhD
Brooks School of Public Policy
Cornell University

Alan Mathios, PhD
Brooks School of Public Policy
Cornell University

Grace Phillips
Fogelman College of Business and Economics
University of Memphis

Revathy Suryanarayana
O'Donnell School of Public Health
UT Southwestern Medical Center

Hua Wang, PhD
Brooks School of Public Policy
Cornell University

Sen Zeng
Department of Economics
Cornell University

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Abstract

Heated tobacco products (HTPs), a harm reducing cigarette alternative, gained popularity over the past decade and contributed significantly to the reduction of smoking in Japan. While the increased popularity of HTPs suggests a consumer preference for cigarette alternatives, there is a limited understanding of how consumers choose between different tobacco products. Understanding consumer choice is especially salient given the evolving policy landscape and proposals to increase HTP taxes. This study uses a large discrete choice experiment to examine the decision-making processes of smokers in Japan when choosing between cigarettes, HTPs, and quitting. We assess the influence of various product attributes such as prices, flavors, nicotine content, and warning messages on these choices. The findings reveal that prices and flavors significantly influence smokers' preferences. Specifically, higher HTP prices tend to drive smokers back to combustible cigarettes and discourage them from choosing to quit. Additionally, there is some evidence that consumers prefer HTPs with a wide variety of flavors. Meanwhile, hypothetical policy situations that change warning messages or nicotine content do not affect consumers' choices.

1. Introduction

Like many other high-income countries, Japan has experienced a consistent decline in the use of combustible cigarettes since 1990. More recently, Japan and other countries have seen significant increases in the use of alternative products that provide users nicotine – the addictive component of tobacco smoke – without the combustion of tobacco. Although in many countries e-cigarettes are the most popular alternative nicotine products, e-cigarettes containing nicotine are illegal in Japan. Instead, heated tobacco products (HTPs), also known as tobacco heating systems or heat-not-burn products, have gained a large market share in Japan in the last decade. A 2019 survey shows that over 30 percent of current cigarette users are also HTP users, with pronounced prevalence for dual use among adults between the ages of 20 and 30 (Hori et al. 2021). Previous research has credited part of the declining trend in cigarette sales to the introduction of HTPs in the Japanese market (Cummings et al. 2020, 2024, Levy et al. 2024).

HTPs' surge in popularity in Japan led to significant changes in public policies and government regulations of tobacco products. When HTPs entered the market in 2014, they were taxed at rates 10 percent to 30 percent lower than combustible cigarettes based on the lower weight of tobacco per stick. Over the years, however, taxes on HTPs gradually increased. Driven by revenue concerns, the Japanese federal government capitalized on the growing popularity of HTPs by creating a new "heat-not-burn tobacco" category with higher tax rates per tobacco weight (in grams). By 2023, the new tax system equalized the excise taxes on HTPs and combustible cigarettes.

Understanding how different attributes affect consumer choice between HTPs, cigarettes, and quitting, helps to quantify the potential economic tradeoffs involved in the taxation and regulation of HTPs in the Japanese tobacco marketplace. In addition to generating tax revenues,

HTP taxation also has the potential to improve public health, to correct for health externalities, and to correct for internalities HTP consumers impose on themselves due to irrationality or misinformation (Prieger 2023). One approach to HTP taxation suggests that compared to the cigarette tax, the HTP tax should be proportionate to the relative health risk of HTPs versus combustible cigarettes. As is discussed in the background section, HTPs significantly reduce the risk associated with tobacco products compared to combustible cigarettes; the risk-proportionate HTP tax is thus much lower than the cigarette tax. Designing an optimal HTP tax also depends on whether HTPs and cigarettes are economic substitutes or complements (Allcott and Rafkin 2022). If HTPs and cigarettes are compliments, a lower tax rate on HTPs, may increase demand for cigarettes. However, if they are substitutes, a lower tax rate on HTPs may shift demand away from cigarettes. Our results help clarify the extent to which consumers see HTPs and cigarettes as substitutes and how HTP prices influence consumer choices, offering valuable insights for policymakers as they weigh trade-offs in designing an optimal HTP tax rate.

Consumer choice over HTPs, cigarettes, and quitting is not limited to taxation and prices. Other attributes, like available flavors, nicotine content, and required health messaging labels, also have the potential to affect consumer preferences. These factors are especially important, as they present additional trade-offs for policymakers aiming to discourage non-smokers, particularly youth, from starting HTP use while also encouraging smokers to switch to HTPs as a lower-risk alternative to cigarettes.

Our study focuses on a prospective economic policy analysis of HTP tax levels and product regulations that have not yet been adopted in Japan. Without actual shifts in policy environments, it becomes challenging to predict how smokers will respond to new regulations. Once a policy is enacted, researchers can observe choices pre- and post-implementation and

conduct a retrospective policy analysis. However, it is important to understand the likely impacts of policies prior to implementation to avoid enacting policies that have unintended negative consequences or are unlikely to achieve their intended consequences. One strategy for estimating these impacts is to rely on structural models of behavior to predict behavior under different policy scenarios (Heckman and Vytlacil 2005). We use the an alternative strategy and examine stated preferences where smokers are asked to make choices under different hypothetical but realistic policy scenarios.

Using a large online discrete choice experiment (DCE) we study how smokers make decisions between cigarettes, HTPs, and quitting in Japan. Our DCE includes cigarette and HTP prices, the availability of HTP flavors and nicotine content, and HTP health messages as product attributes. We study the influence of these factors on consumers' stated preferences for their immediate choices and choices for six months in the future. Finally, using a conditional logit model, we predict the behavior of tobacco users under various policy scenarios, including a move to risk-proportionate HTP taxation as well as a ban on HTP flavors.

DCEs are widely used in various fields, including economics, public health, and business, to investigate consumer preferences in hypothetical scenarios that are challenging to study using real-world data. Several previous studies use DCEs to predict U.S. smokers' tobacco choices under hypothetical conditions. For instance, Marti et al. (2016) conducted an online DCE to analyze the behavior of different groups of tobacco users in the U.S. across various policy scenarios, including their responses to price changes and public smoking bans. Similarly, Buckell et al. (2019) employed a DCE to explore how smokers choose between cigarettes, e-cigarettes, and quitting when faced with a ban on flavored products. Beyond tobacco research, DCEs are used to address various policy-relevant questions in health economics. For instance,

Kesternich et al. (2013) utilized a DCE to elicit consumer preferences for Medicare Part D plans. In Japan, Shimokawa et al. (2018) used a DCE to analyze the demand for food that is stigmatized by some consumers (Fukushima rice after the Fukushima nuclear power plant accident in Japan).

Our paper contributes to the existing literature by providing a case study of how hypothetical, but potentially realistic, public policies interact with consumer choices in the presence of heated tobacco products. The increasing availability and market share of alternative nicotine products including e-cigarettes has resulted in dramatic changes in their regulation worldwide. Prior research has used quasi-experimental econometric methods to conduct retrospective analysis of U.S. state variation in e-cigarette tax rates, age restrictions, and flavor restrictions. These studies generally find that cigarettes and e-cigarettes are economic substitutes; raising e-cigarette taxes leads to increased cigarette use and vice versa (Saffer et al. 2020, Pesko et al. 2020, Friedman and Pesko 2022, Cotti et al. 2022, Allcott and Rafkin 2022). Consequently, higher e-cigarette taxes might increase combustible cigarette use, potentially having negative public health implications. Recent studies also examine flavor bans and their implications specifically for adolescents and young adults (Cotti et al. 2024, Saffer et al. 2024). These studies estimate a decrease in e-cigarette consumption after flavor bans while observing a simultaneous increase in combustible cigarette consumption use.

Our study provides new evidence that cigarette and HTP prices play crucial roles in Japanese smokers' choices, both in their current preferences and in their projected choices six months ahead. We also find that when HTP flavors are limited, individuals are more inclined to choose combustible cigarettes, again both in their current choices and in their anticipated choices six months later. This is especially prevalent among younger cohorts in our sample, aged 20-49, who value the availability of flavors nearly twice as much as older consumers do. However, we

do not find that available nicotine levels or the health messages on HTPs are important determinants of consumers' stated preferences over the products. The effects of price and flavor availability on consumer choice provides valuable evidence for tobacco regulatory policy.

In our policy simulations, we use predictions from the estimated conditional logit model to compare Japan's actual policy of equalizing the cigarette and HTP taxes to the hypothetical alternative policy of risk-proportionate taxation. Compared to tax equalization, our model predicts that the lower, risk proportionate HTP tax would decrease the fraction of cigarettes choices by 9.4 percentage points. The fraction of HTP choices increases by more than 9.4 percentage points, because the lower HTP tax also reduces the fraction of consumers predicted to quit. As we discuss in the concluding section, although the implications for public health are somewhat mixed, it is likely that the public health gains from the lower HTP tax encouraging smokers to switch to HTPs are larger than the public health losses from reduced quitting.

2. Background

Over the past decade, the smoking landscape has seen a significant increase in the availability of and use of alternatives to traditional combustible cigarettes. The alternative nicotine products available in most markets globally include e-cigarettes or nicotine vaping products, heated tobacco products, and nicotine pouches. These products deliver nicotine without the combustion of tobacco, thus preventing production and consumption of many of the combustion-generated toxicants in tobacco smoke.

In some countries including Japan, HTPs dominate the market for alternative nicotine products. HTPs work by heating tobacco without reaching ignition of the tobacco, to produce an emission containing nicotine and other chemicals (WHO 2020). In 2020, based on its scientific review the U.S. FDA authorized the sales of the IQOS brand of HTPs as a "modified risk

tobacco product." The FDA determined that available information to date indicates that compared to smoking, the IQOS HTP "significantly reduces the production of harmful and potentially harmful chemicals. Scientific studies have shown that switching completely from conventional cigarettes to the IQOS system significantly reduces your body's exposure to harmful or potentially harmful chemicals."[1] While HTPs induce less harm relative to cigarettes, the absolute risk of HTPs as well as the degree of relative risk reduction continue to be debated and researched.

The risk of HTP use is likely to be similar to the risk of e-cigarette use as neither product involves the combustion of tobacco. McNeil et al. (2018) reports an assessment that the lifetime cancer risk from e-cigarettes is less than 0.5 percent of the cancer risk of smoking. A recent FDA science policy memo estimates that e-cigarettes with marketing granted orders in the U.S. pose a median lifetime cancer risk of 118 excess cancer deaths per 100,000 users, which is just over 1 percent of the estimated 10,000 excess cancer deaths per 100,000 for smokers (FDA 2024). Although not quantified, McNeil et al. (2018) also conclude that the relative cardiovascular disease risk and lung disease risk are much lower for e-cigarettes than for smoking. After a comprehensive review of the evidence, McNeil et al. (2018) concluded that e-cigarettes are less than 5 percent as risky as combustible cigarettes. Although HTPs might be riskier than e-cigarettes, 5 percent is also a reasonable estimate of their risk relative to smoking.

Cigarette smoking rates in Japan have declined steadily over time but remain high. Close to 48 percent of the adult male population smoked combustible cigarettes in 2001, while in 2016

[1] The FDA is careful to note that the products are not safe, nor FDA approved. While FDA sees good evidence that IQOS exposes consumers to lower levels of harmful chemicals, they don't see evidence strong enough to show that the reduced exposure translates into reduced risk. Please access the full FDA press release here - https://www.fda.gov/news-events/press-announcements/fda-authorizes-marketing-iqos-tobacco-heating-system-reduced-exposure-information

this number went down to 31 percent (Tabuchi et al. 2018). HTPs entered the Japanese market in 2014 with the advent of two products – "Ploom" and "Ploom Tech" produced by Japan Tobacco and "I Quit Original Smoking (IQOS)" by Phillip Morris International. Currently, the most popular HTP brands include IQOS, Glo, and Ploom Tech, with most users reporting daily usage (Sutanto et al. 2019). In the Japanese market, flavored HTPs are popular. Using the 2018 ITC Japan Survey, Sutanto et al. (2019) estimates that close to 70 percent of HTP users report using flavored tobacco products including menthol and mentholated fruity flavors.

Figure 1 depicts the trends in cigarette sales and HTP sales over time, in comparable physical units (individual cigarettes versus heatsticks).[2] Figure 1 reveals a relatively steady decline in cigarettes sales over the past 30 years. Comparatively, after their introduction, HTP sales grew rapidly and reached 58 billion units by 2023. Over this same period, cigarette sales fell by 91.5 billion units, from 179.3 billion units to 87.8 billion units (a 51 percent decline). Although Japanese cigarette sales have been steadily declining for 30 years, we note a steeper decrease in cigarette sales after the introduction of HTPs (Cummings et al. 2024). For example, in the eight years prior to the introduction of IQOS cigarette sales fell from 270 billion units to 196.9 billion units (27 percent decline) whereas the eight-year decline post introduction was larger in both absolute and percentage terms. Recent survey data show trends that are similar to the trends in sales. Summary reports from the 2019 National Health and Nutrition Survey (NHNS) of Japan document declining smoking rates from 2009 to 2019. The proportion of regular smokers aged 20 or above declined from 38.2 percent in 2009 to 27.1 percent in 2019. At the same time, Hori et al. (2021) finds that between 2015 and 2019 HTP use increased from 0.2

[2] The data for Figure 1 come from cigarette and HTP sales data publicly accessible from the Tobacco Institute of Japan cigarette and heat-not-burn sales statistics. HTP sales data for the years 2016 and 2017 has been imputed from information on PMI market share information and heatsticks sales data available from PMI (Phillip Morris International) annual reports.

percent to 11.3 percent. Levy et al. (2024) examine cigarette smoking prevalence in the NHNS data from 2011 to 2019. They find that smoking prevalence declined more rapidly after HTP introduction, but the analysis was limited due to the changing format of NHNS questions.

These trends in cigarettes sales and HTP sales occur within a dynamic and changing tax environment. Tobacco products sold in Japan, including cigarettes and heated tobacco products, are subject to three primary taxes: the national tobacco excise tax, the national tobacco special excise tax, and the local tobacco excise tax (excluding municipal taxes). Over the past three decades, Japan has revised its national tobacco tax policy multiple times. Recently the most significant changes for cigarettes occurred in 2010 and 2018. In October 2010, tobacco taxes were raised by 3.5 yen per cigarette, marking the largest increase in cigarette taxes in Japan in a decade. In the most recent revision, the tax on each cigarette stick was increased by 1 yen each year between 2018 and 2021, resulting in a total increase of 3 yen per stick by 2021 (Tabuchi et al. 2018, Ichikawa and Tabuchi 2022). The Japanese government justified the increased taxes by citing the need to raise revenue for social security expenses, particularly to support an aging population. By 2023, the total tax on cigarettes reached 15,244 yen per 1,000 units (approximately 15 yen per cigarette stick or 305 yen per pack of 20 cigarettes).

For HTPs, a significant tax policy change occurred in 2018 when Japan's Ministry of Finance established a new tax category for these products, moving away from the previously low-tax status. The Ministry also announced a plan to increase taxes on HTPs over five years by increasing taxes each year by 1 yen per stick of heated tobacco. The first increase went into effect in October 2018, bringing HTP taxes to12.244 yen per stick. This marked a major shift in the taxation of HTPs, which had previously benefited from lower taxes before 2018.

3. Data and Empirical Strategy

3.1 The Discrete Choice Experiment

To study how smokers choose between various products with different product attributes we conducted a discrete choice experiment in Japan. Our experimental design consisted of a 3 (cigarette price) X 3 (HTP product price) X 3 (HTP nicotine levels) X 3 (HTP flavor availability) X 4 (HTP label warning) design, for a total of 324 possible attribute combinations that could be presented to respondents. Each respondent was presented with 12 scenarios. Different subjects were assigned different sets of scenarios; across all subjects the DCE presented 120 of the 324 possible scenarios. The number of products, attribute levels, and scenarios follow good practice guidelines for DCEs (Johnson et al. 2013). The assignment of scenarios to subjects was designed to maximize statistical efficiency to identify the parameters of interest. We included placeholder nicotine content and warning message for the cigarette choice too, but they did not vary across the scenarios.

In the experiment, cigarette price levels were varied as 0.5p, p, and 2p where p was the actual price paid by the respondents (collected in the background survey questions asked before the experiment). We use online sources to calculate the median price of a heated tobacco product which would be equal to a pack of cigarettes taking into consideration the nicotine content. We again use 0.5p, p, and 2p as the variation in prices for the heated tobacco product in the experiment.

For the cigarette warning attribute, we use the status quo cigarette warning in Japan as the cigarette warning for all respondents across all scenarios which read *"Smoking is a cause of lung cancer. According to epidemiological estimates, smokers are about two to four times more likely than non-smokers to die of lung cancer."*

For the HTP warning labels, we use 4 different levels of health messages. These were as follows:

i. No message
ii. HTPs aren't completely risk-free, but they carry a small fraction of the risk of cigarettes
iii. This product contains nicotine, nicotine is an addictive chemical
iv. Smoking is a cause of lung cancer, and can increase the risk of myocardial infarction, stroke, and aggravate the symptoms of emphysema.

Each health message corresponded to a currently used health message currently used about e-cigarettes or HTPs in some country. The second health message corresponded to current health messages about e-cigarettes in the UK and the third health message to the currently used e-cigarette label in the US. The fourth message was the original HTP warning label used in Japan.

Our experiment also varied nicotine levels as well as the flavors of the HTPs in each scenario. Once again for the cigarette choice attributes, we presented each respondent with a default nicotine level and flavor based on the status quo that did not vary across choice tasks. However, the available HTP nicotine levels and flavors varied across choice tasks. Nicotine was described as “various levels available” up to 10 mg, 30 mg, or 50 mg. Available flavors were described as: tobacco, menthol, mentholated fruity/coffee/mint; tobacco and menthol; or tobacco.

Each survey respondent was presented with 12 choice tasks, each consisting of a combination of product attributes. After the presentation of each scenario, respondents were asked to choose either the cigarette product, the HTP, or quitting (phrased as 'I will quit using cigarettes and not use HTP products'). Following their initial choice, the scenario reappeared, and they were asked

to choose again between the same products with the same attributes, but this time their decision was about what they would do six months in the future. This process was repeated 12 times, with one or more product attributes varying each time. We provide screenshots of a typical choice task from our experiment in both Japanese and English in Figure 2.

3.2 The Survey Instrument and the Sample

Our survey consists of three sections. The first asks respondents about their current tobacco choice behavior. The second is the discrete choice experiment, and the third section is a set of follow-up questions including questions about risk perceptions. We provide summary statistics of all demographic and smoking and HTP use behavior in Tables 1-6.

Our initial sample consists of 602 respondents chosen from opt-in non-probability online panels by the survey company. While the sample may not be probability-based, they are representative of the general economic and demographic features of the country. We ensure that all individuals selected for the experiment are current smokers. The survey is given in Japanese. Recall that cigarette prices used in the DCE were calculated based on the prices provided by the respondents. We note that some of the prices were outside the usual range of cigarette prices in Japan. About 10 percent of the sample reported unreasonably low prices while 5 percent of the sample reported unreasonably high prices. Given that these prices are then halved or doubled in the experiment and would be extreme outliers, we chose to trim our sample by removing them from the sample. After trimming, our sample consists of 523 respondents. The mean cigarette price equals 615.5 yen for a pack. This is in the range of prices for a pack of cigarettes in Japan across all available brands in the country.[3]

3.3 Empirical Model

[3] See - https://www.jt.com/media/news/2021/pdf/20210730_14.pdf

We use the DCE data to estimate a conditional logit model of consumer tobacco product choices (McFadden 2017).[4] The model is based on a random utility model, which assumes individual i's indirect utility from choosing product j at choice task t is a linear function of alternative specific constants (ASCs) and product characteristics:

$$U_{ijt} = ASC_{jt} + \alpha p_{ijt} + X'_{ijt}\beta + \epsilon_{ijt}$$

The ASCs capture the baseline utility from each tobacco product (cigarettes and HTPs) relative to quitting which is the omitted category in all our models. p is the price of the product and α measures the disutility from paying the price. X is a vector of HTP attributes including available flavors, available nicotine levels, and warning messages. As previously stated, we offer three options for the availability of flavors and nicotine strength, along with four choices for HTP warning messages. The default flavor category is "Tobacco Flavor Available," and the default nicotine level category is "Various nicotine levels available, up to 10mg". Our default category for warning labels on HTP is the blank option with no warning message. ϵ is the idiosyncratic error term. The model is estimated by maximum likelihood.

4. Results

4.1 Descriptive Results

Table 1 – 5 describes the respondents along various dimensions. Table 1 describes the various DCE attributes and how they are distributed across the sample. The mean cigarette price attribute is 615.5 yen. There were 3 levels of HTP prices, 4 levels of HTP warning labels, 3 levels for the availability of HTP nicotine content, and 3 levels of HTP flavors. The attributes are not distributed perfectly equally across the available levels because our analysis sample drops

[4] We use the STATA command 'cmlogit' to estimate our models.

respondents who reported paying extremely high or low prices for cigarettes. However, the difference across attribute levels is negligible.

Table 2 describes respondents' demographic characteristics and Tables 3 and 4 describe their current smoking and HTP use. All subjects in the sample are current smokers. 85 percent of the sample are everyday smokers and more than 50 percent of the sample smoke within 30 minutes of waking up, indicating high levels of addiction. Surprisingly, more than 70 percent of the sample did not try quitting in the past 12 months nor are they planning to quit in the next 6 months. This is inconsistent with findings of other studies based in Japan. For example, Sugihara and Tabuchi (2024) report from the Japan "Society and New Tobacco" Internet Survey (JASTIS) that 70 percent of respondents expressed intentions to quit smoking.

From Table 4, 72 percent of respondents have previously used a HTP product; 57 percent of those who had ever-used HTPs were current everyday users at the time of the surveys. Only 41 percent of our sample of smokers are dual everyday users of HTPs, compared to the 30 percent dual use rate reflected in data from a 2019 survey (Hori et al. 2021). Among the current HTP users in our sample, close to 70 percent report using flavored HTP products compared to a regular tobacco flavored product.

Table 5 depicts choices made by individuals during the experiment. Across all 12 current choice scenarios, almost 50 percent of the individuals chose cigarettes, 39 percent of the individuals chose HTPs, and 11 percent of individuals chose to quit. The six months from now choices are similar. Across all 12 scenarios 48 percent chose cigarettes, 40 percent chose HTPs, and 12 percent chose the quit option.

4.2 Conditional Logit Model Results

Table 6 presents the estimated conditional logit model of consumer tobacco product choices. Column (1) reports the estimates based on the immediate choice today and column (2) reports the results for the six-months-from-now choices. The alternative specific constants indicate that compared to quitting, consumers receive higher utility from cigarettes and HTPs, with cigarettes providing more utility than HTPs. The negative sign on the estimated price coefficient reflects consumers lost utility from paying higher prices.

The HTP attributes results reveal that consumers derive the most utility from having the widest set of flavors available. The coefficient on the availability of fruit, mint, coffee, menthol, or tobacco HTP flavors is positive and statistically significant. When HTP flavor attributes are restricted to just tobacco and menthol, the coefficient is not economically or statistically significant. The tobacco and menthol coefficient implies that relative to the omitted category, only tobacco flavor availability, the adding the option of menthol flavored HTPs has a limited impact on utility.

Compared to the availability of flavors, the other HTP attributes have more muted effects on utility. When looking at the immediate choice results, the coefficients for different HTP health messages are small and not statistically significant. Compared to the omitted category, no health message, none of the other health messaging has a meaningful impact on consumer utility regarding their immediate choice today. There are similarly small and not statistically significant coefficient estimates on the availability of various HTP nicotine levels. When looking at consumer's state choices six months from now, their estimates are similarly small and statistically insignificant.

4.3 Heterogeneity Analysis

Motivated by the variation in HTP consumptions across age groups (See Appendix E for a review of descriptive statistics by age cohorts), our heterogeneity analysis splits our sample into two age group cohorts. A recent study by Yoo et al. (2024) in Korea suggests that HTP usage patterns can differ substantially depending on the smoker's age. In Japan, research by Levy et al. (2024) indicates that the decline in smoking prevalence following the introduction of HTPs was more pronounced among younger age groups, especially in comparison to those aged 60 and older. In our heterogeneity analysis, we define younger age groups as those aged 20-49 and older cohorts as those over 50. Grouping this way allows us to divide the sample approximately in half.

In Table 7 we report the estimates from the conditional logit model of immediate choices by cohort group. We find that the effect of prices on utility is consistent across both age cohorts. However, younger cohorts value the availability of flavors approximately twice as much as older cohorts (0.127 compared to 0.060). Additionally, while younger cohorts derive similar levels of utility from both cigarettes and HTPs, older cohorts derive significantly higher utility from cigarettes than from HTPs. These findings suggest a preference for HTPs, particularly flavored ones, among younger cohorts in our sample, which implies that HTP taxes or HTP flavor bans may have potentially differential effects across cohorts.

4.4 Policy Scenario Predictions

In this section we use the estimated conditional logit model for the full sample to predict how consumers might respond to different possible policy changes (Table 8). We focus on potential policy scenarios related to the statistically significant estimates from Table 6 – prices and the availability of flavors. The first set of predictions are for the fractions of consumers whose immediate choice would be cigarettes, HTPs, or quitting under different HTP tax policies.

The second set of predictions consider a ban on flavored HTP products, alone or in combination with a higher HTP tax. Each policy scenario is compared with choices made under the status quo market conditions. In our Online Appendix, to ensure the robustness of our findings we estimate a mixed logit model that captures more flexible substitution patterns. We perform counterfactual predictions under different policy scenarios presented in the paper and find results consistent with the conditional logit model.

Comparing the predictions in Table 8 for the status quo market conditions to the observational data from our background survey sheds light on the external validity of our model's predictions. The status quo market condition is defined as: the cigarette price is what the subject usually pays for one pack of cigarette, the HTP price is set to 470 Japanese yen, the HTP available flavors include tobacco, menthol, mentholated fruity/coffee/mint, the HTP available nicotine level is up to 50mg, and the HTP health message is "Smoking is a cause of lung cancer, and can increase the risk of myocardial infraction, stroke, and aggravate the symptoms of emphysema". Under status quo conditions the model predicts that 52 percent of respondents will choose cigarettes, 38 percent will choose heated tobacco products, and 10 percent will choose quitting both products.

Every respondent in our sample currently smokes combustible cigarettes, while 41 percent of sample are dual everyday users of HTPs. From responses to the background survey, we calculate that over the past 30 days, on average respondents used cigarettes on 27.7 days and used HTPs on 15 days. Assuming that the frequency of purchases is proportional to the number of days of use, the observational background survey data indicates that HTP choices occur about 54 percent as often as cigarette choices. In comparison, the model's status quo predictions

suggest that HTP choices are about 73 percent as frequent as cigarette choices. Our model, thus, over-predicts HTP choices.

When asked about their quit intentions, around 28 percent reported that they tried to quit in the past 12 months and 26 percent reported that they were planning to quit tobacco products in the next 6 months. Interpreting the DCE choice task as corresponding to a weekly shopping trip, observed quit attempts and intentions are higher than the model's status quo prediction of 10 percent at the next trip. In Section D of our Online Appendix, we perform various data restriction exercises to evaluate the external validity of the stated preference data collected in our experiment. The evidence that our model over-predicts HTP choices relative to cigarette choices and under-predicts quitting, provides an important a caveat to our policy scenario predictions.[5]

The first set of policy scenario predictions explore different HTP tax policies. In 2018, the government of Japan began a series of HTP tax hikes designed to equalize the HTP tax and the cigarette tax by 2023. Our DCE was conducted in 2021, when the HTP tax was still lower than the cigarette tax. In our high HTP tax scenario, we design an HTP tax that has increased beyond its 2021 level so that the HTP and cigarette tax rates are equalized. For the low-tax scenario, we mimic a risk-proportionate tax where the HTP tax is set to be 5 percent of the cigarette tax. For both scenarios, we assume that the HTP tax is fully passed through one-to-one to consumer prices. In our high-tax scenario, the HTP price is set at 538 yen per pack (which includes an HTP tax of 305 yen per pack). In our low-tax scenario, the HTP price is set at 249 yen per pack (which includes an HTP tax of 15 yen per pack). Compared to the status quo HTP

[5] Given the evidence of over-predictions, another approach is to use the observational data to calibrate the predictions from the conditional logit model. As Train (2002, p. 176) explains, a calibrated model uses the experimental variation in attributes to identify their relative importance in consumer choices, while using the observational data to "ground the predicted shares in reality." The online Appendix provides a calibrated model.

price of 470 yen per pack, the high-tax scenario corresponds to a modest price increase of about 14.5 percent, while the low-tax scenario corresponds to a large price decrease of 47 percent.

Compared to the status quo HTP price, at the low-tax HTP price, the market share of HTPs increases by 8.8 percentage points; while at the high-tax HTP price, the market share of HTPs decreases by 2.5 percentage points (Table 8). The price decrease with the low-tax scenario is 3.2 times larger than the price increase with the high-tax scenario. Roughly commensurate, the low-tax scenario market share increase is 3.5 times larger than the high-tax scenario market share decrease. The corresponding price increases and decreases in the tax scenarios implies that HTP's own-price elasticity of the market share is about -0.44. Prior research typically finds similar estimates of the own-price elasticity of cigarette demand (DeCicca et al. 2022). Recent U.S. studies find that the demand for e-cigarettes is more price-elastic with estimates around -1.3 (Allcott and Rafkin 2022, Cotti et al. 2022). Regarding HTPs and cigarettes, Dauchy and Shang (2024) report a global own-price elasticity for HTPs between -1.2 and -1.3, which is higher than what we find among our respondents in Japan.

Comparing the low- and high-tax policy predictions in Table 8 allows us to compare Japan's actual policy of equalizing the HTP and cigarette taxes (the high-tax scenario) to the hypothetical alternative policy of risk-proportionate taxation (the low-tax scenario). Compared to tax equalization, our model predicts that the lower risk-proportionate HTP tax would decrease the market share of cigarettes by 9.4 percentage points. The HTP market share increases by more than 9.4 percentage points, because the lower HTP tax also reduces the fraction of consumers predicted to quit by 1.9 percentage points. Given that we predict that risk-proportionate taxation decreases both smoking and quitting, the public health implications of the lower risk-proportionate HTP tax are mixed.

We next study scenarios involving a HTP flavor ban., which limits availability of HTP flavors to only tobacco. Our predictions find that a complete flavor ban would increase the market share of cigarettes and decrease the market share for heated tobacco products, although the predicted changes are small. Compared to the status quo scenario, imposing a flavor ban decreases the HTP market share by 0.7 percentage points and increases the market share of cigarettes by 0.6 percentage points. In the presence of a policy that increases HTP tax and introduces a HTP flavor ban, we find that the market shares of HTPs decrease by 4 percentage points and the market share for combustible cigarettes increase by 2.7 percentage points. In both scenarios, the predicted market shares of quitting all tobacco products did not change much.

In Table 9 we estimate the policy scenarios separately across age cohorts. In the status quo scenario, 46.2 percent of respondents aged 20-49 chose HTPs, while only 29.2 percent of those aged 50 and over chose HTPS. In contrast, 56.3 percent of older cohort chose cigarettes, compared to 47.3 percent of younger cohort. Compared to older respondents, a lower, risk-adjusted HTP tax is predicted to shift a higher proportion of younger respondents toward HTPs. In the policy scenario with a higher HTP tax and a flavor ban, the proportion of younger respondents choosing HTPs drops more sharply (from 46.2 percent to 42.2 percent) than among older respondents (from 29.2 percent to 26.7 percent). Again, the choice to quit remains relatively constant for both cohorts across the policy scenarios.

5. Discussion

Smoking in Japan has steadily decreased, and part of this decline may be due to the introduction of HTPs. In this paper, we use data from a discrete choice experiment to analyze how current smokers choose between cigarettes, HTPs, and quitting based on various product attributes. Our

findings indicate that while taxes on cigarettes and HTPs reduce their respective usage among smokers, these products are economic substitutes. When HTP taxes are increased, current smokers are more likely to choose cigarettes. Similarly, in the event of banning flavored HTPs, users tend to switch to cigarettes. These preferences persist across time even when smokers are asked about their choices six months into the future. Our study fails to find evidence that limits on HTP nicotine levels or different required health messages on HTP packaging would result in noticeable changes in cigarette use, HTP use, or quitting.

In 2023, cigarette sales in Japan exceeded 87 billion units, while HTP sales exceeded 58 billion units. Although HTPs were previously taxed at a lower rate than cigarettes, by 2023 the HTP and cigarette taxes were equalized. The increased HTP tax helped offset the revenue losses from the continued decline in cigarette sales. But our results provide evidence that the increased HTP tax might have worked against another common goal of tobacco taxation – improving public health. When we predicted the impact of an alternative risk-proportionate tax approach, which would require a 95 percent decrease in the HTP tax, we found the lower HTP tax would encourage 9.4 percent of smokers to switch to lower-risk HTPs. At the same time, we estimate that the lower HTP tax reduced quitting all tobacco use (cigarettes and HTPs) by 1.9 percentage points.

Predicting the public health consequences of a simultaneous decrease in cigarette smoking, increase in HTP use, and decrease in quitting is beyond the scope of this paper. Scientific reviews by U.K. and U.S. health authorities have concluded that HTPs expose users to substantially lower levels of harmful chemicals (McNeil et al. 2018, FDA 2020). To calculate the risk-proportionate HTP tax, we assumed that HTP use is 5 percent as risky as cigarette smoking. Under this assumption, the risk reduction from switching 9.4 percent of smokers from cigarettes

to HTP use is equivalent to increasing smoking cessation by 8.9 percentage points. Combined with the predicted decrease in quitting, the net impact of risk-proportionate HTP taxation is equivalent to a 7 percentage points increase in smoking cessation rate. Although such an increase in the smoking cessation rate would substantially improve public health, we stress that our calculations are only meant as illustrative. In addition to depending on the estimated relative risk between cigarettes and HTPs, the overall public health effects also depend on the patterns of lifetime use and dual use.

Allcott and Rafkin (2022) develop a formula for the optimal tax on an alternative nicotine product that depends on its risk relative to cigarettes, the cross-price elasticity of demand with respect to cigarettes, and the sizes of the uncorrected externalities and internalities associated with each product. When consumers over-estimate the alternative nicotine product's relative risk, Allcott and Rafkin (2022) conclude that the optimal tax can be positive, i.e., it may be optimal to subsidize the lower-risk alternative as a second-best policy in response to consumer misinformation. After our discrete choice experiment, we collected information on our subjects' perceptions of the relative risks of cigarettes and HTPs (Table 10). In terms of relative risk perceptions, 64 percent correctly perceived HTPs as less harmful or much less harmful than cigarettes; however, a substantial minority, 24 percent, perceived HTPs to be just as harmful or more harmful than cigarettes. In terms of absolute risk perceptions, the average perceived years of life expectancy lost due to HTP use was 6.4 years, compared to 7.2 years lost due to cigarette use. The average perception that HTP use is almost 90 percent as risky as smoking cigarettes (7.2 years/6.4 years) is inconsistent with current scientific evidence. Future work is needed to explore whether the optimal policy for Japan would be to subsidize rather than tax HTPs. A complete cost-benefit analysis of an HTP subsidy would also need to consider the possible unintended

consequence of encouraging non-smoking youth to initiate HTP use. Our study did not include respondents under the age of 18 and so does not provide evidence of their responsiveness to the product prices and attributes.

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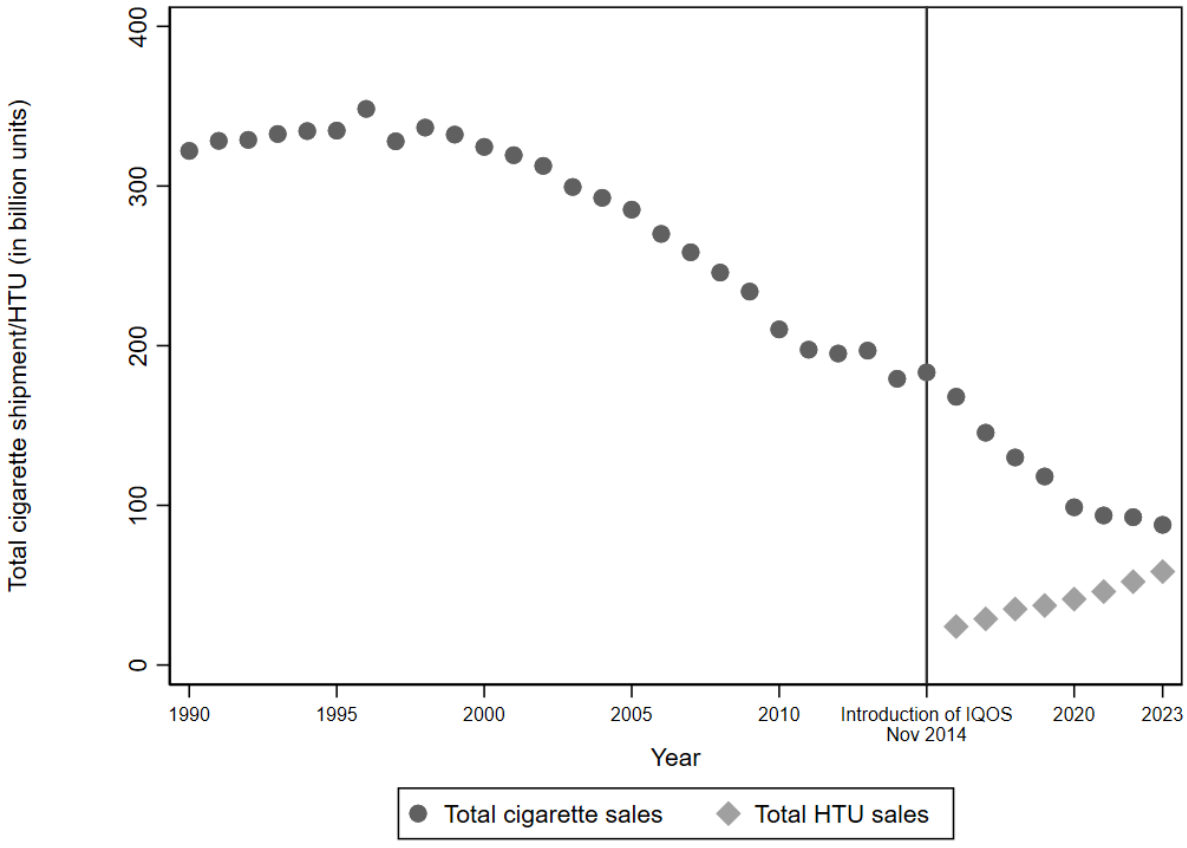
Figure 1: Total Cigarette and Heated Tobacco Unit Shipment between 1990 and 2023



Notes: Data for the figure comes from tobacco statistics on cigarette and heat-not-burn sales obtained from Tobacco Institute of Japan. For more information: https://www.tioj.or.jp/data/

Figure 2: Snapshot of a choice task presented in the DCE

Here is the first set of products that could be available to you.

Think about your immediate choice **today**.

Here are the set of cigarettes and heated tobacco products available when you are shopping.

Please select one option **for your immediate choice today** from the choices below.

(If you want to see a larger version of the images, please click the magnifying glass below.)

Please select one option.

	Cigarettes	Heated Tobacco Product	Neither
PRODUCT			I will quit smoking cigarettes and not use e-cigarettes.
PRICE	1000.00 yen	235 yen	
NICOTINE CONTENT	You will inhale between 22-38 mg of nicotine per pack of typical cigarettes if you smoke regulars, or between 12-20 mg of nicotine per pack if you smoke so-called mild or light cigarettes.	Various nicotine levels available, up to 30mg	
FLAVOUR	Your current cigarette flavor	Available flavors are tobacco and menthol	
WARNING MESSAGE	Smoking is a cause of lung cancer. According to epidemiological estimates, smokers are about two to four times more likely than non-smokers to die of lung cancer.	This product contains nicotine, nicotine is an addictive chemical	

あなたが利用可能な最初の 製品のセットをご覧ください。

今回は、時間をかけずにすぐに選択していただきます。

以下は買い物の際に購入可能な紙タバコと加熱式タバコのセットです。

今回は、下の選択肢の中から、**時間をかけずにすぐに1つ選択**してください。

（画像を拡大してご覧になりたい場合は、下の虫眼鏡マークをクリックしてください。

1つ選択してください。

	紙タバコ	加熱式タバコ	私は
製品			紙タバコをやめて、電子タバコも使用しないだろう
価格	500.00 円	235円	
ニコチン含有量	常習喫煙者の場合、通常の紙タバコでは、1パックあたり22～38mgのニコチン、いわゆるマイルドやライトな紙タバコでは、1パックあたり12～20mgのニコチンを吸い込むことになります。	さまざまなニコチン含有量あり：最大10mg	
フレーバー	現在お使いの紙タバコのフレーバー	利用可能なフレーバー：タバコ、メンソール、フルーティメンソール、コーヒー、ミント	
警告メッセージ	喫煙は肺がんの原因になります。 疫学的な推計によると、喫煙者は非喫煙者に比べて肺がんで死亡する確率が約2～4倍高いとされています。	本製品にはニコチンが含まれており、ニコチンは中毒性のある化学物質です	

Table 1: Descriptive Statistics of DCE Attributes

	Mean	Standard Deviation
Cigarette price in Yen	615.46	(350.78)
HTP price levels		
HTP price = 235 yen	0.336	(0.47)
HTP price = 470 yen	0.339	(0.47)
HTP price = 940 yen	0.325	(0.47)
HTP health messages		
No warning	0.251	(0.43)
Small fraction of risks of cigarettes	0.255	(0.44)
Contains nicotine, which is addictive	0.243	(0.43)
Smoking is a cause for lung cancer	0.252	(0.43)
HTP nicotine content levels		
Nicotine content up to 10mg	0.333	(0.47)
Nicotine content up to 30mg	0.333	(0.47)
Nicotine content up to 50mg	0.333	(0.47)
HTP flavor levels		
Tobacco, menthol, mentholated fruity	0.333	(0.47)
Tobacco and menthol	0.333	(0.47)
Tobacco only	0.333	(0.47)
N = 6,276		

Notes: Data from Japan Discrete Choice Experiment (2021). Reported statistics include Mean and Standard Deviation.

Table 2: Descriptive Statistics of Demographics

	Mean	Standard Deviation
Female	0.258	(0.44)
Age	48.535	(15.13)
Household size	2.906	(1.39)
Education		
Junior high school	0.023	(0.15)
High school	0.254	(0.44)
Vocational school	0.092	(0.29)
Junior college	0.031	(0.17)
Some undergrad	0.021	(0.14)
Undergraduate	0.541	(0.50)
Postgraduate	0.038	(0.19)
Full time employed	0.625	(0.48)
Income above 5000k yen	0.626	(0.48)
N = 523		

Notes: Data from Japan Discrete Choice Experiment (2021). Reported statistics include Mean and Standard Deviation.

Table 3: Descriptive Statistics of Smoking History

	Mean	Standard Deviation
Everyday smoker	0.847	(0.36)
Age of smoking initiation	23.21	(9.01)
On avg, how many cigs per day?		
0-5	0.212	(0.41)
6-10	0.289	(0.45)
11-15	0.218	(0.41)
16-20	0.191	(0.39)
21-25	0.044	(0.21)
26-30	0.023	(0.15)
31-35	0.008	(0.09)
36-40	0.010	(0.10)
Above 40	0.006	(0.08)
How soon do you smoke after waking up		
Within 5 minutes	0.189	(0.39)
6-30 minutes	0.436	(0.50)
31-60 minutes	0.149	(0.36)
1-2 hours	0.117	(0.32)
2-3 hours	0.044	(0.21)
3-4 hours	0.015	(0.12)
More than 4 hours	0.050	(0.22)
Usual smoking flavor		
Menthol	0.369	(0.48)
Non-menthol	0.512	(0.50)
Other flavor	0.008	(0.09)
No usual type	0.111	(0.31)
Did not try quitting in past 12 months	0.715	(0.45)
Not planning to quit in next 6 months	0.738	(0.44)
N = 523		

Notes: Data from Japan Discrete Choice Experiment (2021). Reported statistics include Mean and Standard Deviation.

Table 4: Descriptive Statistics of HTP Use

	Mean	Standard Deviation	N
Have you ever used an HTP	0.723	(0.45)	523
Everyday HTP user	0.571	(0.49)	378
Uses any flavored HTP	0.683	(0.47)	334
Use tobacco flavored HTP	0.527	(0.50)	334
Use menthol flavored HTP	0.575	(0.49)	334
Use mentholated fruity flavored HTP	0.225	(0.42)	334
Use mint flavored HTP	0.120	(0.32)	334
Use coffee flavored HTP	0.060	(0.24)	334

Notes: Data from Japan Discrete Choice Experiment (2021). Reported statistics include Mean, Standard Deviation, and number of respondents for each variable.

Table 5: Descriptive Statistics of DCE Choice Now and in Six Months

	Mean	Standard Deviation
Choose cig now	0.498	(0.50)
Choose HTP now	0.390	(0.49)
Quit now	0.112	(0.31)
Choose cig in 6 months	0.482	(0.50)
Choose HTP in 6 months	0.400	(0.49)
Choose quit in 6 months	0.118	(0.32)
N = 6,276		

Notes: Data from Japan Discrete Choice Experiment (2021). Reported statistics include Mean and Standard Deviation.

Table 6: Conditional Logit Estimates

		Immediate Choice Today	Choice of 6 Months from Now
Alternative-Specific-Constant	Cigarettes	2.466***	2.409***
		(0.122)	(0.122)
Alternative-Specific-Constant	HTPs	2.049***	2.086***
		(0.131)	(0.132)
Price	Price in 100 JPY	-0.162***	-0.169***
		(0.010)	(0.010)
HTP available flavor	Tobacco, menthol, fruity/coffee/mint	0.092*	0.131***
		(0.051)	(0.049)
	Tobacco and menthol	0.016	0.076
		(0.051)	(0.048)
HTP available nicotine level	Up to 30mg	0.004	-0.008
		(0.049)	(0.050)
	Up to 50mg	-0.034	-0.039
		(0.052)	(0.052)
HTP health messages	Small fraction of risks of cigarettes	0.016	-0.037
		(0.063)	(0.063)
	Contains nicotine, which is addictive	-0.019	-0.135*
		(0.071)	(0.072)
	Smoking is a cause of lung cancer	0.027	-0.050
		(0.063)	(0.062)
Log-likelihood at convergence		-5589	-5628
Number of Respondents X choice scenarios		6,276	6,276

Notes: Data from Japan Discrete Choice Experiment (2021).

Table 7: Conditional Logit Estimates by Age Cohort

		Ages 20-49	Ages 50 plus
Alternative-Specific-Constant	Cigarettes	2.910***	2.168***
		(0.179)	(0.167)
Alternative-Specific-Constant	HTPs	2.740***	1.438***
		(0.190)	(0.183)
Price	Price in 100 JPY	-0.175***	-0.157***
		(0.015)	(0.015)
HTP available flavor	Tobacco, menthol, fruity/coffee/mint	0.127*	0.060
		(0.075)	(0.072)
	Tobacco and menthol	-0.018	0.055
		(0.073)	(0.075)
HTP available nicotine level	Up to 30mg	-0.056	0.092
		(0.071)	(0.070)
	Up to 50mg	-0.052	-0.016
		(0.075)	(0.074)
HTP health messages	Small fraction of risks of cigarettes	0.131	-0.140
		(0.088)	(0.093)
	Contains nicotine, which is addictive	0.039	-0.126
		(0.098)	(0.109)
	Smoking is a cause of lung cancer	0.077	-0.068
		(0.090)	(0.090)
Log likelihood at convergence		-2774	-2685
Number of respondents X choice scenarios		3,384	2,892

Notes: Data from Japan Discrete Choice Experiment (2021).

Table 8: Conditional Logit Prediction with Estimates from Immediate Choices

Counterfactual scenarios	Cigarettes	HTP	Quit
Status quo	0.516	0.381	0.103
Lower HTP tax	0.443	0.469	0.088
Higher HTP tax	0.537	0.356	0.107
HTP flavor ban	0.522	0.374	0.104
Higher HTP tax + HTP flavor ban	0.543	0.349	0.108

Notes: Data from Japan Discrete Choice Experiment (2021).

Table 9: Conditional Logit Prediction with Estimates from Immediate Choices by Age Cohort

	Ages 20-49			Ages 50 plus		
Counterfactual scenarios	Cigarettes	HTP	Quit	Cigarettes	HTP	Quit
Status quo	0.473	0.462	0.065	0.563	0.292	0.145
Lower HTP tax	0.389	0.558	0.053	0.502	0.369	0.129
Higher HTP tax	0.499	0.432	0.069	0.58	0.27	0.15
HTP flavor ban	0.482	0.451	0.066	0.566	0.288	0.146
Higher HTP tax + HTP flavor ban	0.508	0.422	0.07	0.583	0.267	0.15

Notes: Data from Japan Discrete Choice Experiment (2021).

Table 10: Descriptive Statistics of Post DCE Perceptions of Smoking and HTP Use

	Mean	Standard Deviation
Perception: Life lost smoking	7.164	(7.86)
Perception: Life lost using HTPS	6.430	(6.92)
Comparing to cigs, HTPs are		
Much less harmful	0.140	(0.35)
Less harmful	0.503	(0.50)
Just as harmful	0.212	(0.41)
More harmful	0.019	(0.14)
Much more harmful	0.013	(0.11)
I don't know	0.113	(0.32)
I smoke more than I should		
Strongly agree	0.055	(0.23)
Somewhat agree	0.283	(0.45)
Neither disagree nor agree	0.293	(0.45)
Somewhat disagree	0.277	(0.45)
Strongly disagree	0.090	(0.29)
I don't know	0.002	(0.04)
Compared to tobacco & menthol flavors, using other HTP flavors are		
Much less harmful	0.094	(0.29)
Less harmful	0.390	(0.49)
Just as harmful	0.338	(0.47)
More harmful	0.021	(0.14)
Much more harmful	0.011	(0.11)
I don't know	0.145	(0.35)
N = 523		

Notes: Data from Japan Discrete Choice Experiment (2021). Reported statistics include Mean (Standard Deviation).