Understanding the Demand-Side of an Illegal Market: A Case Study of the Prohibition of Menthol Cigarettes

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Abstract

Economic research has long focused on illegal markets and the consequences of prohibitions. We provide a case study of the proposed prohibition of menthol cigarettes, which are smoked by almost 19 million people in the U.S. Illegal markets for menthol cigarettes could not only blunt the prohibition's intended consequence to reduce smoking but could also lead to unintended consequences. We use data from a discrete choice experiment. Our mixed logit model predicts a substantial potential consumer demand for illegal menthol cigarettes, especially if menthol e-cigarettes are also illegal.

I. Introduction

Economic research has long focused on illegal markets and the intended and unintended consequences of prohibitions (Becker, Grossman, and Murphy 2006). Recent economic research on prohibitions explores policy tradeoffs on various margins. Hansen, Miller, and Weber (2020) explore whether the partial lifting of the prohibition of marijuana in some U.S. states leads to a "race to legalization." Alpert, Powell, and Pacula (2018) explore whether the reformulation of a legally prescribed opioid product stimulated demand for illegal opioids. Another line of research explores partial prohibitions based on product riskiness, such as street versus brothel prostitution (Gertler and Shah 2011, Immordino and Russo 2015) or rifles versus handguns (Moshary, Drango, and Shapiro 2023).

In this paper, we provide a case study of the proposed prohibition of menthol cigarettes in the U.S. Menthol cigarettes are tobacco cigarettes to which natural menthol from mint or synthetic menthol has been added as a flavoring; menthol and non-menthol cigarettes have similar nicotine- and tar-content. Menthol is not risky per se, but public health policymakers argue that menthol might make it easier for youth to start smoking and harder for adult smokers to quit. Almost 19 million people in the U.S. currently smoke menthol cigarettes, and if they continue to smoke many of them will die from heart disease, lung cancer, or another smoking-related disease. Almost 85 percent of Black smokers use menthol cigarettes as their usual type, compared to 30 percent of white smokers. In April 2022 the U.S. Food and Drug Administration (FDA) published an official proposal in the Federal Register for "a tobacco product standard that would prohibit menthol as a characterizing flavor in cigarettes" (FDA 2022a).[1] The FDA

[1] The Final Rule, i.e. the finalized version of the proposal, has not yet been published. After several delays, the Spring 2024 Unified Agenda of Regulatory and Deregulatory Actions now lists the Final Rule under current long-term actions, with the date of publication to be determined. The Final Rule will become effective one year after its publication in the Federal Register.

describes the prohibition of menthol cigarettes as a targeted step to prevent youth from starting to smoke, help more current smokers quit, and address tobacco-related health disparities. However, illegal markets for menthol cigarettes could not only blunt the prohibition's intended consequence to reduce smoking but could also lead to unintended consequences including implications for racial justice (American Civil Liberties Union 2021).

We conducted an online discrete choice experiment (DCE) where adult menthol smokers made hypothetical choices between menthol and non-menthol cigarettes, menthol and non-menthol e-cigarettes, and attempting to quit. A novel feature of our DCE is that it presented subjects with choice tasks where menthol cigarettes and menthol e-cigarettes are described as either legal, prohibited but available under-the-counter and online from retailers who continue to sell them, or prohibited and strictly enforced and only available from illegal dealers. Our novel DCE allows us to estimate the impact of possible supply-sides of illegal menthol markets on consumers' choices. The menthol prohibition can achieve its intended consequences of improved health and reduced health disparities if menthol smokers switch to less harmful e-cigarettes or quit tobacco product use entirely. But to the extent we find that menthol smokers are willing to switch to non-menthol cigarettes or to illegal menthols, the prohibition's impact on public health and health disparities may be blunted.

We contribute new evidence on the likely impacts of the prohibition of menthol cigarettes. We estimate a mixed logit model which predicts that the prohibition of menthol cigarettes would substantially increase the fraction of menthol smokers who attempt to quit tobacco product use. However, our model also predicts a substantial potential consumer demand for illegal menthol cigarettes, especially if menthol e-cigarettes are also illegal. Although menthol e-cigarettes are currently widely available, the FDA has issued marketing denial orders

for all but one manufacturer's menthol e-cigarettes. Our estimated model predicts that, depending on the impact of illegality on product prices, the potential demand-side of an illegal market for menthol cigarettes could be 59-92 percent the size of the status quo market if menthol e-cigarettes are legal, and 69-100 percent the size of the status quo market if menthol e-cigarettes are also illegal. In sub-group analysis the results hold for Black and non-Black subjects. If the illegal supply-side response meets most of the illegal demand, the predicted equilibrium market share of illegal menthol cigarettes could be a substantial fraction of the status quo.

Discrete choice experiments are commonly used in marketing research and economics to provide predictions of consumer demand in scenarios that are not yet observed in actual markets, as is the case with the proposed national prohibition of menthol cigarettes.[2] There is a broad consensus that stated preference (SP) data collected through discrete choice experiments and the related contingent valuation method can provide valuable information (Carson 2014).[3] In a narrative review of discrete choice experiments, McFadden (2017) concludes that: "Forecasts that are comparable in accuracy to [revealed preference] forecasts can be obtained from well-designed SP studies for familiar, relatively simple goods that are similar to market goods purchased by consumers…." Penn and Hu (2018) report a meta-analysis that provides quantitative evidence consistent with McFadden's (2017) conclusion that SP data are more reliable for familiar market goods. Our discrete choice experiment asked smokers to make choices about tobacco products which are mainly similar to the real-world purchases they make on a weekly or even more frequent basis. The descriptions of possible sources of illegal products

[2] In economics, for example, Kesternich, Heiss, McFadden, and Winter (2012) report a discrete choice experiment about consumers' decisions to purchase Medicare Part D insurance plans, which was conducted before Part D plans were on the market. Moshary, Drango, and Shapiro (2023) use data from a discrete choice experiment about consumers' choices to purchase firearms to study alternative counter-factual firearm regulations.

[3] The Online Appendix includes more discussion of research on the external validity of predictions from DCEs. The Online Appendix also presents the results of validity checks on the quality of our SP data.

were also designed to correspond to real-world illegal cigarette markets that are active in some U.S. cities.

Although there are limitations to the stated preference approach, given the gaps in the existing research base discussed in sections II and III, we believe the results from our study make a valuable contribution to predict the results of a U.S. nationwide prohibition of menthol cigarettes. We use our results to conduct a prospective analysis that predicts the effects of a public policy in a new environment, the type of analysis that Heckman and Vytacil (2005) describe as one of the central tasks of empirical economics. Our prospective analysis also parallels the prospective regulatory impact analysis that the FDA is required to conduct.[4] Our use of a novel discrete choice experiment to collect stated preferences over illegal choices contributes a case study and uses a research method that could be used to study the economics of both the starts and ends of prohibitions more generally in health economics.

This paper proceeds as follows. Sections II and III provide background and discuss previous research on menthol cigarettes prohibitions and on illegal cigarette markets. Section IV discusses our discrete choice experiment and the resulting sample. Section V presents the empirical model, results, and model predictions of the potential demand for illegal menthol cigarettes. Section VI combines our estimates of the potential demand-side with assumptions about the supply-side to develop a range of predicted illegal market equilibria. Section VII provides a concluding discussion of the policy implications and directions for future work.

[4] We included results from our preliminary analysis of the DCE data in a public comment submitted to the FDA on the proposed rule to prohibit menthol cigarettes. The comment is available online. [Link not listed to maintain author confidentiality during review process.]

II. Background on Menthol Cigarette Prohibitions

Menthol cigarettes are currently prohibited in Canada, Ethiopia, Great Britain, and the European Union, and in two states and 190 localities in the U.S. (Mills et al. 2024, Campaign for Tobacco Free Kids 2024).[5] At the federal level in the U.S., the 2009 Tobacco Control Act established the FDA's regulatory authority over tobacco products and directed the FDA to study the impact of menthol cigarettes on public health. After completing several studies, in May 2022 the FDA proposed a national prohibition of menthol cigarettes. The FDA also proposed a national prohibition of menthol and other flavors in cigars. The prohibitions are scheduled as current long-term regulatory actions with the date of publication to be determined; they will become effective one year after publication of the final versions of the proposals. E-cigarettes are not included in these prohibitions. Instead, the FDA regulates flavors of e-cigarettes through a process where manufacturers submit pre-market tobacco applications. After scientific review, the FDA either grants or denies the application. To date, the FDA has only issued marketing granted orders for tobacco-flavored e-cigarettes and one manufacturer's menthol-flavored e-cigarettes. The FDA has issued multiple marketing denial orders (MDOs) for other manufacturers' menthol- and other-flavored e-cigarettes, but a legal challenge to some MDOs is being considered by the U.S. Supreme Court. Five U.S. states and over 375 localities restrict the availability of menthol and other flavors in e-cigarettes, although not all localities' restrictions are complete prohibitions (Campaign for Tobacco Free Kids 2024).

A long line of economic research estimates the effects of tobacco regulations including taxes, restrictions on advertising, and prohibitions of smoking in public places (DeCicca, Kenkel,

[5] In our analysis sample of 639 subjects, we are able to identify 44 (7.3 percent) who lived in a state or locality where menthol cigarettes were already banned at the time of our survey. The results reported below are not sensitive when we drop these subjects from the sample (Online Appendix Tables A6 and A7).

and Lovenheim 2022). However, economic research on the effects of menthol prohibitions is much more limited. Carpenter and Nguyen (2021) estimate difference-in-difference models of the menthol prohibitions enacted in some Canadian provinces prior to Canada's national prohibition. They estimate that the prohibitions did not decrease overall smoking rates. Carpenter and Nguyen (2021) also find evidence that among adult smokers, the prohibitions increased purchases on First Nations reserves, where menthol cigarettes remained legally available for First Nations' peoples but were illegal for non-First Nations customers.

Goli, Mummalaneni, and Chintagunta (2024) estimate difference-in-difference and synthetic control models of the state-wide menthol prohibition enacted in Massachusetts in 2020. Using retailer sales data, they find evidence that the prohibition shifted some demand to non-menthol cigarettes, while about half of the pre-prohibition menthol demand was shifted to neighboring states. From their difference-in-difference and synthetic control models, Goli et al. (2024) estimate that the statewide prohibition did not decrease overall cigarette demand in Massachusetts. They also estimate a structural model which predicts that a national menthol prohibition would be more effective than the statewide prohibition. The assumptions in their model-based simulation are equivalent to assuming that the national prohibition is complete so that menthol cigarettes are not available from illegal markets or any other sources.

In its preliminary regulatory impact analysis of the proposed prohibition of menthol cigarettes, the FDA (2022b) relies on public health research. Carpenter and Nguyen (2021) point out that most public health research on the prohibition of menthol cigarettes in Canada and the E.U. does not use quasi-experimental methods required for causal inference.[6] In addition to the lack of quasi-experimental methods, public health research findings on prohibitions in Canada,

[6] The Online Appendix discusses a review of the large body of public health research on menthol prohibitions.

the E.U., and Great Britain might not generalize to U.S. illegal markets for menthol.[7] The pre-prohibition menthol market shares in Canada, the E.U., and Great Britain were lower than the U.S. menthol market share and far lower than the 85 percent menthol share among U.S. Black smokers. As a result, Canadian, E.U., and British illegal menthol markets may be thin, with their size limited by high prices and high transactions costs (Jacobson 2004, Cook et al. 2007, Cutler and Donohoe 2024). Moreover, the high market share of menthol cigarettes among U.S. Black smokers raises unique issues for racial disparities and racial justice. The racial justice concerns about unequal enforcement of a menthol prohibition are especially salient in light of the death of Eric Garner who was killed by police in an attempt to arrest him for selling illegal single cigarettes (American Civil Liberties Union 2021).

Public health research on state and local menthol prohibitions in the U.S. provides very limited evidence about the potential for illegal menthol markets. Mills et al. (2024) reports the results of a systematic review and meta-analysis of public health research on menthol prohibitions. Out of 68 studies covered in the narrative systematic review, three are U.S. studies of real-world tobacco use behaviors and 10 are U.S. studies of hypothesized behaviors after a menthol prohibition (Mills et al. 2024 references 26, 28, and 68 study real-world behaviors and references 31-40 study hypothesized behaviors). The three studies of real-world behaviors conduct before-and-after analysis of small samples of special populations in Boston and San Francisco (menthol smokers sample size N = 14 in reference 26, N = 81 in reference 28, and N = 120 in reference 68). In six of the ten studies of hypothesized behaviors, respondents were not

[7] Studies of the E.U. and Great Britain prohibitions also might not generalize to the U.S. because they are more limited than the FDA proposal. The E.U. and British prohibitions allow for the sale of menthol flavored tobacco products like cigars and heated tobacco products, as well as the sale of menthol-flavored filters, cards and sprays (Brink et al 2022, Hiscock 2020). Buss, Brown, Tattan-Birch et al. (2024) find evidence that with menthol accessories still legal, after menthol prohibition some menthol smokers in Great Britain shifted away from factory-made cigarettes to roll-your-own cigarettes. The proposed FDA prohibitions will apply to cigars and menthol accessories.

given the opportunity to indicate that they would try to continue using menthol cigarettes after a prohibition. Almost all the studies of hypothesized impacts asked about smokers' intentions in the event of a menthol prohibition, sometimes with qualifications such as asking what respondents "might" do or "most likely" would do. In contrast, discrete choice experiments like we report below are designed to create a hypothetical but realistic market and ask consumers about their choices in such a market.

Two studies included in the Mills et al. (2024) systematic review use data from discrete choice experiments to predict the impact of a menthol prohibition in the U.S.: Buckell, Marti, and Sindelar (2019) and Buckell et al. (2023). However, the choice sets in these experiments did not include an alternative corresponding to an illegal purchase. Like Goli et al. (2024), both studies use a model-based approach to simulate the impact of a menthol prohibition, which is equivalent to assuming that the menthol prohibition is complete, and menthol cigarettes are not available from illegal markets.

Given the limited evidence base on menthol prohibitions in the U.S., for its quantitative estimates the FDA's preliminary regulatory impact analysis uses the results of an expert elicitation in which 11 experts were asked to predict the impacts of a menthol prohibition (Levy et al. 2021). The FDA recognized that its analysis of illegal markets was not definitive and requested "comment, including data and additional studies, on this discussion of illicit trade [and] the expert elicitation estimates" that were used in its analysis (FDA 2022b, pp. 213-214). The DCE results reported below contribute to the evidence base on the potential for illegal menthol markets after a national prohibition in the U.S.

III. Background on Illegal Cigarette Markets

Although not much is known about illegal menthol markets, several lines of research explore illegal tobacco markets that have arisen mainly to avoid cigarette taxes. The World Bank (2019) cites a consensus estimate that illegal trade accounts for 10 percent of global cigarette consumption. A National Academy of Sciences study reviews estimates from multiple methods and concludes that illicit cigarettes sales accounted for between 8.5 percent and 21 percent of the total U.S. cigarette market (National Research Council 2015). The study reports wide variation across states and estimates that 45 percent of cigarettes consumed in the high-tax state of New York in 2010-11 were subject to tax avoidance and evasion. Cigarette tax avoidance occurs when smokers in high-tax states legally purchase cigarettes for their own consumption from lower-tax states or from Native American reservations where state taxes are not collected (Lovenheim 2008; DeCicca, Kenkel, and Liu 2013, 2015; Bishop 2018). Cigarette tax evasion occurs when cigarettes are illegally produced or when legally produced cigarettes are illegally diverted at a later point in the supply chain. Because a national menthol prohibition could not be avoided by consumer cross-state purchases, the extent of cigarette tax evasion is most relevant to predict the impact of a national prohibition.

Although illegal tax evasion is inherently difficult to study, a body of evidence suggests that there are active illegal cigarette markets (tax evasion) in large U.S. cities. One set of studies examine whether discarded cigarette packs have the appropriate tax stamps; this is one of the methods reviewed by the National Research Council (2015). Samples of discarded packs might not be representative of the purchases of the entire smoking population, but they help document the existence of substantial illegal wholesale and retail activity. Merriman (2010) finds that 75 percent of littered cigarettes in Chicago did not have the required Chicago tax stamp. Kurti, von Lampe, and Johnson (2014) study the impact of a change in New York tax law that affected the

availability of untaxed brand-name cigarettes on Native American reservations. Before the tax law change, 42 percent of discarded cigarettes had no tax stamp, which indicates that their likely origin was from reservations. After the tax law change, the share of discarded packs with no tax stamps dropped dramatically while the share with tax stamps from lower-tax states – mainly Virgina – increased from 18 percent to 66 percent. Kurti et al. (2014) suggest that illegal cigarette wholesalers quickly adapted to the new tax law and shifted to another supply. Davis, Grimshaw, Merriman et al. (2014) report results from collecting discarded packs in Boston, New York City, Philadelphia, Providence, and Washington DC. In the pooled data for the five cities, 59 percent of discarded packs did not have the required local tax stamp. Davis et al. assumes that all packs from non-border states or with no stamp were supplied by illegal wholesalers, while some of the discarded packs with stamps from border states reflect legal tax avoidance by consumers. Based on these assumptions, they conclude that between 30.5 percent and 42 percent of discarded packs were supplied by illegal wholesalers. A recent study collected discarded packs in California in May and June 2023, about 6 months after the state's prohibition of menthol sales (WSPM Group, 2023). About 14 percent of all discarded packs were menthols, almost none of which had a California tax stamp. Under the same assumptions used by Davis et al. (2014), the results imply that at least 47 percent of discarded menthol packs were supplied by illegal wholesalers, while the rest might reflect tax avoidance through legal consumer cross-border purchases.

In addition to discarded pack studies, several other lines of evidence help document the existence of illegal cigarette markets. Prieger (2022) reports novel data from an online survey that asked almost 5,000 California smokers about their cigarette purchasing behavior. The survey was conducted in March 2017; prices and taxes had been stable in California since 2009. The

survey used indirect survey techniques to reduce bias in self-reports of potentially sensitive topics. Between 24 to 32 percent of respondents reported that they thought they might have purchased untaxed cigarettes in the past month and 20 percent thought they might have purchase counterfeit cigarettes.

Qualitative ethnographic researchers have also collected in-depth data on attitudes towards illegal cigarette markets in small samples of subjects. Shelly, Cantrell, Moon-Howard et al. (2007) report the results of focus groups conducted in May 2003 (shortly after a cigarette tax increase) with 104 residents of Harlem, a predominantly Black low-income community in New York City. Focus group participants used the term "$5 man" to describe a highly visible network of illegal dealers who sold cigarettes in public places such as street corners and near subway entrances. Most smokers in the focus groups stated that they had made purchases from the $5 man to avoid paying higher prices at stores. However, subsequent ethnographic research in the South Bronx neighborhood of New York City describes consumer attitudes favoring under-the-counter purchases from retailers like bodegas over purchases from illegal dealers on the street (von Lampe et al., 2016). By one recent estimate, there are about 8,000 illegal smoke shops selling tobacco and cannabis products in New York City (New York City Council 2023).

Although there is evidence of active networks of illegal cigarette wholesalers and retailers, a separate question is how these networks would be supplied with menthol cigarettes after a national prohibition. Because a national prohibition of menthol could not be evaded by cross-U.S.-jurisdiction purchases, in its preliminary regulatory impact analysis the FDA (2022b, p. 212) concluded that that the impact of menthol prohibition on the illicit cigarette market "would not be significant." However, other sources of supply include illegal production of cigarettes including counterfeits, diversion into illegal markets of in-transit cigarettes legally

produced for export, and illegal imports (smuggling) (National Research Council 2015, pp. 33-42). A report by the U.S. Governmental Accountability Office (GAO) provides examples where law enforcement has intercepted each of these schemes and quotes officials who describe enforcement as "like a whack-a-mole problem" where law enforcement success is short-lived as illegal markets shift to new sources of supply (GAO 2011, p. 19).

Cross-country smuggling might be the most likely source of supply of illegal menthol cigarettes after a national prohibition. In many countries other than the U.S., illegal cigarettes are often sourced from cross-country smuggling (Chaloupka et al 2015). For example, in Australia, which has very high cigarette taxes, large overseas shipments of smuggled cigarettes supply the illegal markets (Lauchs and Kearns 2017). The U.S. also has a long history of illegal cross-country smuggling of other prohibited substances including cannabis, cocaine, heroin, and longer ago, alcohol during Prohibition.[8] Currently, from the 2022 National Survey on Drug Use and Health, there were an estimated 70 million past-year users of illicit drugs, including 62 million past-year users of marijuana, which is illegal at the federal level but legal for recreational use in some states.[9] Other than marijuana, illegal drug use includes: 5 million users of cocaine; 8.5 million users of hallucinogens; 2.7 million users of methamphetamine; and 9 million users of opioids. Cross-country smuggling plays a large role as the source of supply for the illegal markets in these drugs.

In the study below we provide evidence on the potential demand-side of illegal markets for menthol cigarettes, but we do not study the illegal supply-side. The evidence reviewed in this

[8] Interestingly, during the 1917 Senate debate, supporters of Prohibition argued that federal enforcement of the nationwide Prohibition would prevent cross-state smuggling of alcoholic beverages from "wet" states into "dry" states (Congressional Research Service 2023, p. 2).
[9] 2022 National Survey of Drug Use and Health Detailed Tables. https://www.samhsa.gov/data/sites/default/files/reports/rpt42728/NSDUHDetailedTabs2022/NSDUHDetailedTabs2022/NSDUHDetTabsSect1pe2022.htm. Accessed 1/19/2024.

section suggests that in large cities where high taxes create significant demand-side incentives, illegal wholesalers and retailers create a substantial supply-side that leads to market equilibria where many smokers obtain their cigarettes illegally. In Section VI below we combine our estimates of the potential demand-side with assumptions about the supply-side to develop a range of predicted illegal market equilibrium outcomes.

IV. Data

The data are from an online discrete choice experiment (DCE) conducted in April 2022 which we designed to evaluate the impact of the prohibition of menthol cigarettes. Subjects were presented with four product choice options – non-menthol and menthol cigarettes and e-cigarettes – and a fifth option "I will quit smoking cigarettes and not use e-cigarettes." The product attributes of prices and legality were experimentally varied across three levels: a 3 (non-menthol cigarette price) by 3 (menthol cigarette price) by 3 (non-menthol e-cigarette price) by 3 (menthol e-cigarette price) by 3 (menthol cigarette legality conditions) by 3 (menthol e-cigarette legality conditions) experimental design, for a total of 729 possible combinations. Because 729 choice tasks would be too demanding, each subject was presented with 12 choice tasks. Each subject was assigned to one of 12 different blocks (sets) of 12 choice tasks. Within each block, the order of choice tasks was randomized. Because some choice tasks were repeated across blocks, across all subjects the DCE presented 108 (instead of 12 x 12 = 144) of the 729 possibilities. The assignment of choice tasks to subjects was designed to maximize statistical efficiency to identify the parameters of interest, i.e. the main effects of prices and the legality conditions on choices. Because the DCE uses a fractional factorial design instead of the full factorial of 729 combinations, not all possible interactions of the experimentally varied attributes are identified in the data.

The design follows good practice guidelines for DCEs (Johnson et al. 2013). Across all subjects, the experimental design is balanced so that each level within an attribute appears an equal number of times. However, balance does not hold within individual blocks. The design is not strictly orthogonal but does not lead to severe multicollinearity of the un-interacted main effects. The final design was tested for D-efficiency and acceptably low standard errors.[10] The target sample size of at least 600 subjects was chosen to provide sufficient statistical power to precisely estimate the main effects, keeping in mind the fact that with 12 choice tasks each subject contributes 12 observations.[11]

In the DCE, after introductory material that sets the context, subjects are presented with one of the possible choice sets and were asked to make two choices. First, each subject is asked about their choice today. After the choice for today is made, the scenario reappears, and the subject is asked which choice they would make 6 months from now. This process is repeated 12 times (with different combinations of product attributes), so that we collect 24 choices per subject. This study is limited to the 12 responses about choices today. Figure 1 shows the introductory material and an example of a DCE choice task.

The survey firm SSRS conducted our online survey.[12] SSRS recruited subjects from their Probability Panel and screened on eligibility for our experiment based on age, current smoker

[10] The survey firm SSRS used commercially available software (Sawtooth) to design the DCE, with input from the authors.

[11] Johnson et al. (2013) discuss a study of simulated sample sizes on estimate precision for three DCE studies. For the three studies, precision increases flattened out at around 300 subjects. For robustness, after we present the mixed logit results (Table 2), we also present reduced-form linear probability models of subjects' choices (Table 4). The precision of the estimated main effects is transparent in the linear probability model results.

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

status, and menthol use. We required respondents to be over the age of 18, to have smoked 100 or more cigarettes in their life, to currently smoke either daily or some days, and to usually smoke menthol cigarettes. 673 adult smokers completed our DCE. After dropping subjects with extreme values of the reported price they last paid for 20 cigarettes (less than $1.00 or more than $20.00 per pack),[13] our sample of analysis consists of 639 subjects, each of whom contributes 12 choice outcomes for a total of 7,668 observations of choices.

We designed our DCE to explore several possible supply sources for illegal menthol cigarettes and e-cigarettes. Our DCE included three levels of the legality condition: legal, prohibited but still available from retailers under-the counter or online, or prohibited and strictly enforced availability only from illegal dealers, e.g. street sellers. For convenience we will refer to the legal availability conditions as: legal, illegal retail market, and illegal street market. We distinguish between the illegal retail market and the illegal street market based on ethnographic research findings that consumers dislike making purchases from illegal dealers on the street (von Lampe et al. 2016).

The DCE introductory material explained that FDA enforcement of a menthol prohibition will address manufacturers and retailers, and that the FDA cannot and will not enforce against individual consumer possession or use of menthol cigarettes or any other tobacco product.[14] The description of FDA enforcement, as well as the online nature of the DCE, may reduce social desirability bias where subjects might be reluctant to state preferences for illegal choices

[13] To determine last price paid the survey first asked: "The last time you purchased cigarettes, did you buy your cigarettes by the pack, the carton, did you roll your own, or as individual cigarettes in amounts less than 20?" The survey then asks the price paid for the quantity purchased. We normalize the reported price to the price paid for 20 cigarettes (a pack). In the U.S., cartons of cigarettes contain 10 packs. For those that role their own, the survey asked about the price/cost of rolling 20 cigarettes. For those purchasing individual cigarettes, the survey asked what they paid and how many individual cigarettes they purchased and normalized to the price paid for 20 cigarettes. The vast majority of the sample purchased either packs or cartons.

[14] This wording is taken verbatim from the discussion of enforcement in the FDA's preliminary regulatory impact analysis (FDA 2022b).

(Stancheva 2022). Still, the potential for under-reporting of preferences for illegal menthol products should be kept in mind as a possible limitation of our data.

In our DCE we also varied the levels of product prices to explore different possible supply-sides of illegal markets for menthol products. Illegality adds costs to the supply chain of illegal products and tends to raise prices (Miron 2003). But because cigarettes are subject to local, state, and federal excise taxes, in some jurisdictions the price of untaxed illegal cigarettes might still be lower than the price of taxed legal cigarettes. For example, in New York City the price of legal cigarettes includes $1.50 local tax, $4.35 state tax, and $1.01 federal tax per pack, which together account for almost 50 percent of the average retail price. In other, lower-tax, jurisdictions, the extra supply-chain costs of illegal cigarettes might more than offset the tax savings. An FDA white paper discusses evidence on the impact of illegality on cigarette prices, including an example from Statistics Canada where prices for illegal cigarettes are thirty percent of legal prices (FDA 2018). The FDA white paper concludes that depending on the context surrounding the illegal market, it is difficult to estimate if the expected price level will be higher or lower than the current market price.

Our DCE included three levels of cigarette prices: the price the subject reported paying for their last pack of cigarettes, half that price, or twice that price. E-cigarette price levels could not be set based on the price the subject paid, because many subjects had not previously purchased e-cigarettes. Based on then-current market prices, the experimental e-cigarette price conditions were $2, $4, or $8 for a pack-equivalent e-cigarette.

The DCE was part of a survey that consisted of three sections. The first section included questions focused on their cigarette, e-cigarette, and other tobacco products' consumption habits including frequency of consumption, history of menthol use, location of purchase, previous quit

attempts, their intention to quit in the next 6 months and methods they intend to use to quit. As discussed above, questions were also asked which enabled us to compute the price they last paid for cigarettes. The second section of the survey consisted of presentation of the 12 choice tasks in the DCE. The third section of the survey included follow-up questions that were asked after the DCE to avoid influencing stated preferences. The third section included questions about subjects' knowledge about the proposed prohibition of menthol and their perceptions of its impact. Table A1 in the Online Appendix provides descriptive statistics.

V. Empirical Model and Results

Empirical Model

We use our DCE data to estimate a random coefficients mixed logit model of consumer tobacco product choices. Mixed logit is a highly flexible model that allows individual heterogeneity to interact with product characteristics. It relaxes the independence of irrelevant alternatives assumption of McFadden's conditional logit model. Our mixed logit model is based on a random utility model, where individual i's indirect utility from product j at time (choice task) t is linear and additively separable in an alternative specific constant (ASC), the tobacco product's price, and the legal availability of the tobacco product:

$$\boldsymbol{U_{ijt} = ASC_{ijt} + \alpha_i p_{ijt} + \beta_i' Legal\ Availability_{ijt} + \epsilon_{ijt}}$$

The ASCs capture the baseline utility from each tobacco product or the alternative of quitting; the ASC for the alternative of attempting to quit is the omitted category. The ASCs are identified by subjects' choices between the alternatives under the baseline conditions for the attributes and as a result tend to correspond to the choice shares in the data.[15] The ASCs are

[15] If an attribute level has a very strong impact on utility, it can offset the baseline utility captured by the ASCs.

assumed to have normal distributions. The negative of coefficients α_i and β_i are assumed to have lognormal distributions, which restricts the signs of the effects of these attributes on consumer utility. The variables measuring cigarette and e-cigarette prices are linearized versions of the experimentally assigned price levels. Legal availability takes three levels: legal, illegal retail market, and illegal street market. Legal is the omitted baseline category. The model includes four indicators for two illegality levels for both menthol cigarettes and menthol e-cigarettes.

As noted above, the experimental variation across assigned choice tasks in the DCE identifies the main effects of the price and legality attributes – i.e. the coefficients α and β – but not all possible interactions. Fox, Kim, Ryan, and Bajari (2014) show that the distribution of the random coefficients is nonparametrically identified by variation in the product attributes. Because identification does not rely on commonly used distributional assumptions such as normality, Fox et al. (2014) argue that their results provide "a solid econometric foundation" for the widespread use of the mixed logit model in empirical work. However, the mixed logit model estimation of the utility function imposes structure. To explore its robustness, after we present the mixed logit model results and predictions, we present and discuss the results of reduced-form linear probability models of subjects' choices.

Mixed Logit Results and Benchmarks

Table 1 presents the estimated mixed logit model of consumer tobacco product choices, including the mean and standard deviation of the distributions for each of the estimated random coefficients of the model. The reported coefficients are transformed such that they are directly interpretable as the impact on consumer utility, and the standard errors are also transformed using the Delta method. The sizes of the mean ASCs show that in our sample of menthol smokers, the most preferred option is menthol cigarettes, followed by menthol e-cigarettes,

attempting to quit (the omitted alternative), non-menthol cigarettes, and tobacco-flavored e-cigarettes. As expected, the mean of the price coefficient is negative. The means of the legality condition coefficients show consumer disutility from the illegality of tobacco products; more strict illegal street markets impose more disutility; illegal markets for menthol cigarettes and menthol e-cigarettes impose similar levels of disutility.

We use the estimated mixed logit model to predict consumer choices under the status quo market conditions and various policy scenarios. Table 2 presents the predicted market shares, i.e., the fraction of subjects who choose each tobacco product or choose to attempt to quit under the conditions described.

Before turning to the policy scenario predictions, to shed light on the model's performance we compare our model's predictions in rows 1 – 5 of Table 2 to results from observational data. The first benchmark is to compare the model's predictions under status quo conditions (row 1) to the moments of observational data from the background survey. The model predictions and the observational data show a broadly similar mix of smoking, vaping, and quit attempts. The model predicts that under status quo conditions 52 percent of subjects will choose menthol or non-menthol cigarettes (row 1, Table 2). In the observational data, 58 percent are daily smokers (Online Appendix Table A1). The model predicts that most cigarette choices will be menthol with a small share of non-menthol. In the observational data all subjects usually smoke menthol cigarettes, but 13 percent report having smoked non-menthol half or more than half of the years they smoked. The model predicts that 32 percent will choose menthol or tobacco-flavored e-cigarettes. E-cigarette use is also common in the observational data; in the past 30 days, 11 percent vaped daily and another 40 percent vaped on some days. The model

predicts that16 percent will attempt to quit both cigarettes and e-cigarettes. In the observational data, 51 percent of the sample report having attempted to quit smoking in the past 12 months.

The observational data do not measure the frequencies of cigarette and e-cigarette purchases, which would be more directly comparable to the DCE data. If we make the additional assumption that the frequency of purchases is proportional to the number of days of use, the observational data imply that e-cigarette choices occur 29 percent as often as cigarette choices. By comparison, in the model's status quo predictions in row 1 of Table 2, e-cigarette choices are about 61 percent as frequent as cigarette choices. Our model, thus, appears to over-predict e-cigarette choices. The predicted 16 percent share of quit attempts under status quo conditions also appears to be inflated. The immediate choice in the DCE corresponds to the subject's next tobacco product choices, which will often be within a week. In data from the Population Assessment of Tobacco and Health, 7 percent of smokers plan to quit using tobacco products for good within the next seven days.[16]

For the next set of benchmarks, in rows 2 – 5 Table 2 presents the predicted effects of changing product prices under the status quo condition where menthol cigarettes and menthol e-cigarettes are legal. The Table 2 results from the mixed logit model and the Table 4 linear probability model results discussed below show that the DCE subjects' choices respond to price incentives as predicted by basic economics. We can also compare the magnitude of the price-responsiveness to other studies' estimated price-elasticities from observational data. The comparison of scenario 2 with the status quo scenario 1 allows us to calculate the own-price arc-elasticity along the menthol cigarette demand curve from the average price to 50 percent lower than the average price; the comparison of scenario 3 with scenario 1 allows us to calculate the

[16] Authors' calculations.

arc-elasticity along the demand curve from the average price to 50 percent higher than the average price. Comparing scenarios 4 and 5 to the status quo scenario 1 allows us to calculate the corresponding own-price arc-elasticities along the menthol e-cigarette demand curve. Calculated this way, the predictions in Table 2 imply that the own-price arc-elasticities of menthol cigarette choices are -0.45 for a price increase and -0.31 for a price decrease. These elasticities are within or slightly below the consensus range of cigarette demand price-elasticity estimates from econometric studies of observational data.[17] The own-price arc-elasticities of menthol e-cigarette choices are -0.44 for a price increase and -0.28 for a price decrease. Research on e-cigarette demand is limited; these elasticities are smaller (in absolute value) than two recent econometric estimates of -1.32 (Allcott and Rafkin, 2020) and -2.20 (Cotti et al., 2023). The predictions in Table 2 also show positive cross-price effects between menthol cigarette and menthol e-cigarette choices, which implies these products are substitutes. Cotti et al. (2023) also conclude that cigarettes and e-cigarettes are substitutes, but Allcott and Rafkin (2020) report mixed results.

Although not definitive, the benchmarks in Table 2 help bolster the credibility of our mixed logit model. The model predictions are broadly like the patterns of behavior in our observational data and imply reasonable price-elasticity estimates. However, we find evidence that the model over-predicts e-cigarette use and quit attempts. McFadden (2017) and other research discussed in the Online Appendix stress the importance of calibrating DCE results to revealed preference data on choices in real-world markets. Figure 2 uses a simple approach to

[17] The review by DeCicca et al. (2022) suggests that the price-elasticity of demand for cigarettes might be slightly more inelastic than the range of -0.4 to -0.7 which past research suggested was a consensus. We are unaware of any credibly identified econometric studies of the price-elasticity of demand for menthol cigarettes specifically.

calibrate our DCE results and expresses the predicted market shares under the policy scenarios as fractions of the predicted status quo shares.[18]

Our discussion now turns to the model's predictions about the impacts of menthol prohibition (Table 2 and Figure 2).

Predictions of Consumer Choices Under Different Policies

Rows 6 to 17 in Table 2 contain the model's predictions of consumer choices under alternative sets of market conditions that correspond to four different policy scenarios and three assumptions about the impact of illegality on prices. Policy scenarios 6-8 predict choices with an illegal retail market for menthol cigarettes and a legal market for menthol e-cigarettes; policy scenarios 9-11 predict choices with illegal retail markets for both menthol cigarettes and e-cigarettes; policy scenarios 12-14 predict choices with an illegal street market for menthol cigarettes and a legal market for menthol e-cigarettes; policy scenarios 15-17 predicts choices with illegal street markets for both menthol cigarettes and e-cigarettes. Because the impact of illegality on prices is unknown, to illustrate the range of possibilities, for each market combination we make three sets of predictions where illegal product prices are either the same as in the status quo, 50 percent higher, or 50 percent lower. The range of price variation across the predicted scenarios is within the range of experimental price variation in the DCE, where prices were varied from 100 percent higher to 50 percent lower than the status quo.

[18] The Online Appendix provides additional discussion of DCE calibration and reports the results of a calibrated conditional logit model estimated using data from the background survey combined with the DCE responses (Online Appendix Table E1). Table E1 also reports the sensitivity of conditional logit models of tobacco product choices to two alternative approaches to improve the validity of the data from our DCE. In the first approach we drop responses from 8 "speedster" subjects who completed the choice tasks in under 2 minutes. In the second approach, we drop responses from 106 subjects who were inattentive to variation in the attributes of menthol cigarettes, as determined by their responses to survey questions asked after all the DCE choice tasks were completed. The estimated conditional logit models are not sensitive to any of these approaches to improve data validity.

Although our model predicts that menthol prohibition will shift consumers from menthol cigarettes to other tobacco products and to attempts to quit, under many of the policy scenarios the predicted consumer demand for illegal menthol cigarettes will be substantial (Figure 2). We limit our discussion to the scenarios where illegality does not result in a net change in product prices. In those scenarios, our model predicts that the illegal retail market share of menthol cigarettes would be 73 percent as large as the status quo and an illegal street market share would be 64 percent as large as the status quo. If FDA marketing denial orders result in a *de facto* prohibition of menthol e-cigarettes, our model predicts that the illegal retail and street market shares of menthol cigarettes could be as large as 82 percent and 75 percent as large as the status quo, respectively. If illegal choices in the stated preference data are under-reported due to social desirability bias, these predictions may be underestimates.

Of course, the potential size of illegal markets for menthol depends on the supply-side response, as well as FDA enforcement activities. However, the results of our DCE suggest a potentially strong consumer demand for illegal menthol cigarettes, even if strict enforcement means that menthol cigarettes will only be available from street dealers. Our model predicts a much larger consumer demand for illegal menthol cigarettes than the quantitative estimates from the expert elicitation used in the FDA's preliminary regulatory impact analysis (FDA 2022b). The means of the experts' responses were that with a prohibition 6 percent of menthol smokers aged 25-54 will purchase illegal menthol cigarettes and 46 percent of menthol smokers will switch to non-menthol cigarettes (Levy et al. 2021). Our model's predictions under policy scenario 7 are roughly the reverse of the experts' predictions for these two categories; the policy scenario 7 predictions are that 33 percent of menthol smokers will purchase illegal menthol cigarettes and 8.5 percent will purchase non-menthol cigarettes (Table 2). The reasons for these

differences are not clear. However, as we noted above, the FDA recognized that its analysis of illegal markets was not definitive and specifically requested additional data and studies.[19]

Sub-group Analyses

Given the high market share of menthol cigarettes among Black smokers and the importance of racial disparities as a rationale for the proposed prohibition, we conduct subgroup analysis for Black versus non-Black subjects (Table 3).[20] As in the full sample models, the results show that in both sub-groups the utility consumers receive from choosing a tobacco product depends on its price and legal availability. The estimated parameters have the same signs and similar but not identical magnitudes across the sub-groups.

The sub-group models yield similar predictions about the impacts of prohibition on the rate of quit attempts in the Black and non-Black sub-groups (Online Appendix Table A4). However, the Black sub-group is predicted to attempt to quit at a higher rate under status quo conditions.[21] As a result, prohibition is predicted to increase the quit attempt rate as a smaller

[19] As discussed above in section II, public health research on real-world and hypothesized behaviors in the U.S. provides very limited evidence about the potential for illegal markets after a menthol prohibition. For its quantitative analysis, the FDA relied on the results of an expert elicitation study (Levy et al. 2021). Before the expert elicitations, Levy et al. (2021) provided the experts with background material. The material included a review of public health research through 2019 by Cadham, Sanchez-Romero, Fleischer et al. (2020); this is an earlier review of the same body of research in the systematic review by Mills et al. (2024) discussed in section II. Based on three studies of implemented prohibitions in Canadian provinces, Cadham et al. (2020) concluded that legal retailer compliance was high. However, the only evidence reviewed on illegal markets was from a brief report of a time-series analysis of illegal cigarettes seized in Nova Scotia before-and-after menthol prohibition (Stoklosa 2019). Although 90 percent of the 11 experts expressed confidence in their elicited predictions, the evidence base regarding illegal markets for that confidence is not clear. It should also be noted that the 11 experts' predictions are not necessarily independent of each other. In the first round, the experts were given the same background material and provided their initial set of predictions. In a second round, each expert was given summary statistics (mean and range) of the group's initial predictions. They were then allowed to revise their predictions to "possibly move toward consensus."

[20] Online Appendix Tables A4 and A5 also report results for models estimated separately for sub-groups by gender, age, and dual use status. The results are broadly similar to the model reported in Table 1.

[21] Under status quo conditions, the predicted rate of quit attempts is 21 percent for the Black sub-group versus 11 percent for the non-Black sub-group. The status quo predictions mirror differences in observational data from the background survey, where 58 percent of the Black sub-group versus 48 percent of the non-Black sub-group report attempting to quit in the past 12 months. Similarly, using observational data from the 2018-2019 Tobacco Use Supplements to the Current Population Survey, Cheng et al. (2024) find that Black menthol smokers are 6 percentage points more likely to report a past 12 month quit attempt than non-Black menthol smokers.

fraction of status quo quit attempts for the Black sub-group (Online Appendix Figure A1). For example, when prices do not change and menthol e-cigarettes are illegal, the predicted quit attempt rate is 30 percent larger than predicted under status quo conditions for the Black sub-group, compared to 70 percent larger than the status quo for the non-Black sub-group. This difference suggests that the impact of menthol prohibition to reduce racial health disparities might be more limited than expected by the FDA.

The predicted impacts of prohibition on the market share of menthol cigarettes are smaller in the Black sub-group analysis. As a result, the predicted consumer demand for illegal menthol cigarettes is larger in the Black sub-group analysis than in the non-Black sub-group analysis, especially for an illegal street market. For example, when prices do not change and menthol e-cigarettes are illegal, from the Black sub-group model the predicted share of an illegal street market is 88 percent as large as the status quo, while from the non-Black sub-group model the predicted share of an illegal street market is 80 percent as large as the status quo. This difference tends to increase concerns about the racial justice implications of menthol prohibition. The DCE's description of illegal markets informed subjects that the FDA cannot and will not enforce against individual consumers. However, in response to a question asked after the DCE, 36 percent of the Black sub-sample versus 27 percent of the non-Black sub-sample agreed that an illegal menthol purchaser might be subject to arrest.

Linear Probability Model Results

Table 4 presents the results of five reduced-form linear probability models (LPMs) of choosing menthol cigarettes, menthol e-cigarettes, non-menthol cigarettes, tobacco-flavored e-cigarettes, and attempting to quit. Each equation is estimated separately. The broad patterns of

LPM results are consistent with the mixed logit results and show negative own-price effects, positive cross-price effects, and illegality effects.

The LPM coefficients and the mixed logit predictions have similar but not identical magnitudes. As an illustration that focuses on the impact of a menthol prohibition, we compare the estimated LPM coefficients on the indicator for an illegal street market to the mixed logit predicted differences between the status quo and scenario 7 in Table 2.[22] The LPM results imply that compared to when menthol cigarettes are legal, with an illegal retail market the probability of choosing menthol cigarettes decreases by 15 percentage points, while the probability of choosing non-menthol e-cigarettes increases by 3.2 percentage points and the probability of quitting increases by 8.3 percentage points. From the Table 2 mixed logit predictions, an illegal retail market is predicted to decrease choices of menthol cigarettes by 12.5 percentage points and to increase choices of non-menthol cigarettes and quitting by 3.5 percentage points each.

VI. Potential Illegal Market Equilibrium Outcomes

In this section we combine our estimates of the potential demand-side of an illegal menthol market with assumptions about the illegal supply-side to develop a range of predicted illegal market equilibrium outcomes (Table 5). On the supply-side, we assume that between zero to 100 percent of the illegal demand is met by illegal suppliers. The exercise requires two sets of demand-side predictions – predicted demand by those consumers supplied by an illegal market, and predicted demand by those consumers who face a zero illegal supply-side. The predicted illegal market equilibrium outcomes in Table 5 are simply linear combinations of the two demand-side predictions. For example, if 80 percent of illegal demand is met by illegal suppliers,

[22] In scenario 7 prices and the legality of menthol e-cigarettes are held constant at the status quo levels, which corresponds to the omitted baseline in the LPMs.

the equilibrium outcomes are 80 percent the predicted demands when illegal markets exist and 20 percent the predicted demands when menthol cigarettes are unavailable. For the first set of predictions of demand when illegal markets exist, we use the demand-side predictions under the assumptions used in Table 2's scenario 7: an illegal retail market for menthol cigarettes, a legal market for menthol e-cigarettes, and no net change in price. For the second set of predictions of demand when menthol cigarettes are unavailable, we use a model-based estimate of the impact of a zero supply-side.

The assumption that the illegal supply-side is zero corresponds to a prohibition that makes menthol cigarettes completely unavailable. As discussed above in section II, two previous DCE studies used the model-based approach to predict the impact of a complete menthol cigarette prohibition (Buckell, Marti, and Sindelar 2019; Buckell et al. 2023). Unlike in those two studies, our DCE subjects always had the option to choose menthol cigarettes, but in some choice tasks menthol cigarettes were described as illegal. To adapt the model-based approach used in the previous studies to our DCE data, we set the alternative specific constant for menthol cigarettes and the non-price attributes of menthol cigarettes to zero and set the price to $40 per pack to choke off demand. As shown in the first row of Table 5, with a zero illegal supply-side our model-based approach predicts that after a prohibition, approximately zero percent of menthol smokers will continue to smoke menthols, 43 percent will use menthol e-cigarettes, 14 percent will smoke non-menthols, 12 percent will use tobacco-flavored e-cigarettes, and 30 percent will attempt to quit.

Table 5 shows the range of illegal market equilibrium outcomes (market shares) under different assumptions about the fraction of potential demand that is met by the illegal supply-side. We do not view the extreme cases – a complete prohibition with a 0 supply-side or a

complete illegal supply-side that meets 100 percent of potential demand – as plausible scenarios; they are presented for transparency because they are the basis of the other calculations. Other than the extremes, because illegal supply-side responses are inherently difficult to predict and are beyond the scope of this paper, we remain agnostic about which supply-side assumptions in Table 5 are the most realistic.

If the illegal supply-side response meets most of the illegal demand (between 60 to 80 percent), the predicted equilibrium market shares of illegal menthol cigarettes in Table 5 are between 20 and 26 percent as large as the predicted status quo menthol market (Table 2). If the illegal supply-side response does not meet much of the potential illegal demand, much of the market share shifts to menthol e-cigarettes. The Table 5 predictions assume that menthol e-cigarettes remain legal. Although the FDA has issued a marketing granted order for one brand of menthol e-cigarette products, other FDA actions could result in a de facto prohibition of menthol e-cigarettes too, which would change the Table 5 predictions. Across all assumptions about the supply-side for illegal menthol cigarettes in Table 5, the market shares among former menthol smokers of non-menthol cigarettes and non-menthol e-cigarettes remain low.

Menthol prohibition's success in achieving its intended consequence to increase smoking cessation hinges on the extent of the supply-side response. If the supply-side only meets 20 percent of the demand for illegal menthol cigarettes, the share of menthol smokers who attempt to quit is predicted to be 72 percent higher than the status quo quit attempt rate. If the supply-side response increases to meet 80 percent of the illegal demand, the predicted increase in quitting is cut to a 34 percent increase over the status quo rate.

To provide some context for the supply-side assumptions, we note that the potential development of illegal markets for menthol cigarettes depends in part upon whether the markets

will be thick enough to keep down prices and transactions costs. Using variation in market thickness over time, Jacobson (2004) concludes that the larger youth cohorts due to the baby boom reduced arrest risk and provided informational economies in illegal marijuana markets. In contrast, Cook et al. (2007) provide evidence that even in a high-crime neighborhood in Chicago, the small numbers of buyers and sellers of illegal guns led to thin markets with high transaction costs and high prices.

The geographic distribution of menthol smokers suggests that although it is unlikely that illegal menthol markets will meet 100 percent of the potential demand, many local markets are likely to be thick, at least in larger metropolitan areas. We use data from the 2018-2019 Tobacco Use Supplements to the Current Population Survey to calculate the distribution of menthol smokers across metropolitan statistical areas (MSAs) of different sizes. Just under 20 percent of menthol smokers live in non-metropolitan areas where illegal markets might be thin and geographically disperse.[23] 33 percent of menthol smokers live in MSAs with populations of 2.5 million or more; 51 percent of menthol smokers live in MSAs with populations above 1 million. The potential size of illegal menthol markets in these MSAs is on par with or larger than existing thick markets for illegal drugs in many large cities and is orders of magnitude larger than the thin market for illegal guns studied by Cook et al. (2007).

VII. Concluding Discussion

We contribute evidence from a discrete choice experiment about how current menthol smokers might respond to the prohibition of menthol cigarettes. Our results suggest that the prohibition could achieve its intended consequence and lead to menthol smokers attempting to quit at rates

[23] Some consumers in nonmetropolitan areas might be able to obtain menthol cigarettes through illegal online sales and package delivery services.

higher than currently. However, our results also suggest that the demand-side of an illegal market for menthol cigarettes could be far larger than previously estimated. Subjects' stated preferences in our study might not correspond to consumers' actual behavior in illegal markets. Nevertheless, our results suggest that the FDA's assumption that the impact of menthol prohibition on illegal cigarette markets "would not be significant" (FDA 2022b, p. 212) should be viewed with some caution.

The market equilibrium outcomes after a menthol prohibition depend on the potential demand-side that we study and the illegal supply-side response, which we do not study. Strict enforcement of the prohibition might help achieve the intended consequence to increase quitting, but at additional cost and at the risk of unintended consequences. In its preliminary regulatory impact analysis, the FDA (2022b, p. 170) assumed that the inspection and monitoring activities to enforce the national prohibition would require an additional 2.5 full-time equivalent employees (FTEs). If the potential illegal demand-side is strong and illegal menthol markets develop in larger cities, the FDA might need to hire many more FTEs. At the same time, because by statute the FDA cannot enforce against consumers, enforcement costs might spill over to other federal, state, and local law enforcement agencies. In a public comment on the FDA proposal, the National Organization of Black Law Enforcement Executives stress that in addition to the budgetary implications: "this potential ban will invite law enforcement into communities of color to become the menthol cigarette police at a time when all stakeholders are looking for ways to improve police-community relations…. we fail to see how criminalizing menthol cigarettes will do anything but make matters worse." (NOBLE 2022)

An important direction for future work is to conduct a cost-benefit analysis (CBA) of a national prohibition of menthol cigarettes in the U.S. A neoclassical CBA would compare the

benefits of reducing the externalities from secondhand smoke to the enforcement costs, the costs of unintended consequences, and the opportunity costs imposed on consumers who continue to smoke illegal menthol cigarettes. A behavioral CBA would add the benefits of reduced internalities for menthol smokers who quit smoking or switch to e-cigarettes in response to the prohibition.[24] Internalities may also play an important role in youth smoking initiation, which our DCE does not address. However, many tobacco control policies already target youth smoking, including the 2020 federal law that increased the national legal purchase age for tobacco products to 21. In the 2023 National Youth Tobacco Survey, 1.6 percent of middle and high school students report past 30-day use of cigarettes (Birdsey et al. 2023). Finally, a cost-benefit analysis of the prohibition of menthol cigarettes could also shed light on optimal regulation of non-menthol cigarettes. The analysis could also follow Becker, Grossman, and Murphy (2006) and compare prohibition of menthol or all cigarettes to the alternative of taxation.

[24] Levy, Norton, and Smith (2018) discuss a general approach to cost-benefit analysis of tobacco regulations when smokers impose internalities on themselves. Cheng et al. (2024) provide evidence that casts doubt on whether adult menthol smokers are different from non-menthol smokers in ways that provide an internality-based rationale to regulate menthol more strictly than non-menthol cigarettes.

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Tables and Figures

Table 1: Mixed Logit Models of Consumer Tobacco Product Choices

	Immediate Choice Today	
	Mean	SD
ASC (Non-menthol cigarettes)	-0.176	3.117***
	(0.222)	(0.223)
ASC (Menthol cigarettes)	4.472***	3.098***
	(0.165)	(0.205)
ASC (Tobacco-flavored e-cigarettes)	-2.053***	3.908***
	(0.322)	(0.276)
ASC (Menthol-flavored e-cigarettes)	1.737***	3.292***
	(0.150)	(0.182)
Price ($)	-0.384***	0.654***
	(0.034)	(0.180)
Illegal Retail Market for Menthol Cigarettes	-1.544***	1.192***
	(0.226)	(0.403)
Illegal Street Market for Menthol Cigarettes	-2.157***	1.688**
	(0.338)	(0.715)
Illegal Retail Market for Menthol E-cigarettes	-1.534***	0.484***
	(0.136)	(0.187)
Illegal Street Market for Menthol E-cigarettes	-2.547***	2.623**
	(0.378)	(1.022)
Log-likelihood	-6736.713	
Observations	7668	

Notes: The columns report the estimated mean and standard deviation (SD) of the distributions for each of the random coefficients. ASC = alternative specific constant. ASCs are assumed to follow normal distributions. The negative of the coefficients associated with price and legality variables are assumed to follow lognormal distributions. The coefficients are transformed such that they are directly interpretable as the impact on consumer utility, and the standard errors are also transformed using the Delta method. All random coefficients are assumed to be correlated. 500 Halton draws are used for simulation. Standard errors are in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Source: Cornell online Discrete Choice Experiments 4/26-5/9, 2022.

Table 2: Predicted Market Shares of Tobacco Products and Quit Attempts

Policy Scenario	Menthol Cigs	Menthol-flavored E-cigs	Non-menthol Cigs	Tabacco-flavored E-cigs	Quit Attempt
Status quo					
1. Status quo legality & prices	0.455	0.253	0.065	0.066	0.162
2. 50% lower price for menthol cigs	0.559	0.215	0.056	0.055	0.115
3. 50% higher price for menthol cigs	0.380	0.281	0.073	0.074	0.192
4. 50% lower price for menthol e-cigs	0.437	0.306	0.062	0.062	0.133
5. 50% higher price for menthol e-cigs	0.469	0.212	0.067	0.069	0.182
Illegal Retail Market for Menthol Cigs					
6. 50% lower price for illegal products	0.420	0.274	0.077	0.072	0.156
7. No price change	0.330	0.306	0.085	0.082	0.197
8. 50% higher price for illegal products	0.270	0.328	0.093	0.088	0.221
Illegal Retail Market for Menthol Cigs & E-cigs					
9. 50% lower price for illegal products	0.455	0.211	0.088	0.080	0.166
10. No price change	0.374	0.194	0.100	0.094	0.237
11. 50% higher price for illegal products	0.316	0.176	0.113	0.106	0.290
Illegal Street Market for Menthol Cigs					
12. 50% lower price for illegal products	0.372	0.294	0.084	0.078	0.172
13. No price change	0.290	0.322	0.092	0.087	0.210
14. 50% higher price for illegal products	0.236	0.342	0.099	0.093	0.231
Illegal Street Market for Menthol Cigs & E-cigs					
15. 50% lower price for illegal products	0.418	0.191	0.101	0.091	0.199
16. No price change	0.340	0.174	0.114	0.104	0.268
17. 50% higher price for illegal products	0.286	0.157	0.125	0.115	0.317

Notes: Predictions are derived from estimation results of a mixed logit model.

Table 3: Mixed Logit Models Subgroup Analysis of Consumer Tobacco Product Choices by Race

	Black		Non-black	
	Mean	SD	Mean	SD
ASC (Non-menthol cigarettes)	-0.846**	2.058***	0.181	3.705***
	(0.423)	(0.287)	(0.255)	(0.344)
ASC (Menthol cigarettes)	3.825***	3.467***	5.021***	3.742***
	(0.308)	(0.445)	(0.215)	(0.191)
ASC (Tobacco-flavored e-cigarettes)	-2.176***	3.517***	-1.456***	3.413***
	(0.531)	(0.475)	(0.265)	(0.217)
ASC (Menthol-flavored e-cigarettes)	1.136***	2.805***	2.097***	3.764***
	(0.365)	(0.289)	(0.167)	(0.220)
Price ($)	-0.431***	1.341	-0.305***	0.328***
	(0.110)	(1.838)	(0.022)	(0.046)
Illegal Retail Market for Menthol Cigarettes	-1.129***	0.621	-1.879***	1.267***
	(0.328)	(0.569)	(0.216)	(0.337)
Illegal Street Market for Menthol Cigarettes	-2.212	5.670	-2.654***	1.552***
	(1.456)	(17.383)	(0.236)	(0.371)
Illegal Retail Market for Menthol E-cigarettes	-1.170***	0.329	-2.007***	2.285
	(0.253)	(0.356)	(0.593)	(1.859)
Illegal Street Market for Menthol E-cigarettes	-1.523***	1.122	-2.849***	2.820***
	(0.484)	(0.887)	(0.408)	(0.992)
Log-likelihood	-1917.161		-4786.768	
Observations	2112		5556	

Notes: The columns report the estimated mean and standard deviation (SD) of the distributions for each of the random coefficients. ASC = alternative specific constant. ASCs are assumed to follow normal distributions. The negative of the coefficients associated price and legality variables are assumed to follow lognormal distributions. The coefficients are transformed such that they are directly interpretable as the impact on consumer utility, and the standard errors are also transformed using the Delta method. All random coefficients are assumed to be correlated. 500 Halton draws are used for simulation. Standard errors are in parentheses. * p<0.1, ** p<0.05, *** p<0.01.
Source: Cornell online Discrete Choice Experiments 4/26-5/9, 2022.

Table 4: Linear Probability Models of Consumer Tobacco Product Choices

Variables	Menthol cigarettes	Menthol-flavored e-cigarettes	Non-menthol cigarettes	Tobacco-flavored e-cigarettes	Quit Attempt
Price ($) of Menthol Cigarettes	-0.014***	0.004***	0.001	0.002***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Price ($) of Menthol-flavored E-cigarettes	0.016***	-0.019***	-0.003*	0.006***	0.000
	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)
Price ($) of Non-menthol Cigarettes	0.005***	-0.002**	-0.006***	0.002**	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Price ($) of Tobacco-flavored E-cigarettes	0.010***	-0.005**	-0.000	-0.004**	-0.001
	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
Illegal Retail Market for Menthol Cigarettes	-0.150***	0.012	0.032***	0.023***	0.083***
	(0.014)	(0.009)	(0.009)	(0.007)	(0.011)
Illegal Street Market for Menthol Cigarettes	-0.206***	0.027***	0.053***	0.036***	0.089***
	(0.015)	(0.009)	(0.009)	(0.007)	(0.011)
Illegal Retail Market for Menthol E-cigarettes	0.018	-0.115***	0.002	0.059***	0.035***
	(0.011)	(0.012)	(0.007)	(0.008)	(0.011)
Illegal Street Market for Menthol E-cigarettes	0.008	-0.146***	0.017**	0.071***	0.050***
	(0.011)	(0.014)	(0.007)	(0.009)	(0.011)
Constant	0.504***	0.347***	0.117***	-0.034	0.066
	(0.045)	(0.036)	(0.028)	(0.025)	(0.042)
Mean of the dependent variable	0.432	0.177	0.089	0.080	0.221
Adjusted R-square	0.092	0.053	0.024	0.020	0.022
Observations	7,668	7,668	7,668	7,668	7,668

Notes: Standard errors clustered at the individual level are in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table 5. Predicted Illegal Market Equilibrium Outcomes

Fraction of Illegal Demand Met by Illegal-Supply Side	Menthol Cigs	Menthol E-cigs	Non-menthol Cigs	Tobacco-flavored E-cigs	Quit Attempts
0%	0.010	0.430	0.140	0.120	0.300
20%	0.060	0.405	0.129	0.112	0.279
40%	0.132	0.380	0.118	0.105	0.259
60%	0.198	0.366	0.107	0.097	0.238
80%	0.264	0.331	0.096	0.090	0.218
100%	0.330	0.306	0.085	0.082	0.197

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Figure 1: Introduction to Choice Tasks and Sample Task

We are interested in smokers' choices between menthol and non-menthol cigarettes, e-cigarettes which contain nicotine, or quitting. We want you to imagine that you can buy non-menthol cigarettes and e-cigarettes where you usually buy your cigarettes or e-cigarettes. In some questions, we will ask you to imagine that menthol cigarettes and e-cigarettes are legal and available where you usually buy your cigarettes. In other questions, we will ask you to imagine that menthol cigarettes and menthol little cigars/cigarillos and/or menthol flavored e-cigarettes are prohibited so that you will no longer be able to purchase them at many locations, but some locations might still sell the prohibited products. When a menthol-flavored product is described as prohibited, you should assume that the U.S. Food and Drug Administration has prohibited the product in all 50 states and DC. The FDA's enforcement of any prohibition on menthol-flavored products would only address manufacturers, distributors, wholesalers, importers and retailers. The FDA cannot and will not enforce against individual consumer possession or use of menthol cigarettes or any other tobacco product.

In what follows you will see different scenarios each with different combinations of the price of your cigarette brand, the price of an e-cigarette, along with descriptions of the legal status of menthol cigarettes and e-cigarettes and flavored little cigars/cigarillos and how this might affect their availability for purchase.

When considering e-cigarettes, we will be asking you about e-cigarette packages that are equivalent to one pack of your brand of cigarettes. For the purposes of your choices, please do not consider the price of buying the startup kit for reusable e-cigarettes.

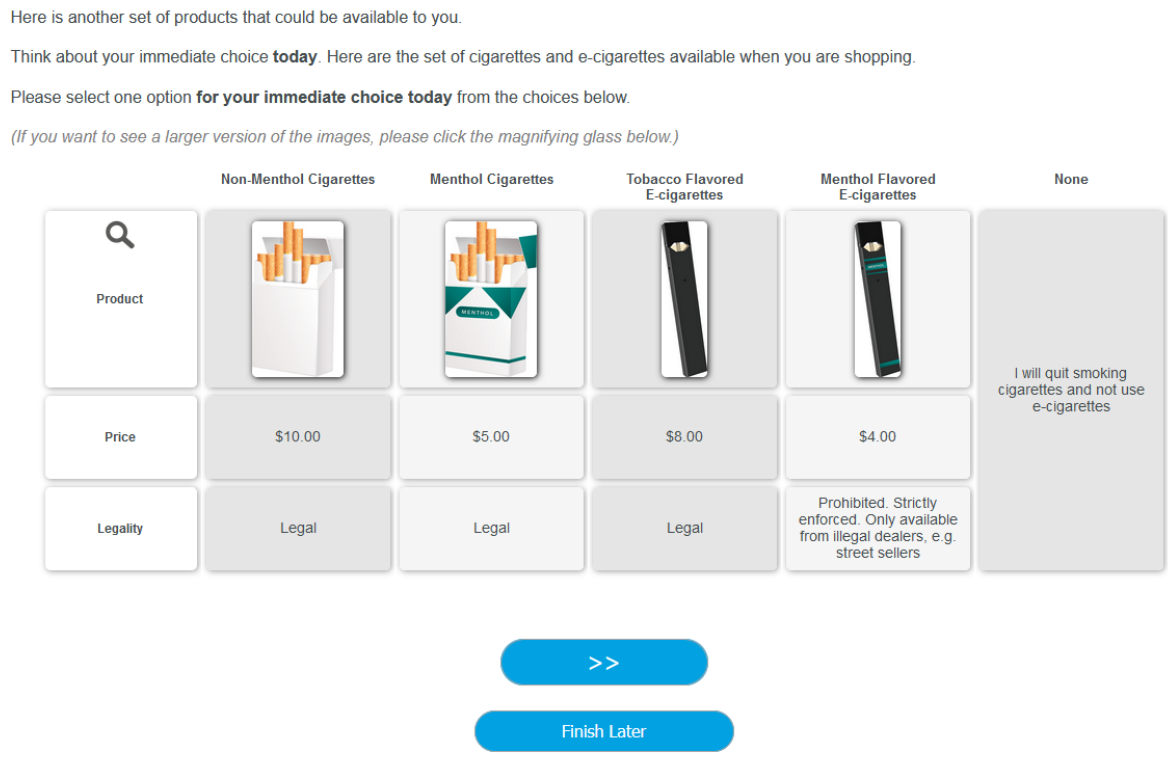
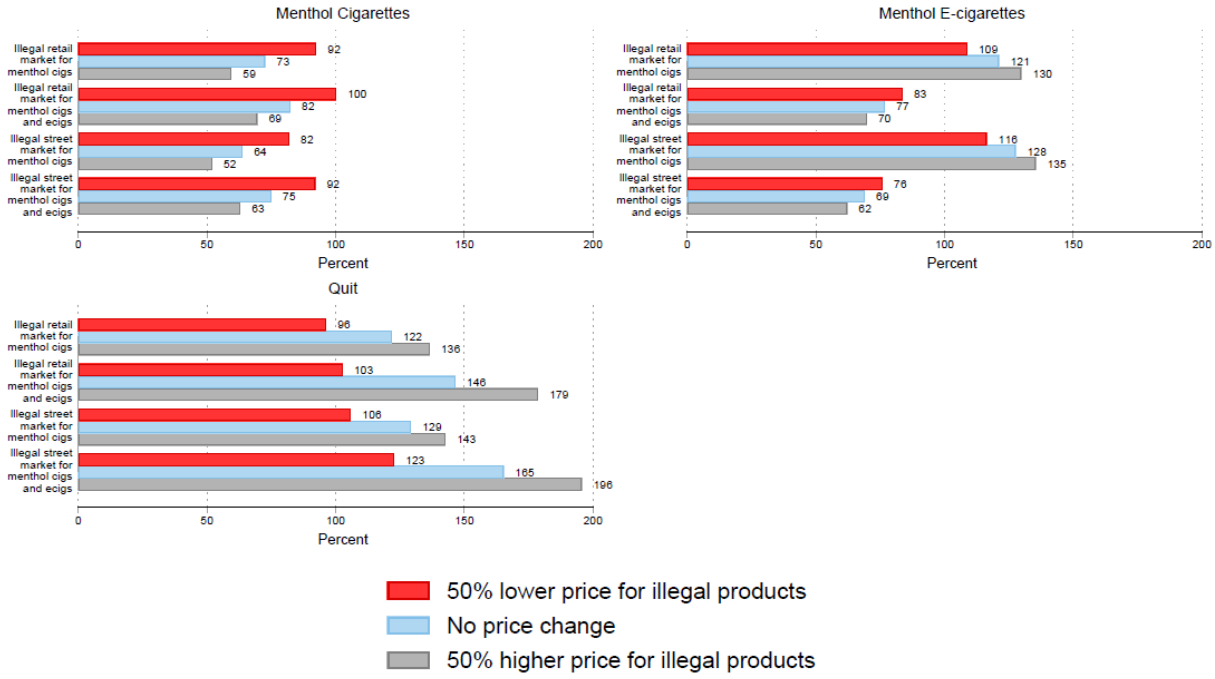


Figure 2: Predicted Market Shares of Menthol Products Relative to the Status Quo



Source: 2022 online Cornell survey