Supplementary Appendix

This appendix has been provided by the authors to give readers additional information about their work.

Supplementary Appendix

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Appendix A: Baseline Data Inputs

Model Component	Model Parameter	Data Sources and Notes
Initial Population	Population distribution by sex and age	Data were obtained from US Census National Population Estimates for 2015.[1]
	Tobacco use status (combinations of current, former, and never use for cigarettes and non-combusted products) by sex, age, and time since cessation (for cigarettes only)	Data were obtained from the 2015 National Health Interview Survey (NHIS)[2] for adults (ages 18 years and older) and the 2015 National Youth Tobacco Survey (NYTS)[3] for youth (ages less than 18 years old). NYTS and NHIS data were used to partition smoking prevalence into prevalence of 1) exclusive cigarette smoking, 2) dual cigarette and non-combusted product use, 3) exclusive non-combusted product use, and 4) no tobacco use for 2015.
Births	Annual births by sex	Annual births by sex[4] were derived from projections produced by the U.S. Census Bureau for the years 2015-2060. Births for the years 2061-2100 were projected using an exponential smoothing state space model.[5,6]
Net International Migration	Annual net migration by sex	Annual net migration by sex[7] was derived from projections produced by the U.S. Census Bureau for the years 2015-2060. Migration the years 2061-2100 was projected using an exponential smoothing state space model.[5,6]
	Immigrant age distribution	Data were obtained from U.S. Census Bureau, 2015 American Community Survey 1-Year Estimates. Selected Characteristics of the Native and Foreign-Born Populations.[8]
	Immigrant smoking prevalence by sex	Data were obtained from the 2011-2015 NHIS.[2] Smoking prevalence was calculated for immigrants to the US ages 18 years and over who had been in the US less than five years.

Model Component	Model Parameter	Data Sources and Notes
	Immigrant non-combusted prevalence by sex	Assumed to be zero in the model.
Deaths		See Vugrin et al. for detailed methods[9] and Appendix C below. Mortality scaling factors are included in table Appendix D.
Cigarette Smoking and Non-Combusted Transition Behaviors	Sex and age-specific initiation rate	Cigarette smoking initiation rates were derived by CISNET researchers for 2015 based on 2015 NHIS data.[10] Limited data are available to derive national estimates of annual smokeless tobacco and e-cigarette initiation rates. In the absence of reliable estimates of non-combusted product initiation rates from the published scientific literature, we scaled the sex- and age-specific smoking initiation rates derived by CISNET researchers[10] using youth prevalence estimates from the 2015 NYTS.[3] We used 2015 NYTS prevalence estimates for current cigarette, smokeless and e-cigarette use to scale smoking initiation rates to obtain sex- and age-specific initiation rates for exclusive cigarette use, exclusive non-combusted use, and dual cigarette/non-combusted use (see Appendix E). In the baseline scenario, age-specific initiation rates are assumed to remain constant in all years, and it is assumed that there is no new product initiation after the age of 30. This assumption means that, in the baseline scenario, there is no product switching or uptake of dual use among users of a single product after age 30.
	Sex and age-specific relapse rate	Set to zero for cigarettes and non-combusted products. Relapse rates are set to zero because cessation rates that are applied reflect long term success.

Model Component	Model Parameter	Data Sources and Notes
	Sex and age-specific cessation rate	Limited data are available to derive national estimates of annual smokeless tobacco and e-cigarette cessation rates. In the absence of reliable estimates of non-combusted product cessation rates from the published scientific literature, cigarette smoking cessation rates for 2015, derived by CISNET researchers based on 2015 NHIS data,[10] were used for cessation of both cigarettes and non-combusted products. In the baseline scenario, age-specific cessation rates are assumed to remain constant in all years.

Appendix B: Prevalence of current tobacco product use, by age group and sex, NYTS 2015, used for baseline youth prevalence*

	Females % (95% CIs)				Males % (95% CIs)			
	Exclusive cigarette smoking (no non-combusted use)	Dual cigarette and non-combusted use	Exclusive non-combusted use (no cigarette smoking)	No cigarette smoking and no non-combusted use	Exclusive cigarette smoking (no non-combusted use)	Dual cigarette and non-combusted use	Exclusive non-combusted use (no cigarette smoking)	No cigarette smoking and no non-combusted use
Age								
9-12 years avg.	0.3 (0.1-0.9)	0.1 (0.0-0.5)	0.7 (0.4-1.3)	98.9 (98.1-99.4)	0.1 (0.0-0.5)	0.4 (0.2-0.9)	0.9 (0.4-1.9)	98.6 (97.6-99.2)
13 years	0.4 (0.1-2.1)	0.1 (0.0-0.4)	0.8 (0.3-1.7)	98.8 (97.4-99.4)	0.2 (0.1-0.6)	0.2 (0.1-0.6)	0.7 (0.3-1.5)	98.8 (98.0-99.3)
14 years	0.2 (0.1-0.8)	0.2 (0.1-0.5)	0.8 (0.4-1.3)	98.8 (98.2-99.3)	0.8 (0.3-2.1)	0.5 (0.2-0.9)	1 (0.4-2.2)	97.8 (96.3-98.7)
15 years	1.4 (0.6-3.5)	0.4 (0.1-1.1)	0.7 (0.3-1.7)	97.5 (95.3-98.7)	1.8 (0.7-4.7)	1.5 (0.8-3.0)	4.3 (2.3-7.9)	92.3 (86.9-95.6)
16 years	2.1 (1.3-3.6)	1.2 (0.4-3.2)	1.5 (0.8-2.8)	95.2 (93.0-96.7)	1.9 (1.3-3.0)	2.4 (1.4-4.1)	6.0 (3.9-9.2)	89.6 (85.5-92.7)
17 years	3.6 (2.4-5.4)	0.7 (0.3-1.3)	1.1 (0.5-2.3)	94.6 (92.5-96.1)	3.6 (2.4-5.5)	3.4 (2.2-5.3)	6.3 (4.8-8.3)	86.6 (83.5-89.2)

*Cigarette smoking reflects 100 or more lifetime cigarettes. Non-combusted use refers to smokeless tobacco and/or e-cigarette use; smokeless product use reflects use on 20 or more of the past 30 days for chew/snuff/dip or >=1 of the past 30 days for snus or dissolvables; e-cigarette use reflects use on 20 or more of the past 30 days.

Appendix C: Relative Risk Estimates

Table C1 lists assumptions and calculations used to combine individual product relative risk values (i.e. relative risks for smoking and relative risks for non-combusted product use).

Relative risk values for smoking were taken from hazard ratios that were estimated for 1997-2004 NHIS Sample Adult Questionnaire participants followed for mortality through linkage with the National Death Index through the end of 2006.[11] Relative risks for current, former and never smokers are described in Appendix S2 in Vugrin et al.[9] For the current paper, we used observed hazard ratios in the baseline scenario for former cigarette smokers, given that the increased risks among recent quitters are attributable to smoking. In the policy scenario, we capped hazard ratios for former smokers at the levels for current smokers of the same sex and age-group because increased smoking cessation in this scenario would be due to the policy rather than the result of sick smokers quitting. In addition, to be conservative, we excluded the first 3 years after the implementation of the policy from our cumulative estimates of tobacco-related deaths averted and life-years gained.

To obtain non-combusted tobacco mortality relative risks, we conducted a systematic review of studies of all-cause mortality risk among smokeless tobacco users in the U.S. Three prospective cohort studies with mortality follow-up were identified: the First National Health and Nutrition Examination Survey (NHANES I), the American Cancer Society Cancer Prevention Study I (CPS-I), and Cancer Prevention Study II (CPS-II). The CPS-I and II studies were much larger than the NHANES study, with each enrolling over one million participants to study health behaviors and cancer risk.[12] Analyses of these studies have examined mortality risk among male exclusive smokeless tobacco users compared with never tobacco users, controlling for demographic characteristics and other health behaviors. Since CPS-II was a more recent cohort (beginning in 1982), we utilized these results here. In CPS-II, current use of chewing tobacco or snuff at baseline was associated with increased mortality risk (Hazard Ratio [HR] = 1.18, 95% Confidence Interval [CI] = 1.08-1.29). No increased risk of mortality was observed among former smokeless tobacco users in CPS-II data (HR = 0.98, 95% CI = 0.85-1.13). In an analysis of people who switched from cigarette smoking to smokeless tobacco use compared with those who quit smoking entirely, the mortality risk was significantly elevated (HR = 1.08, 95% CI = 1.01-1.15).[13] For the model, all individuals less than 35 years old, regardless of tobacco product

use state are assigned a relative risk value of 1. For males and females 35 years or older, we use a relative risk of 1.18 for current non-combusted product users and a relative risk of 1 for former non-combusted product users, compared with never tobacco users, and a relative risk of 1.08 for former cigarette smokers who subsequently use non-combusted tobacco, compared with former smokers who subsequently do not use tobacco products. Given the limited time frame that e-cigarettes have been on the market, there are no data on the long-term health risks of their use. As a result, we apply the same risks that are used for traditional smokeless tobacco to e-cigarette users in this analysis. With the exception of the former cigarette smoker/current non-combusted tobacco product user (FC in Table C1) product use state, the relative risks are the maxima of the relevant smoking and non-combusted product relative risks (i.e. whichever relative risk is greater is the one that is applied).

Table C1. Relative risk (RR) scenario assumption

Tobacco Use Status*	Relative Risk Calculation	Interpretation
NN	RR = 1	NN is the state for individuals who never used either group of tobacco products. Individuals in this state have the null relative risk value, RR = 1.
CN	RR = RR for current smoker	CN is the state for current smokers who never used non-combusted tobacco products. Individuals in this state are assumed to have RR values equal to current smokers.
FN	RR = RR for former smoker	FN is the state for former smokers who never used non-combusted tobacco products. Individuals in this state are assumed to have RR values equal to former smokers.
NC	RR = RR for current smokeless tobacco user	NC is the state for current users of non-combusted tobacco products who have never smoked cigarettes. The relative risk is assumed to be equal to the hazard ratio value for users of chewing tobacco or snuff reported by Henley et al. (2005).
CC	RR = maximum[RR for current smoker, RR for current user of non-combusted tobacco	CC is the state for dual users. RR for dual use is the maximum of the individual product RRs.

	products]	
FC	RR = max{min[1.08*RR for former smokers, RR current smokers],RR for current non-combusted use}	FC is the state for former smokers who are current users of non-combusted tobacco products. Using the results of Henley et al.'s (2007) study, the RR for this state is 8% higher than the RR for the FN (individuals who quit cigarettes but do not use non-combusted products) as long as: - 8% above the RR for former smokers is not larger than the RR for current smokers. If not, RR is set to that for current smokers; - 8% above the RR for former smokers is not less than the RR for current non-combusted tobacco product users. If not, RR is set equal to that for current non-combusted use.
NF	RR = 1	NF is the state for former users of non-combusted tobacco products who never smoked cigarettes. It is assumed that the relative risk for this state is equal to RRs for individuals who never used either group of tobacco products, i.e., RR = 1.
CF	RR = RR for current smoker	CF is the state for current smokers who are former users of non-combusted tobacco products. These individuals are assigned an RR equal to current smokers' RR since that value is equivalent to using the maximum value of current smoker RR (≥1) and former non-combusted tobacco product user RR (=1).
FF	RR = RR for former smoker	FF is the state for former smokers and former users of non-combusted tobacco products. The individuals retain the RR from the highest risk behavior, i.e., smoking.

*First letter denotes cigarette use status, and second letter denotes use of non-combusted tobacco product use status.

N=never, C=current, and F=former

Appendix D: Mortality scaling factors obtained from Lee-Carter mortality forecasting method for US from 2015-2100 by sex and age, in 5 year intervals*

Lee-Carter Mortality Scaling Factors for Females

Current Age	2015	2025	2035	2045	2055	2065	2075	2085	2095
0	0.656	0.495	0.373	0.282	0.213	0.161	0.121	0.091	0.069
1	0.692	0.541	0.423	0.331	0.259	0.202	0.158	0.124	0.097
5	0.719	0.577	0.463	0.371	0.298	0.239	0.192	0.154	0.124
10	0.788	0.672	0.574	0.489	0.417	0.356	0.304	0.259	0.221
15	0.885	0.816	0.752	0.694	0.639	0.590	0.544	0.501	0.462
20	0.848	0.760	0.681	0.610	0.547	0.490	0.439	0.393	0.352
25	0.836	0.742	0.658	0.584	0.518	0.460	0.408	0.362	0.321
30	0.825	0.726	0.639	0.562	0.494	0.435	0.382	0.336	0.296
35	0.860	0.750	0.654	0.570	0.497	0.433	0.378	0.330	0.287
40	0.853	0.738	0.639	0.552	0.478	0.414	0.358	0.310	0.268
45	0.861	0.752	0.656	0.573	0.500	0.437	0.381	0.333	0.290
50	0.873	0.772	0.682	0.603	0.533	0.471	0.417	0.368	0.326
55	0.897	0.813	0.737	0.668	0.605	0.548	0.497	0.450	0.408
60	0.903	0.822	0.749	0.683	0.622	0.567	0.516	0.470	0.428
65	0.898	0.814	0.738	0.669	0.606	0.550	0.498	0.452	0.409
70	0.889	0.799	0.718	0.645	0.580	0.521	0.468	0.421	0.378
75	0.873	0.771	0.681	0.602	0.532	0.470	0.415	0.367	0.324
80	0.890	0.801	0.720	0.648	0.583	0.525	0.472	0.425	0.382
85	0.936	0.882	0.831	0.783	0.737	0.695	0.654	0.616	0.581

Lee-Carter Mortality Scaling Factors for Males

Current Age	2015	2025	2035	2045	2055	2065	2075	2085	2095
0	0.611	0.440	0.317	0.229	0.165	0.119	0.085	0.062	0.044
1	0.677	0.522	0.402	0.310	0.239	0.184	0.142	0.110	0.085
5	0.683	0.530	0.411	0.319	0.247	0.192	0.149	0.115	0.089
10	0.758	0.630	0.524	0.436	0.362	0.301	0.250	0.208	0.173
15	0.914	0.861	0.812	0.765	0.720	0.679	0.639	0.602	0.567
20	0.903	0.843	0.788	0.736	0.687	0.642	0.599	0.560	0.523
25	0.937	0.898	0.860	0.823	0.789	0.755	0.723	0.693	0.664
30	0.958	0.931	0.905	0.880	0.855	0.831	0.808	0.785	0.763
35	0.938	0.885	0.836	0.789	0.744	0.702	0.663	0.625	0.590
45	0.861	0.752	0.656	0.573	0.500	0.437	0.381	0.333	0.291
50	0.844	0.724	0.621	0.532	0.456	0.391	0.335	0.287	0.246
55	0.857	0.744	0.647	0.562	0.488	0.424	0.369	0.320	0.278

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60	0.868	0.764	0.672	0.591	0.519	0.457	0.402	0.353	0.311
65	0.881	0.785	0.700	0.624	0.556	0.496	0.442	0.394	0.351
70	0.900	0.818	0.743	0.675	0.613	0.557	0.506	0.460	0.418
75	0.906	0.828	0.757	0.692	0.633	0.578	0.529	0.483	0.442
80	0.928	0.867	0.810	0.757	0.708	0.661	0.618	0.577	0.540
85	0.957	0.920	0.884	0.849	0.816	0.784	0.753	0.724	0.696

Methods are described in Vugrin et al.[9]

Appendix E: Prevalence of current tobacco product use, among U.S. middle and high students, NYTS 2015, used for scaling factors*

	Exclusive cigarette smoking (no non-combusted use) % (95% CI)	Dual cigarette and non-combusted use % (95% CI)	Exclusive non-combusted use (no cigarette smoking) % (95% CI)	Any cigarette smoking % (95% CI)	No cigarette smoking and no non-combusted use % (95% CI)
Female	1.4 (1.0-1.9)	0.5 (0.3-0.7)	0.9 (0.7-1.2)	1.8 (1.4-2.4)	97.2 (96.6-97.8)
Male	1.7 (1.3-2.3)	1.5 (1.2-2.1)	3.7 (2.7-5.0)	3.3 (2.6-4.2)	93.1 (91.3-94.5)

*Cigarette smoking reflects 100 or more lifetime cigarettes. Non-combusted use refers to smokeless tobacco and/or e-cigarette use; smokeless tobacco use reflects use on 20 or more of the past 30 days for chew/snuff/dip or >=1 of the past 30 days for snus or dissolvables; e-cigarette use reflects use on 20 or more of the past 30 days.

Appendix F: An Expert Elicitation of Behavioral Effects of a Potential Nicotine Tobacco Product Standard for Cigarettes in the U.S.

Background

The effect of using very low nicotine content (VLNC) cigarettes has been studied among cigarette smokers in a variety of clinical settings. These studies suggest that VLNC cigarettes may encourage cessation intent, increase cessation, and lower smoking exposure.[14-17] These studies, although informative, are not designed to project population-level impacts if nicotine reductions in cigarettes were mandated by a regulatory agency. To examine this issue and the associated uncertainty, FDA conducted an expert elicitation regarding a potential product standard that would limit nicotine in cigarettes and certain other substitutable combusted tobacco products to a minimally addictive level. The use of expert elicitation is a common practice in policy decision processes, especially uncertainty exists about possible outcomes.[18] It is a systematic process of formalizing and quantifying judgements about uncertain quantities, typically conducted with subject matter experts who provide subjective probability distributions for parameters of interest.

The Office of Management and Budget (OMB) recommends expert elicitation as one approach for addressing uncertainty of key parameters in regulatory analyses.[19] Expert elicitations have been used in various public policy fields, most commonly in regulatory impact analyses conducted by the Environmental Protection Agency, and are increasingly being used in other fields.[20-23] In the field of tobacco control, such elicitations have been conducted for the relative risks of low nitrosamine smokeless tobacco products[24] and the impact of plain packaging on smoking prevalence and initiation.[25] In this study, we describe the use of expert elicitation to characterize the potential behavioral responses to a nicotine product standard in the U.S.

Methods

Composition of Panel

FDA contracted with Industrial Economics, Inc. (IEc) to conduct the expert elicitation. Using a pre-specified protocol, IEc identified US and Canadian-based researchers with extensive records of publications on topics such as smoking initiation and cessation, nicotine addiction, clinical trials of very low nicotine tobacco products, and the effectiveness of existing tobacco control measures. First, IEc used pre-specified search terms in the Scopus database to identify potential candidates in two categories: tobacco policy and tobacco science (see Tables F1 & F2 for search terms). For each category, the top 30 candidates were identified based on citation count. Next, IEc limited the pool of candidates in each category to individuals with h-index scores (a metric that measures both an author's productivity and citation impact) above 20, resulting in 53 candidates.

FDA screened potential panelists for known conflicts of interest, resulting in a group of 32 candidates, 20 with expertise in tobacco science, nine with expertise in tobacco policy, and three with expertise in both fields. Candidates were required to certify that they were free of any actual, apparent, or potential conflict of interest and sign a non-disclosure agreement.

IEc then invited candidates to participate in the elicitation process in order of their h-index score. Sixteen invitations were extended to produce a panel of eight experts (Table F3); five individuals declined the invitation and three others were found to have actual, apparent, or potential conflicts of interest. Actual, apparent, or potential conflicts included interests, financial or otherwise, in any business that manufactures, distributes, markets, or sells any tobacco products, including electronic cigarettes, other electronic nicotine delivery devices, or any nicotine- or tobacco-related pharmaceutical products. This included during the period of

participating in the expert elicitation or during the 36 months prior: having a proprietary interest in a product or technology; salary or consulting fees; a grant and/or salary support from one; party to a research contract; payment for expert testimony; or holding stock, stock options, or receiving payment from either from any such business. Receiving honoraria totaling more than $10,000 from these private sector sources in any one of the prior three calendar years (2012, 2013, or 2014) was considered a conflict of interest. Additional conflicts of interest were being the lead current direct contract with the FDA or current FDA "special Government employee" (SGE).

Participants were sent and asked to sign non-disclosure agreements agreeing to protect non-public information shared with them as part of the elicitation process from disclosure. Panelists were aware they would be identified as a panel member, but their individual estimates and comments would remain anonymous. They were informed that their judgments would inform FDA's assessment of the public health impacts of a potential standard. IEc provided panelists with an honorarium to compensate them for their time and effort.

Elicitation Process

IEc structured the elicitation process around three online workshops conducted during a five-week period in January and February, 2015. Each workshop lasted approximately four hours. IEc designed an extensive written protocol to elicit opinions using a logical, structured approach that ensured all panelists were asked the same questions in a clearly-defined manner. FDA reviewed and pilot tested the elicitation protocol.

Three weeks prior to the first workshop, IEc sent each panelist background materials including the elicitation protocol, presentations for this workshop, a training exercise on

developing probabilistic judgments, scientific evidence relevant to the potential standard, and published articles on related topics such as the effect of VLNC cigarette use on smoking cessation.

The first workshop was generally devoted to introduction of the participants, training, and familiarization with the expert elicitation process. To maintain panelist independence and encourage open discussion, FDA staff involvement was limited to the first workshop. During this workshop, FDA provided information about a population health model that FDA was exploring developing that would incorporate estimates from the elicitation. Participation in all other aspects of the workshops and elicitation was restricted to IEc staff and panelists.

The second workshop allowed panelists the opportunity to present and discuss information that they believed should be considered in assessing the likely impacts of the potential standard. Panelists were not required to base their judgments solely on the background materials and were encouraged to identify and request other relevant information. These materials were distributed to everyone.

Participants were instructed to assume that the potential standard would be fully and effectively implemented and enforced, and that once the standard was in effect, non-compliant cigarettes would be entirely unavailable, including from illegal or illicit sources. These assumptions were made to simplify the panel's tasks and to allow panelists to concentrate on the potential standard's behavioral impacts.

Following the second workshop, panelists completed the elicitation protocol and provided their initial estimates during individual interviews led by IEc staff, conducted by telephone and supported with web conferencing software. IEc also invited each panelist to comment on the elicitation protocol and process in general.

The third workshop allowed panelists to review and consider all initial estimates. To protect the anonymity of the experts' responses, IEc presented each panelist's estimates using randomly assigned letter codes A-H. IEc staff then facilitated a discussion of the responses and their rationales but did not seek to form a consensus. After this workshop, panelists were able to individually revise their estimates. Six panelists revised at least one quantitative estimate. As all revisions were minor, we focus on the final estimates.

Use Behavior Estimates

Participants were asked to provide quantitative estimates of the effect of the potential product standard on key behaviors involving cigarettes and other tobacco products not covered by the standard (defined as premium cigars, waterpipe/hookah, smokeless tobacco, and e-cigarettes or other electronic nicotine delivery devices). While participants were asked to provide these estimates assuming the potential standard would apply also to certain other combusted products (non-premium cigars, and pipe tobacco other than hookah), the behavioral impacts of the potential standard that were assessed focused on cigarette use, and not on use of these other covered products. Participants provided estimates for both the first year after implementation and for subsequent years, and were given the option of providing estimates separately for men and women for all questions.

The elicitation asked the panelist to offer probabilistic estimates of the effect of the potential product standard on five behaviors:

1) Cigarette smoking cessation – percentage of current cigarette smokers who would quit smoking (panelists were told that the average annual cessation rate used in the model at the time was 3.7% to 3.8%)

2) Product switching – among those who quit smoking cigarettes, percentage who would switch to use of one or more non-covered tobacco products

3) Dual use – among those who continue to smoke cigarettes, percentage who would initiate use of one or more non-covered tobacco products

4) Cigarette smoking initiation – percent change in smoking initiation rates due to the standard

5) Initiation of the use of non-covered products – among those who do not initiate smoking because of the standard, percentage who would initiate use of non-covered tobacco products.

To characterize the uncertainty surrounding each expert's judgment, each panelist was asked to provide seven estimates for each requested value: their minimum and maximum values, their 5th and 95th percentile values, their 25th and 75th percentile values, and their 50th percentile values. For each parameter panelists were also asked to list relevant factors and the studies or research findings that were most influential in forming their views.

IEc identified three peer reviewers based on their publications on expert elicitation to review the expert elicitation protocol and a preliminary draft of report, in accordance with OMB guidelines.[26] Reviewer comments were generally positive; all found that the approach employed to elicit expert judgments was consistent with best practices in the field.

Results

The eight panelists believed that the potential standard would lead to increased cessation among smokers, but estimates of the magnitude of change varied (Figure F1). Two panelists (B and D) reported relatively high median cessation percentages, at 50-55%, in the standard's first

year, and Expert G reported the lowest median value at 4.5%. The remaining panelists reported median percentages between 9% and 30% in the first year. Except for Expert G, all panelists reported relatively wide intervals for the various requested percentiles. Responses were generally similar for subsequent years, with most estimates being somewhat lower; although Expert B estimated a median cessation percentage of 80%. Tables F4-F19 present the final estimates.

The panelists believed that the median percentage of individuals who would quit smoking following product standard implementation but initiate use of non-covered products in the first year was 25% to 65% and that switching patterns would be comparable in subsequent years (Figure F2a). Estimates of the percentage of continuing smokers who would also use one or more non-covered tobacco products varied somewhat, with three panelists reporting median percentages of 20% to 40%, four reporting median percentages of 60% to 65%, and Expert B reporting 90% for men and 85% for women (Figure F2b). Most of the panelists who reported different values for following years tended to believe that dual use in those years would decline.

Estimates for percentage decreases in smoking initiation were generally consistent (Figure F3a), with four panelists (A-D) reporting median values of 50% in the first year and another (E) reporting a median value of 45%. Two panelists (F and G) reported somewhat lower median decreases at 21% and 30%, and Expert H reported the highest median decrease of 70%. Most of the panelists believed that initiation decreases would be similar in subsequent years, but Expert B and, to a lesser extent, Expert G believed that the effect would be greater in later years as smoking became increasingly less common in society.

In terms of the percentage of individuals deterred from smoking initiation who would instead initiate use of tobacco products not covered by the potential standard, responses were fairly consistent, with six panelists reporting median percentages of 25% to 45% in the first year

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(Figure F3b). One expert (G) reported a higher median value of 70%, and Expert B reported lower median percentages of 12% for males and 10% for females. Six panelists reported the same estimates for subsequent years of the standard, and Experts A and B reported only slightly different percentages for subsequent years.

When asked about product choice among switchers, panelists generally agreed that e-cigarettes would be most common among the four presented options, with estimates of 65% to 97% for men and 80% to 98% for women in the first and subsequent years. For men, smokeless tobacco was also considered to be another alternative, with estimates between 15% and 20% in the first year for four panelists. Experts generally agreed that e-cigarettes would also be the most common product choice among dual users and those deterred from initiating smoking.

Discussion

FDA elicited quantitative, probabilistic estimates of the potential behavioral impacts of a nicotine product standard from a panel of subject matter experts. The elicitation process was structured to allow each expert to present an independent assessment, and parameter estimates and their probability distributions varied somewhat between panelists. However, there was general agreement that the potential standard would lead to substantial initial and long-term increases in cessation among smokers and decreased initiation among non-smokers. For example, most panelists estimated that the product standard would result in smoking cessation rates that far exceed current levels of approximately 4% per year.[27]

Panelists also provided supporting evidence for their quantitative estimates through individual feedback and the final workshop's panel discussion, which helped explain their reasoning and differences in estimates. Panelists generally believed that reduced nicotine levels would make it much less likely that smoking experimenters would become nicotine dependent

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and progress to regular use. Although there was some difference in opinion about the possible magnitude of effect of any particular policy on smoking cessation, most panelists believed that reduced nicotine levels would substantially decrease addictiveness and appeal of cigarettes and thus make it easier and more likely for smokers to quit. Several panelists noted the importance of possible responses from the tobacco industry on parameter estimates and suggested that development of new non-covered tobacco products could increase rates of dual use and product switching or initiation of these products among those who would otherwise initiate cigarette use. The panelists generally agreed that the potential standard's effects would be impacted by the degree to which e-cigarette use would become an acceptable substitute for cigarette smoking. Some noted uncertainty about the trajectory of e-cigarette use in the US. In general, panelists who believed that e-cigarettes could become another alternative to cigarettes tended to provide higher estimates for all five behaviors. Panelists also believed that declines in smoking prevalence in society could have a reinforcing effect on behaviors, particularly initiation.

This analysis has certain limitations. Due to the strict conflict of interest requirements, none of the panelists had conducted studies of VLNC cigarettes, which may have influenced the panel's evaluation and use of such studies. Many panelists said that these studies were informative but that study conditions may not reflect real-world circumstances and could thus underestimate impacts of the potential standard. The elicitation process was conducted in 2015, when e-cigarettes were relatively newer in the US; their initiation and use trends may have somewhat stabilized since 2015,[28] which could lead to less uncertainty about switching to these products in future years. Conversely, future product development could also affect switching trends, which this process could not account for. Finally, this process did not specifically address

the possibility of non-compliance or illicit trade; these issues were beyond the scope of this elicitation and panelists' expertise.

This process demonstrates that expert elicitation can be successfully used to estimate the impact of a potential tobacco product standard in situations where parameter values may be unknown or uncertain and where clinical studies may not represent real-world conditions. In this study, we apply the expert elicitation methodology to estimate the impact of a potential reduced nicotine product standard on cigarette smoking. The expert opinions presented here can be used to inform FDA's policy decision-making, including population modeling efforts that seek to quantify the public health benefits of regulation. Despite uncertainty about the magnitude, findings suggest that a potential nicotine product standard for cigarettes would prompt significant increases in smoking cessation and decreases in smoking initiation in the U.S.

Table F1. Keyword Searches Conducted for Selection of Tobacco Science Experts

Topic Area	Search Terms
General Effects of Nicotine Reduction	• very low nicotine cigarettes • reducing/reduction and nicotine content • reduced nicotine content cigarettes • reduced nicotine content and effects • nicotine addiction or nicotine dependence and low nicotine cigarettes • low nicotine cigarettes and harm reduction
Smoking Cessation and Behavior Change	• very low nicotine cigarettes and cessation • low nicotine cigarettes and cessation • nicotine reduction and smoking cessation • reduced nicotine content and smoking behavior • smoking behavior and reduced nicotine • low nicotine cigarettes and smoking behavior • low nicotine cigarettes and smoking reduction • smoking reduction or smoking cessation and low nicotine cigarettes • smoking cessation and reduced nicotine cigarettes • low nicotine cigarettes and compensatory smoking
Dual Use and Product Switching	• dual use and smoking behavior • dual use and low nicotine cigarettes • alternative tobacco products and cigarette use • alternative tobacco products and cessation • reduced nicotine and product switching • reduced nicotine cigarettes and smokeless tobacco • smokeless tobacco and cigarette smoking • cigarettes and smokeless tobacco • concurrent use and cigarettes and smokeless tobacco • smokeless tobacco and harm reduction • dual use and cigarettes and smokeless tobacco
E-cigarettes	• e-cigarette use • e-cigarettes and cessation
Initiation of Tobacco Use	• youth or teen or adolescent or initiation and e-cigarettes • youth or teen or adolescent or initiation and smokeless tobacco • youth or teen or adolescent or initiation and nicotine addiction or nicotine dependence

Table F2. Keyword Searches Conducted for Selection of Tobacco Policy Experts

Search Terms
• tobacco control policy • tobacco policies • tobacco policy trends • tobacco policy interventions • tobacco control policies and impacts • tobacco control models • tobacco control policies and models • tobacco policy modeling • tobacco control regulations • tobacco control and impacts

Table F3. Members of the expert panel[1]

Dr. David Abrams
    Executive Director, Steven A. Schroeder National Institute for Tobacco Research and
    Policy Studies
    American Legacy Foundation

Dr. K. Michael Cummings
    Professor, Department of Psychiatry and Behavioral Sciences
    College of Medicine
    Medical University of South Carolina

Dr. Geoffrey T. Fong
    Professor
    Department of Psychology
    University of Waterloo

Dr. Andrew Hyland
    Chair, Department of Health Behavior
    Division of Cancer Prevention and Population Sciences
    Roswell Park Cancer Institute

Dr. Raymond Niaura
    Associate Director for Science, Steven A. Schroeder National Institute for Tobacco
    Research and Policy Studies
    American Legacy Foundation

Dr. Jennifer O'Loughlin
    Professor, Department of Social and Preventive Medicine
    School of Public Health
    University of Montreal

Dr. Gilles Paradis
    Professor and Chair, Department of Epidemiology, Biostatistics, and Occupational Health
    Faculty of Medicine
    McGill University

Dr. Maxine Stitzer
    Professor
    Department of Psychiatry and Behavioral Sciences
    School of Medicine
    Johns Hopkins University

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[1] Table list panelists' affiliation at time of the expert elicitation, January – February 2015.

Tables F4-F19: Final Elicited Estimates from Panelists

Table F4. Cessation in the First Year - Final Elicited Estimates of the Percentage of Cigarette Smokers Who Would Quit Smoking in the First Year of the Potential Product Standard*

Value	Expert								
	A - Males	A - Females	B	C	D	E	F	G	H
Max	96.3	96.2	90	30	80	50	25	8	50
95th	75	75	80	25	70	40	22	7.5	40
75th	50	40	70	22	60	25	18	5	35
50th	22	18	55	20	50	9	10	4.5	30
25th	12	10	40	12	35	6	5	3.9	20
5th	5	5	20	10	15	4.5	4.3	3.8	12.5
Min	3.7	3.8	10	8	10	3.7	4	3.7	4

*Elicitation protocol asks "During the year immediately following the potential product standard's implementation, what is your estimate of the true percentage of current cigarette smokers in the U.S. (as represented in the health effects simulation model) who would quit smoking cigarettes?"
Note: Experts could provide separate estimates for males and females. Estimates by gender are only shown for experts who chose to provide separate estimates for males and females.

Table F5. Cessation in Subsequent Years – Final Elicited Estimates of the Percentage of Cigarette Smokers Who Would Quit Smoking in the Subsequent Years*

Value	Expert								
	A - Males	A - Females	B	C	D	E	F	G[§]	H
Max	96.3	96.2	95	30	60	75	20	8	25
95th	75	75	90	25	50	50	18	7.5	20
75th	35	30	85	15	40	40	15	5	17.5
50th	15	12	80	10	30	15	8	4.5	15
25th	10	6	50	8	20	10	5	3.9	8.75
5th	5	5	30	6	15	5	4.5	3.8	6.25
Min	3.7	3.8	20	4	10	3.7	4	3.7	2

*Elicitation protocol asks "For the years following the first full year of the potential product standard's implementation, what is your estimate of the true percentage of cigarette smokers in the U.S. who would quit smoking cigarettes each year (i.e., the true average annual cessation rate for cigarette smoking in the U.S.)?"
[§]Expert's estimates are the same as for the first year.
Note: Experts could provide separate estimates for males and females. Estimates by gender are only shown for experts who chose to provide separate estimates for males and females.

Table F6. Switching in the First Year – Final Elicited Estimates of the Percentage of Quitters Who Would Initiate Use of Non-Covered Products in the First Year of the Potential Product Standard*

Value	Expert								
	A	B - Males	B - Females	C	D	E	F	G	H
Max	100	70	60	80	80	90	90	60	60
95th	75	60	50	75	70	80	85	50	45
75th	40	50	40	60	60	70	80	45	40
50th	25	40	30	50	40	65	60	25	30
25th	10	30	20	40	30	50	35	20	20
5th	5	10	10	35	25	45	25	15	15
Min	2	5	3	30	20	38	20	10	10

*Elicitation protocol asks "For the year immediately following the potential product standard's implementation, what is your estimate of the true percentage of those who quit smoking cigarettes who, in that same year, would initiate use of one or more non-covered tobacco products?"
Note: Experts could provide separate estimates for males and females. Estimates by gender are only shown for experts who chose to provide separate estimates for males and females.

Table F7. Switching in Subsequent Years – Final Elicited Estimates of the Percentage of Quitters Who Would Initiate Use of Non-Covered Products in Subsequent Years*

Value	Expert								
	A[§]	B - Males	B - Females	C[§]	D[§]	E[§]	F[§]	G[§]	H
Max	100	70	70	80	80	90	90	60	30
95th	75	60	60	75	70	80	85	50	22.5
75th	40	50	40	60	60	70	80	45	20
50th	25	40	35	50	40	65	60	25	15
25th	10	30	25	40	30	50	35	20	10
5th	5	10	10	35	25	45	25	15	7.5
Min	2	5	5	30	20	38	20	10	5

[*] Elicitation protocol asks "For the years following the first full year of the potential product standard's implementation, what is your estimate of the true percentage of those who quit smoking cigarettes in a given year who, in that same year, would initiate use of one or more non-covered tobacco products?"

[§]Expert's estimates are the same as for the first year.

Note: Experts could provide separate estimates for males and females. Estimates by gender are only shown for experts who chose to provide separate estimates for males and females.

Table F8. Switching Distribution in the First Year – Final Elicited Estimates of the Distribution of Product Switching in the First Year of the Potential Product Standard by Non-Covered Product Category*

Product Category	Expert							
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**
Males								
Premium Cigars	0	10	5	5	0	10	1	5
Waterpipe/ Hookah Tobacco	2	5	3	5	15	10	1	3
E-cigarettes	95	70	72	85	80	65	97	77
Smokeless Tobacco	3	15	20	5	5	15	1	15
Females								
Premium Cigars	0	5	1	5	0	5	1	1
Waterpipe/ Hookah Tobacco	2	5	3	8	10	10	1	3
E-cigarettes	98	80	91	85	90	80	97	95
Smokeless Tobacco	0	10	5	2	0	5	1	1

*Elicitation protocol asks to estimate separately for males and females "the percentage of product switchers who would switch primarily to (1) premium cigars, (2) waterpipe/hookah tobacco, (3) e-cigarettes, and (4) smokeless tobacco each year following the first full year of the potential product standard's implementation." As the protocol asks about the primary product used, it reminds the experts that the four values should sum to 100%.

Table F9. Switching Distribution in Subsequent Years– Final Elicited Estimates of the Distribution of Product Switching in Subsequent Years by Non-Covered Product Category*

Product Category	Expert							
	A[§]	B	C[§]	D[§]	E[§]	F[§]	G[§]	H[§]
Males								
Premium Cigars	0	10	5	5	0	10	1	5
Waterpipe/ Hookah Tobacco	2	5	3	5	15	10	1	3
E-cigarettes	95	75	72	85	80	65	97	77
Smokeless Tobacco	3	10	20	5	5	15	1	15
Females								
Premium Cigars	0	10	1	5	0	5	1	1
Waterpipe/ Hookah Tobacco	2	5	3	8	10	10	1	3
E-cigarettes	98	80	91	85	90	80	97	95
Smokeless Tobacco	0	5	5	2	0	5	1	1

*Elicitation protocol asks to estimate separately for males and females "the percentage of product switchers who would switch primarily to (1) premium cigars, (2) waterpipe/hookah tobacco, (3) e-cigarettes, and (4) smokeless tobacco each year following the first full year of the potential product standard's implementation." As the protocol asks about the primary product used, it reminds the experts that the four values should sum to 100%.

[§]Expert's estimates are the same as for the first year.

Table F10. Dual Use in the First Year – Final Elicited Estimates of the Percentage of Those Who Continue to Smoke Who Would Initiate Use of Non-Covered Products in the First Year of the Potential Product Standard*

Value	Expert								
	A	B - Males	B - Females	C	D	E	F	G	H
Max	100	99	99	50	95	95	90	90	50
95th	95	97	95	48	85	80	85	80	45
75th	75	93	90	30	75	75	75	70	40
50th	40	90	85	20	60	65	60	60	32.5
25th	20	85	80	15	45	40	45	55	25
5th	5	75	70	12	35	25	35	50	20
Min	2	70	60	10	25	10	30	45	15

*Elicitation protocol asks "For the year immediately following the potential product standard's implementation, what is your estimate of the true percentage of those who continue to smoke cigarettes who, in that same year, would become dual users of cigarettes and one or more non-covered tobacco products?"
Note: Experts could provide separate estimates for males and females. Estimates by gender are only shown for experts who chose to provide separate estimates for males and females.

Table F11. Dual Use in Subsequent Years – Final Elicited Estimates of the Percentage of Those Who Continue to Smoke Who Would Initiate Use of Non-Covered Products in Subsequent Years*

Value	Expert							
	A	B	C	D[§]	E	F[§]	G	H
Max	100	99	60	95	50	90	10	25
95th	95	97	55	85	45	85	8.5	22.5
75th	75	93	40	75	40	75	6	20
50th	30	90	30	60	20	60	5	16.25
25th	20	85	20	45	7	45	4	12.5
5th	5	75	15	35	5	35	2.5	10
Min	2	70	10	25	0	30	1	7.5

*Elicitation protocol asks "For the years following the first full year of the potential product standard's implementation, what is your estimate of the true percentage of those who continue to smoke cigarettes who, in a given year, would become dual users of cigarettes and one or more non-covered tobacco products?"

[§]Expert's estimates are the same as for the first year.

Tables F12. Dual Use Distribution in the First Year – Final Elicited Estimates of the Distribution of Dual Use in the First Year of the Potential Product Standard by Non-Covered Product Category*

Product Category	Expert							
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**
Males								
Premium Cigars	0	10	5	5	0	10	1	5
Waterpipe/ Hookah Tobacco	2	5	3	5	5	5	1	3
E-cigarettes	83	75	72	85	90	70	97	77
Smokeless Tobacco	15	10	20	5	5	15	1	15
Females								
Premium Cigars	0	5	1	5	0	5	1	1
Waterpipe/ Hookah Tobacco	2	5	3	8	5	5	1	3
E-cigarettes	98	85	91	85	94	85	97	95
Smokeless Tobacco	0	5	5	2	1	5	1	1

*Elicitation protocol asks to estimate separately for males and females "the percentage of new dual users of cigarettes and non-covered tobacco products who would initiate use of (1) premium cigars, (2) waterpipe/hookah tobacco, (3) e-cigarettes, and (4) smokeless tobacco during the year immediately following the potential product standard's implementation." As the protocol asks about the primary product used, it reminds the experts that the four values should sum to 100%.

Tables F13. Dual Use Distribution in Subsequent Years – Final Elicited Estimates of the Distribution of Dual Use in Subsequent Years by Non-Covered Product Category*

Product Category	Expert							
	A[§]	B	C[§]	D[§]	E[§]	F[§]	G[§]	H[§]
Males								
Premium Cigars	0	10	5	5	0	10	1	5
Waterpipe/ Hookah Tobacco	2	5	3	5	5	5	1	3
E-cigarettes	83	75	72	85	90	70	97	77
Smokeless Tobacco	15	10	20	5	5	15	1	15
Females								
Premium Cigars	0	10	1	5	0	5	1	1
Waterpipe/ Hookah Tobacco	2	5	3	8	5	5	1	3
E-cigarettes	98	80	91	85	94	85	97	95
Smokeless Tobacco	0	5	5	2	1	5	1	1

*Elicitation protocol asks to estimate separately for males and females "the percentage of new dual users of cigarettes and non-covered tobacco products who would initiate use of (1) premium cigars, (2) waterpipe/hookah tobacco, (3) e-cigarettes, and (4) smokeless tobacco each year following the first full year of the potential product standard's implementation." As the protocol asks about the primary product used, it reminds the experts that the four values should sum to 100%.

[§] Expert's estimates are the same as for the first year.

Table F14. Change in Initiation in the First Year – Final Elicited Estimates of the Percentage Change in Annual Cigarette Smoking Initiation Rates Caused by the Potential Product Standard in its First Year*

Value	Expert							
	A	B	C	D	E	F	G	H
Max	-99	-100	-60	-90	-95	-50	-36	-90
95th	-95	-80	-55	-80	-80	-45	-30	-85
75th	-80	-60	-52	-70	-70	-35	-26	-75
50th	-50	-50	-50	-50	-45	-30	-21	-70
25th	-10	-40	-20	-40	-25	-25	-14	-65
5th	-5	-20	-15	-35	-10	-15	-11	-55
Min	-1	-10	-10	-30	-5	-10	-7	-50

*Elicitation protocol asks "For the year immediately following the potential product standard's implementation, what is your estimate of the true percentage change in annual cigarette smoking initiation rates the potential product standard would cause, relative to baseline rates?"

Table F15. Change in Initiation in Subsequent Years – Final Elicited Estimates of the Percentage Change in Annual Cigarette Smoking Initiation Rates Caused by the Potential Product Standard During Subsequent Years*

Value	Expert							
	A[§]	B	C[§]	D[§]	E[§]	F[§]	G[§]	H[§]
Max	-99	-100	-60	-90	-95	-50	-36	-90
95th	-95	-90	-55	-80	-80	-45	-30	-85
75th	-80	-80	-52	-70	-70	-35	-26	-75
50th	-50	-75	-50	-50	-45	-30	-21	-70
25th	-10	-50	-20	-40	-25	-25	-14	-65
5th	-5	-40	-15	-35	-10	-15	-11	-55
Min	-1	-20	-10	-30	-5	-10	-7	-50

*Elicitation protocol asks "For the years following the first full year of the potential product standard's implementation, what is your estimate of the true percentage change in annual cigarette smoking initiation rates the potential product standard would cause, relative to baseline rates?"

[§]Expert's estimates are the same as for the first year.

Table F16. Initiation of Non-Covered Products in the First Year – Final Elicited Estimates of the Percentage of Those Deterred from Becoming Cigarette Smokers Who Would Instead Initiate Use of Non-Covered Tobacco Products in the First Year of the Potential Product Standard*

Value	Expert								
	A	B - MALES	B - FEMALES	C	D	E	F	G	H
Max	98	40	35	50	80	95	90	90	80
95th	95	35	30	45	70	80	80	88	75
75th	80	15	15	40	60	60	65	80	65
50th	25	12	10	30	40	35	45	70	45
25th	10	10	8	20	20	25	25	65	25
5th	5	8	5	10	15	15	15	60	15
Min	2	5	2	5	10	10	10	55	10

*Elicitation protocol asks "consider those who, in the year immediately following implementation, you believe the standard would deter from becoming cigarette smokers. What is your estimate of the true percentage of these individuals who, in that same year, would instead initiate use of one or more non-covered tobacco products?"
Note: Experts could provide separate estimates for males and females. Estimates by gender are only shown for experts who chose to provide separate estimates for males and females.

Table F17. Initiation of Non-Covered Products in Subsequent Years – Final Elicited Estimates of the Percentage of Those Deterred from Becoming Cigarette Smokers Who Would Instead Initiate Use of Non-Covered Tobacco Products During Subsequent Years*

Value	Expert							
	A	B	C[§]	D[§]	E[§]	F[§]	G[§]	H[§]
Max	98	40	50	80	95	90	90	80
95th	95	35	45	70	80	80	88	75
75th	80	15	40	60	60	65	80	65
50th	35	13	30	40	35	45	70	45
25th	10	10	20	20	25	25	65	25
5th	5	8	10	15	15	15	60	15
Min	2	5	5	10	10	10	55	10

*Elicitation protocol asks consider those who, in each year following the first full year of implementation, you believe the standard would deter from becoming cigarette smokers. What is your estimate of the true percentage of these individuals who, in the year they are deterred from becoming cigarette smokers, would instead initiate use of one or more non-covered tobacco products?"

[§]Expert's estimates are the same as for the first year.

Table F18. Final Elicited Estimates of the Distribution of Non-Covered Product Initiation in the First Year of the Potential Product Standard by Non-Covered Product Category*

Product Category	Expert							
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**
Males								
Premium Cigars	0	5	5	5	0	5	1	5
Waterpipe/	10	2	10	20	20	40	2	15
Hookah Tobacco								
E-cigarettes	75	83	65	70	70	40	95	65
Smokeless Tobacco	15	10	20	5	10	15	2	15
Females								
Premium Cigars	0	2	1	2	0	2	1	1
Waterpipe/	8	2	5	25	15	40	2	15
Hookah Tobacco								
E-cigarettes	92	93	92	70	84	50	95	83
Smokeless Tobacco	0	3	2	3	1	8	2	1

*Elicitation protocol says to "consider the population of never smokers who you believe would be deterred from initiating cigarette use in the year immediately following implementation of the potential product standard's implementation, but would instead, in that same year, initiate the use of non-covered tobacco products." Then asks to estimate separately for males and females "the percentage of this group who would initiate use of (1) premium cigars, (2) waterpipe/hookah tobacco, (3) e-cigarettes, and (4) smokeless tobacco." As the protocol asks about the primary product used, it reminds the experts that the four values should sum to 100%.

Table F19. Final Elicited Estimates of the Distribution of Non-Covered Product Initiation in the Subsequent Years by Non-Covered Product Category*

Product Category	Expert							
	A[§]	B	C[§]	D[§]	E[§]	F[§]	G[§]	H[§]
Males								
Premium Cigars	0	5	5	5	0	5	1	5
Waterpipe/	10	2	10	20	20	40	2	15
Hookah Tobacco								
E-cigarettes	75	90	65	70	70	40	95	65
Smokeless Tobacco	15	3	20	5	10	15	2	15
Females								
Premium Cigars	0	3	1	2	0	2	1	1
Waterpipe/	8	2	5	25	15	40	2	15
Hookah Tobacco								
E-cigarettes	92	95	92	70	84	50	95	83
Smokeless Tobacco	0	0	2	3	1	8	2	1

*Elicitation protocol says to "consider the population of never smokers who you believe would be deterred from initiating cigarette use in the years following the first full year of the potential product standard's implementation, but would instead, in the same year they are deterred from becoming cigarette smokers, initiate the use of non-covered tobacco products." Then asks to estimate separately for males and females "the percentage of this group who would initiate use of (1) premium cigars, (2) waterpipe/hookah tobacco, (3) e-cigarettes, and (4) smokeless tobacco." As the protocol asks about the primary product used, it reminds the experts that the four values should sum to 100%.

[§]Expert's estimates are the same as for the first year.

Figure F1. Percent of current cigarette smokers who quit smoking in the first year after the proposed standard (i) and subsequent years (ii)
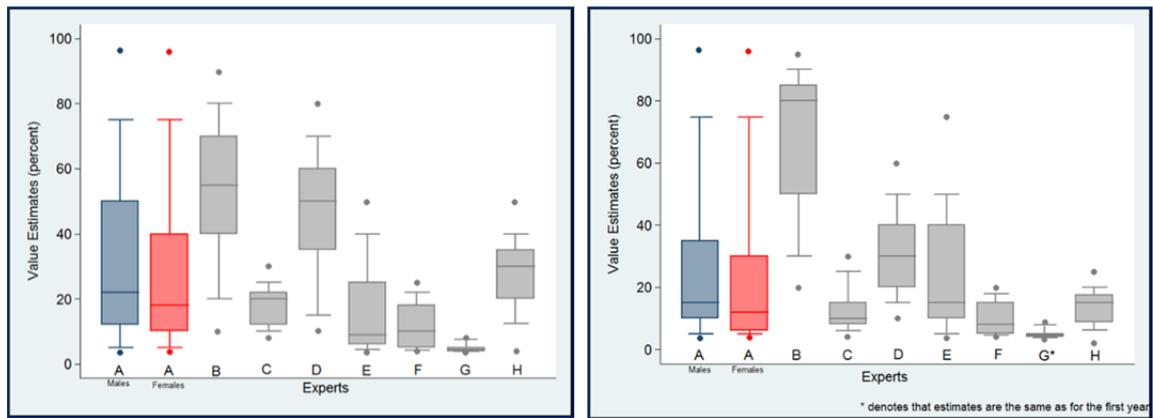

(i) First year   (ii) Subsequent years

Figure F2. Percent of quitters switching to (a) and continued smokers initiating (b) a non-covered product in the first year after the proposed standard (i) and subsequent years (ii)

(a) Switchers
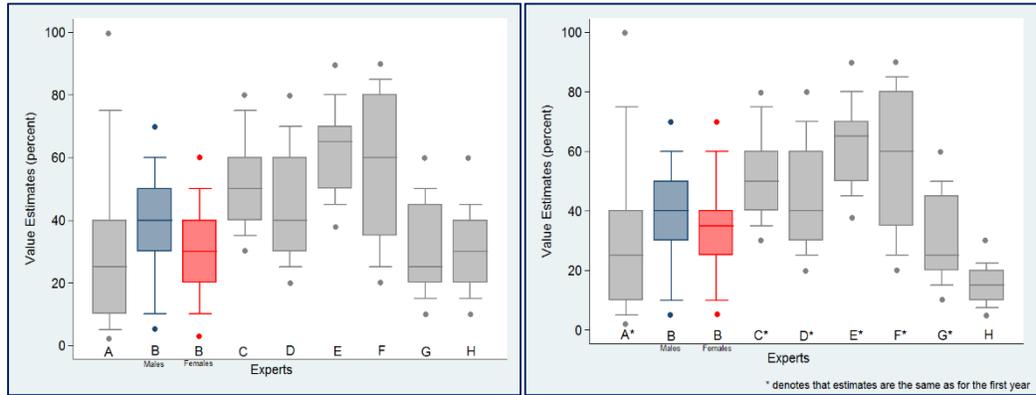
(b) Dual users
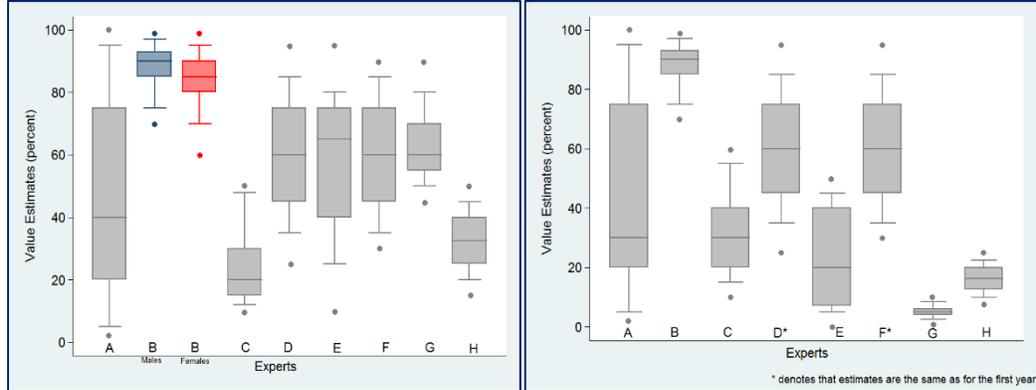
(i) First year   (ii) Subsequent years

Figure F3. Initiation

(a) Percent change in annual cigarette smoking initiation rates in the first year (i) and subsequent years (ii)

(b) Percent of dissuaded smoking initiates who initiate with non-covered tobacco products instead in the first year (i) and subsequent years (ii)

(a)

(b)

First year

(ii) Subsequent years

(i)
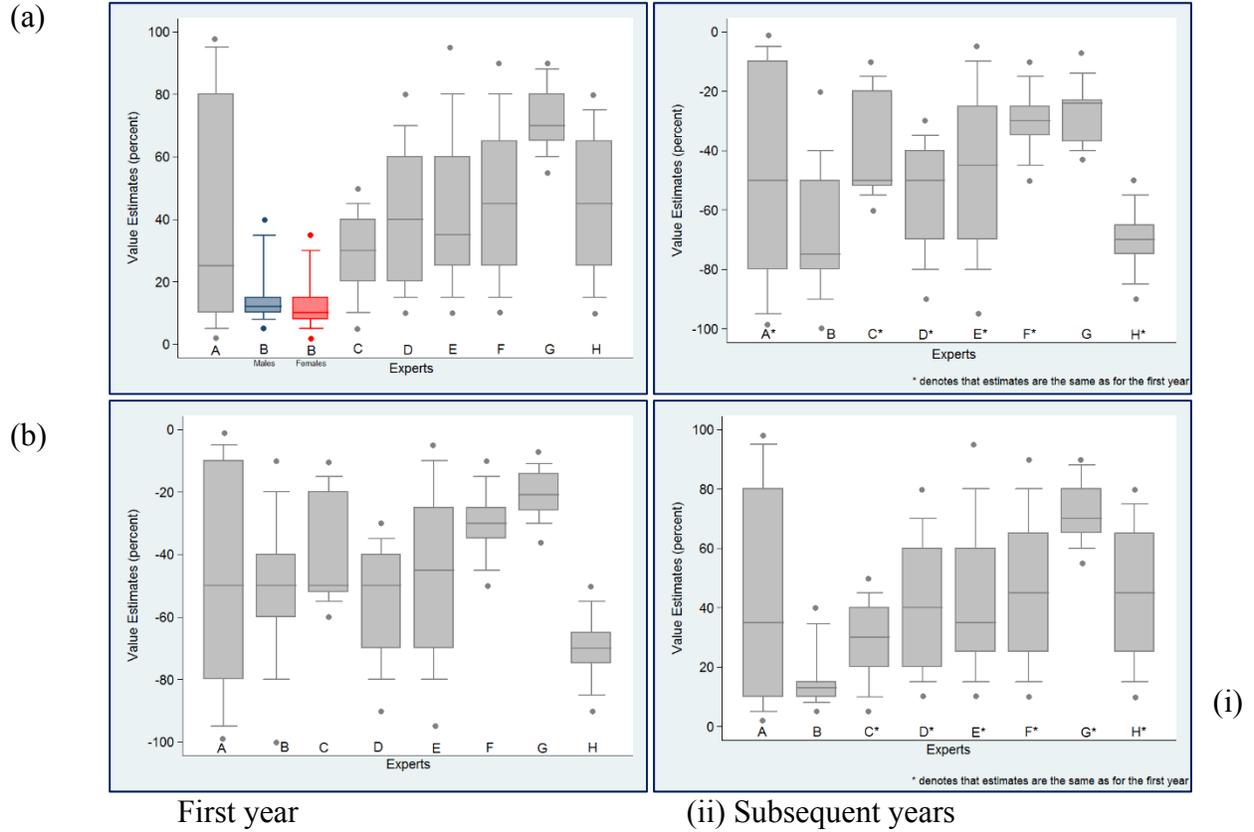
Appendix G: Estimation of Transition Probabilities under the Policy Scenario

In the policy scenario, the transition probabilities for 2015 through 2019 are identical to the ones in the baseline scenario. The following parameters were used to modify the transition probabilities under the policy scenario:

- α(t): fraction of current smokers who quit smoking as a result of the proposed standard divided by the population-weighted average of cessation rates for females and males, respectively, used in the model. Cessation rate estimates and population distribution at baseline are described in Appendix A);
- β(t): fraction of quitters switching to non-covered tobacco products;
- γ(t): fractions of continuing smokers who become duals users of cigarettes and one or more non-covered tobacco products;
- δ(t): fraction reduction in annual smoking initiation rates;
- ε(t): fraction of dissuaded smoking initiates who initiate with non-covered tobacco products.

From 2020, at each year of the simulation, transitions probabilities (denoted by letters a, b, …, p in Figure G1) are computed as follow:

$$a(t, pol) = (1 - \delta(t))\varepsilon(t)b(t, base) + (1 - \delta(t))e(t, base) + a(t, base)$$

$$b(t, pol) = \delta(t)b(t, base)$$

$$c(t, pol) = \delta(t)c(t, base)$$

$$d(t, pol) = d(t, base)$$

$$e(t, pol) = \delta(t)e(t, base)$$

$$f(t, pol) = \alpha^*(t)(1 - \beta(t)),$$
$$\text{where } \alpha^*(t) = \min\{\alpha(t)(f(t, base) + g(t, base)), 1\}$$

$$g(t, pol) = \alpha^*(t)\beta(t)$$

$$h(t, pol) = \delta(t)h(t, base)$$

$$i(t, pol) = \delta(t)i(t, base)$$

$$j(t, pol) = (1 - \alpha^*(t))\gamma(t)$$

$$k(t, pol) = k(t, base)$$

$$l(t, pol) = \begin{cases} \alpha^*(t)\big(1 - \beta(t)\big), & t = 2020 \\ \alpha^*(t), & t = 2021, \dots, 2100 \end{cases}$$

$$m(t, pol) = \big(1 - \alpha^*(t)\big)(p(t, base) + m(t, base))$$

$$n(t, pol) = \alpha^*(t)(1 - p(t, base) - m(t, base))$$

$$o(t, pol) = o(t, base)$$

$$p(t, pol) = \alpha^*(t)(p(t, base) + m(t, base))$$

$$prob(CF \rightarrow CC) = \begin{cases} (1 - \alpha^*(t))\gamma(t), & t = 2020 \\ 0, & t = 2021, \dots, 2100 \end{cases}$$

$$prob(CF \rightarrow FC) = \begin{cases} \alpha^*(t)\beta(t), & t = 2020 \\ 0, & t = 2021, \dots, 2100 \end{cases}$$
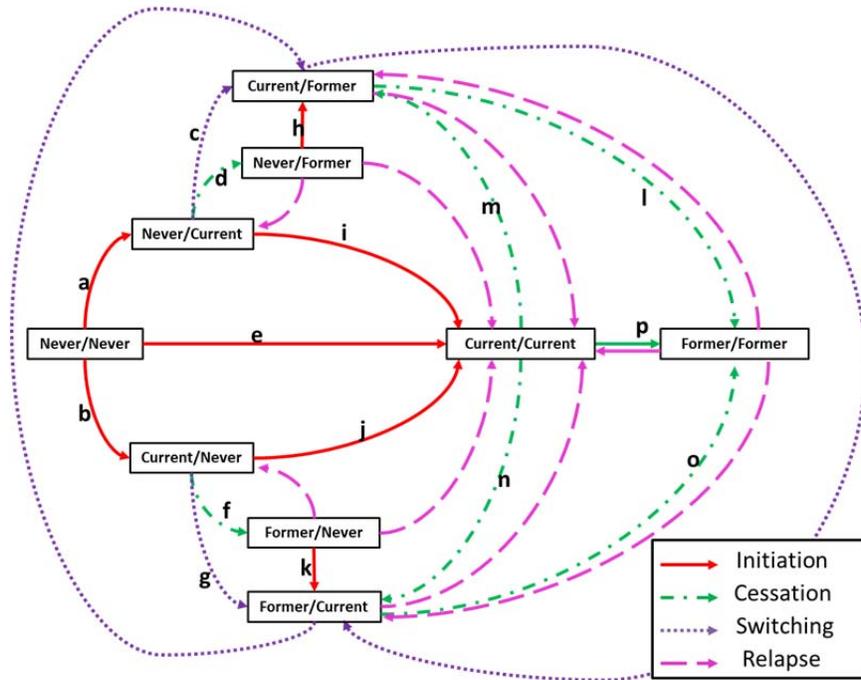
Figure G1: Two-product use states and transitions. Nine possible use states are represented as boxes in which the first and second terms correspond to use of cigarettes and non-combusted tobacco products, respectively.

Appendix H: Latin Hypercube Sampling

The outputs in our model are deterministic in nature. Given the uncertainty associated with projecting the impact of a future policy, we examined the impact of uncertainty around the input parameters derived from an expert elicitation (see Appendix F). These input parameters were used to estimate the impact of the policy on tobacco use behaviors, which, in turn, informed estimates related to deaths and life years saved.

Latin Hypercube Sampling (LHS)[29] is a sampling technique useful for uncertainty analysis when sampling from a collection of variables; in the current investigation the variables are the responses (input parameters) from each of the eight experts who participated in the expert elicitation (see Appendix F). LHS controls sampling from the distribution of each variable separately to ensure even coverage across the range of each of the variables. That is, LHS ensures that the entire range of each input parameter is covered in the sampling process. The main analysis presented in this manuscript was based on a LHS for the expert elicitation responses followed by a Monte Carlo (MC) simulation to run the policy scenario.

A LHS approach was used for each of the eight experts with a total of 1,000 simulations per expert. In LHS the range of each of the response variables is divided into 1,000 (the number of simulations) segments, with equal probability. From each of these segments a value is chosen at random. Once each of the variables is sampled with this process, the samples from each of the variables are randomly grouped to form the 1,000 input parameters associated with the expert's responses. This process was repeated for each of the eight experts leading to a total of 8,000 iterations of the model. The output from each of the 8,000 iterations was collected to form the output associated with the main analysis. The median of each output distribution was reported as the main estimate as well as the 5th and 95th percentiles as lower and upper bound estimates.

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