Appendix A: Tobacco Town Minnesota technical description & data sources

Overview

The fundamental building block of ABMs is the *agent* – here, an adult smoker – complete with *properties* (e.g., age, gender, race, cigarettes consumed per day) and *behavioral rules* (e.g., purchase or not purchase cigarettes according to other properties).[33] The model encodes these properties and rules, then tracks the behavior of the agents within environments over time, and how that behavior changes when policies are implemented (e.g., limiting purchase locations).

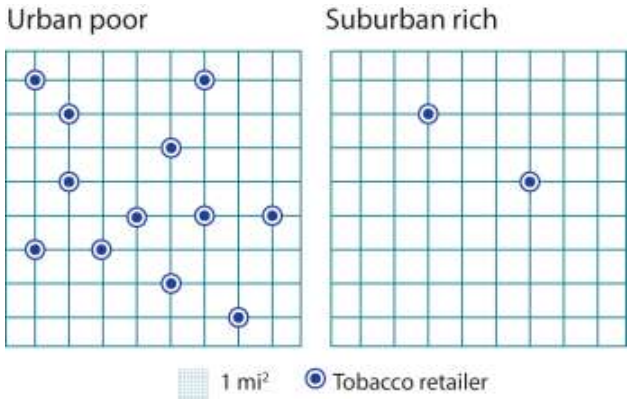
Model Components:

1. Environment
2. Retailers
3. Agents
4. Interventions
5. Sensitivity Analyses
6. Model Output
7. Model Input

Environment

The environment consists of a uniform grid of roads in between city blocks. Agents can only travel along these roads. There are six types of communities that are used to generate the specific environment used in any given simulation. Each type has its own characteristics. For example, "Urban Wealthy" and "Urban Poor" communities are denser with respect to residences, workplaces, schools, and retailers than their Suburban or Rural counterparts. As briefly illustrated in Figure A1, one square mile in an Urban Poor environment contains 12 tobacco retailers, while the same amount of area in a Suburban Rich environment has only two retailers. The full set of characteristics for each town type is described in Table A-5.

Figure A-1. Example of retailer density in two model environments.



Tobacco retailers are randomly placed throughout the city block areas of the environment according to the type-specific retailer densities corresponding to the given community. Workplaces and schools are randomly placed at intersections in the grid, based on the workplace and school density parameters associated with community types. Agents are created based on the population density of the community and assigned intersections to be their home locations.

The parameters that determine the environment during a given run are as follows:

Table A-1. Environment parameters

Parameter	**Type**	**Initialization**	**Notes**
Population density	Integer	Table A-6	Agent density in a given model run is stochastic, based on the distribution of transportation types[1]
Retailer density	Pos. real number	Number of retailers drawn from binomial distribution around mean given by town data (Table A-5)	Retailers per square mile
Retailer type share	Real numbers $\in [0,1]$	Table A-5	Types modeled are convenience stores, general stores, liquor stores, pharmacies, and tobacconists. Shares sum to 1.
Workplace density	Pos real number	Table A-6	Places per square mile
School density	Pos real number	Table A-6	Schools per square mile
Transportation type frequency	Real numbers $\in [0,1]^3$	Table A-6	Options are Walk, Car, Public Transit, and Bike[2].
Demographic distribution	Probability distribution over four agent types: LGBT × Race	Table A-7	
Income distribution	Probability distribution over positive real numbers	Table A-7	
Land area covered	Positive integer	10 square miles	Selected to balance computational load and the likelihood of observing all retailer types in each run

Sources: Distribution of transportation types from American Community Survey 2015; retailer density and types from Counter Tools 2018.

[1] For each transportation type, the model constructs a target number of agents, equal to the overall target population multiplied by the frequency of that transportation type.

[2] The nominal "Bike" category also includes taxi and motorcycle

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Retailers

Retailers are generated for each simulation run based on the environment parameters listed above. Each retailer in the environment has the following properties:

Table A-2. Retailer properties

Property	**Type**	**Initialization**	**Notes**
Location	[int x, int y] within bounds of lattice	Randomly assigned to intersections on lattice	
Price for Regular Pack	Pos real number	Truncated normal distribution parameterized by minimum, mean, and variance of pack prices for each retailer type (Table A-5)	Contingent on town type and retailer type. Minimum empirically observed value is used to truncate left tail[3].
Price for Menthol Pack	Pos real number	Truncated normal distribution parameterized by minimum, mean, and variance of pack prices for each retailer type (Table A-5)	
Carton Multiplier	Pos real number	Pack price multiplied by 8	Agents purchasing cartons receive a discount (per cigarette, cartons cost 20% less than packs).
Type	Categorical	Frequencies drawn from input data, contingent on town type (Table A-5)	types modeled are convenience stores, general stores, liquor stores, pharmacies, and tobacconists

Sources: Price and retailer data from Counter Tools 2018; Carton purchase proportions from National Adult Tobacco Survey (CDC) 2012 & 2014.

[3] To create this distribution, the model generates a normal distribution with the given mean and standard deviation, and then shifts the mean of the underlying distribution so that it has the correct mean when truncated. However, it does not change the standard deviation of the underlying distribution, so the standard deviation of the truncated distribution is slightly smaller than the figure in the data

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Agents

Agents in the Tobacco Town model are generated in each simulation based on the environment parameters listed above, and each has the following properties:

Table A-3. Agent properties

Property	Variable Type & Range	Initialization	Update / Notes
Smoking Rate	Positive integer (cigarettes per day)	Table A-8	Updates only if agent quits smoking (set to zero).
Menthol Preference	Real ∈ (0,1)	Table A-9	Does not update
Current Location	(int x, int y) within bounds of lattice	Initial value = home location	Updates according to *Movement* rule
Mode of Transport	Categorical, ∈ {walk, bike, public transit, car}	Initialized according to a distribution depending on town type; independent of commute length (Table A-6)	Does not update
Home Location	(x, y) coordinate	Random draw from intersections	Does not update
Workplace Location	(x, y) coordinate	Random draw from workplace coordinates	Does not update.
Inventory	Positive integer	Random Uniform [1, 200]	See *Purchase Loop* and *Smoking* rules
Race	Categorical ∈ {Black, Not Black}	Table A-7	Does not update.
LGBT	Categorical ∈ {LGBT, Not LGBT}	Table A-7	Does not update.
Wage	Double.	Table A-7	Does not update. Cutoff between higher- and lower-income agents is an annual wage of $42,500.
Decision Rule	Decision Rule Object	Rational (see *Agent Actions*)	Does not update; varied in sensitivity analyses
Discount Rate	Real ∈ (0,1)	$SR \leq 10: U(0.935, 1)$ $10 < SR < 20: U(0.9, 1)$ $SR = 20: U(0.88, 1)$ $SR > 20: U(0.815, 1)$	Uniform distribution parameters were calibrated to best fit the observed distribution of carton purchase quantity, conditional on smoking rate category, informed by pooled National Adult Tobacco Survey (CDC) 2012 & 2014
Price Sensitivity	$\mathbb{R} \times \mathbb{R} \in (0,1) \times (0,1)$	Rich: $\beta = 0.1,\ \theta = -2.75$ Poor: $\beta = 0.15,\ \theta = -3$	Assigned based on income: poor agents have higher price sensitivity than rich agents.
Days Without Smoking	Positive Integer	0	Increments whenever agent's Inventory is zero and decides not to purchase cigarettes.

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Agent Actions

Each simulated day is divided into two phases (Morning and Evening). During each phase, agents take the following simulated actions:

[1] Purchase Loop (Morning Phase)

[2] Move to work from home, potentially purchase tobacco en route (Morning Phase)

[3] Move from work to home (Evening Phase)

[4] Smoke tobacco at home (Evening Phase)

Purchase Loop

At the beginning of each simulated day, agents decide whether to purchase cigarettes. If their current inventory is less than their daily consumption, then they first choose whether to purchase (a) menthol, (b) regular, or (c) nothing. The probability of each category is computed according to the following soft-max function, where α represents the agent's menthol preference, β and θ are price sensitivity parameters, and c_m and c_r are the per pack sum of travel and purchase costs for menthols and regular, respectively.

$$P(menthol) = \frac{\alpha e^{-\beta c_m}}{\alpha e^{-\beta c_m} + (1-\alpha)e^{-\beta c_r} + e^{\theta}}$$

$$P(regular) = \frac{(1-\alpha) e^{-\beta c_r}}{\alpha e^{-\beta c_m} + (1-\alpha)e^{-\beta c_r} + e^{\theta}}$$

$$P(no\ purchase) = \frac{e^{\theta}}{\alpha e^{-\beta c_m} + (1-\alpha)e^{-\beta c_r} + e^{\theta}}$$

If the agent does not purchase cigarettes, then they enter the **Cessation Loop** (next section).

If the agent decides to purchase cigarettes, then they select a retailer from which to purchase cigarettes and a quantity of cigarettes to purchase. They do by first determining the optimal quantity of cigarettes that they would purchase from every possible retailer. Specifically, they select a quantity that minimizes the average per-pack cost of their hypothetical purchase, including travel and opportunity costs and referred to in the paper as total travel plus price cost (TPC), subject to a discounting term that causes the agent to devalue packs that will be consumed further in the future.[4] When agents buy one or more blocks of 10 packs, we treat those blocks as cartons and apply the carton price. Purchases are capped at 100 packs (i.e. 10 cartons).

Mathematically, for each retailer in the model, agents compute:

[4] This discounting term (δ) acts as a budget constraint. Absent δ, agents would purchase an infinite number of packs (because they value packs consumed in the future exactly as much as packs consumed today).

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$$q_r^* = \underset{q \in \mathbb{N}^+ \leq 100}{\operatorname{argmin}} \left(\frac{C_r(q)}{\sum_{k=1}^{q} \left(\delta^{\left\lfloor \frac{20 \cdot (k-1)+I}{SR} \right\rfloor} \right)} \right) \quad (1)$$

where r is the retailer being considered, q is the quantity expressed in packs, $\delta \in (0,1)$ is the discounting rate, SR is the agent's smoking rate (in cigarettes per day), I is the agent's cigarette inventory (which has $0 \leq I < SR$), and $C_r(q)$ is the expected cost of purchasing q packs of cigarettes at retailer r, calculated as:

$$C_r(q) = \left(\frac{d_r}{s} + \frac{1}{12}\right) \cdot w \cdot v_l + d_r \cdot \frac{P_{fuel}}{E} + q \cdot P_r \quad (2)$$

where d_r is the travel distance off-route to retailer r[5], s is travel speed, w is hourly wage, P_{fuel} is fuel price, E is fuel efficiency, P_r is the expected price of a pack of cigarettes at retailer r, and v_l is the linear value-of-time parameter.[6] The values for these parameters and the sources from which they were derived are provided in the Data and Sources section below. The $\frac{1}{12}$ term represents a 5 minute time cost associated with making a cigarette purchase.

Based on the above calculations, agents thus obtain the expected cost of purchasing an optimal quantity of cigarettes at each retailer:

$$C_r = \left(\frac{d_r}{s} + \frac{1}{12}\right) \cdot w \cdot v_l + d_r \cdot \frac{P_{fuel}}{E} + q_r^* \cdot P_r \quad (3)$$

This function has a few appealing features. First, it describes in a parsimonious fashion how agents would make purchase decisions based on a large set of personal characteristics and environmental factors – including transportation mode, wage, distance to retailers, and the prices of both cigarettes and fuel. Second, it naturally leads agents to engage in tobacco price minimization strategies in response to changes in their environment. When the travel costs increase – say, as the result of a policy – the optimal q_r^* increases, meaning that agents may respond to reductions in tobacco density by increasing the quantity of their per-trip purchases.

Agents then select a retailer using the following "trembling hand" process:

With probability $(1 - \varepsilon)$ the retailer with the lowest value of C_r is chosen; with probability ε (set to .025), a retailer other than the most desirable one is chosen with probability:

$$Prob_r = (1 - x)^{rank(r)-1} \cdot x \quad (4)$$

where $rank(r)$ is the rank (ascending) of retailer r's expected cost., and x is set to .5. This value was chosen because sensitivity analyses show that x's effect is about an order of magnitude smaller than the intervention effect, and does not vary notably across decision rules. Xis conceptually important to reflect

[5] Based on the "Manhattan distance" (distance along a perpendicular street grid as opposed to the shortest Euclidean distance) between the retailer and the closest point on their daily route

[6] In all reported simulations, $v_l = 1$, implying that agents place equal value on the price of lost wages as they do on the price of cigarettes.

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that stochastic choice and is not uniformly distributed across retailers. Setting x >> 0 also reduces unrealistic outliers and avoids epsilon having an outsize influence on average travel costs.

These probabilities sum to slightly less than 1; if no retailer is selected, one is chosen from the set with uniform probability. This "trembling hand" process creates a stochastic variation in purchase behavior that nonetheless heavily privileges retailers with lower expected cigarette costs.

The specific implementation of the purchase behavior generally described above is subject to an agent's "decision rule" property. In the base model, all agents follow a *rational* decision rule: all agents have perfect information about retailer locations and prices and consider every retailer as a possible purchase choice. In sensitivity analyses, we varied this decision rule (see *Sensitivity Analyses* section).

Cessation Loop

Once an agent has made a non-purchase decision, the choice to quit smoking or purchase again is purely probabilistic. Each day, the agent re-enters the **Purchase Loop** with probability equal to 0.8, and remains in the **Cessation Loop** with probability equal to 0.2. If the agent has gone 4 days without smoking, it is considered to have 'quit', and exits the model.

We chose to use this simple formulation to avoid explicitly modeling the biological process of cessation. The probabilities above are calibrated such that there is a 2-5% probability that each agent quits smoking over the course of 90 days, as observed the pooled NATS data (2012 & 2014) considering current and recently quit smokers.

Movement

Agents move back and forth between their home and work locations, making one trip each way every simulated day. Agents travel along roads, and home and work locations are all located at intersections.

Each agent chooses a route at the beginning of the simulation, selecting at random among the set of equal-distance shortest paths between the two points, which they then follow every day during the simulation.

Each time an agent selects a retailer from which to purchase cigarettes, they also find the closest point on their route to that retailer and choose a route between that point and the retailer. This is used for both visualizing the agent visiting the retailer and, when the learning rule is in effect, determining which other retailers' prices they observe.

Smoking

Agents smoke according to their daily cigarette consumption (i.e. smoking rate) at home in the evening. Their current inventory is decremented by an amount equal to their daily consumption in cigarettes per day (CPD).

Initiation

To simulate initiation, new agents are added to the model at a rate of 1.75% per 90 day period. They are added each morning phase, and are initialized with properties in the same manner as agents at the beginning of the run. We calculated this value (1.75%) from the pooled NATS data (2012 & 2014) by

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identifying the percentage of smokers who were new smokers (those who started in the past year) and then divided by 4 to obtain a 3-month or 90-day percentage.

Interventions

Interventions represent policies that may be enacted to restrict availability of cigarettes. The user may specify which day the intervention will take effect; this defaults to 1 (the second day). Multiple interventions may also be applied sequentially to the town in a single simulation in order to estimate joint effects. The interventions that are implemented are as follows:

1. **Baseline:** No changes
2. **Menthol Restriction:**
    a. **Low Intensity**: Menthol purchase permitted at tobacconists. At all other retailers, only regular cigarettes are available.
    b. **High Intensity**: Menthol purchase prohibited at *all* retailers. Only regular cigarettes are available.
3. **Retailer Buffer:** If any pair of retailers are within a specified distance of one another, one member of the pair, chosen at random, is removed.
    a. **Low Intensity**: Buffer distance = 1000 ft.
    b. **High Intensity**: Buffer distance = 2000 ft.
4. **Store Type Restriction:**
    a. **Low Intensity:** No tobacco sales permitted at pharmacies.
    b. **High Intensity:** No tobacco sales permitted at any retailers except tobacconists.
5. **Geographic Menthol Buffer:** Menthol sales are not permitted at retailers that fall within a specified buffer distance from an arbitrary point on the grid. These points are randomly selected based on school density within the community.
    a. **Low Intensity:** Buffer distance = 500 ft.
    b. **Medium Intensity:** Buffer distance = 1000 ft.
    c. **High Intensity:** Buffer distance = 1500 ft.

The full sweep of 19 policy tests, including both individual policies and policies implemented in combination with one another, is shown in Table A.4.

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Table A-4. Policy specifications

Policy Condition	**Policy specification**	**Community Settings**	**Repetitions per setting**	**Runs required**
Baseline (no active policy)	n/a	All	50	300
Menthol restriction	Only tobacconists allowed	All	50	300
Menthol restriction	Total restriction	All	50	300
Store type restriction	No pharmacies	All	50	300
Store type restriction	Only tobacconists	All	50	300
Retailer buffer	1000 feet	All	50	300
Retailer buffer	2000 feet	All	50	300
Geographic menthol buffer	500 feet from randomly selected points (use school density)	All	50	300
Geographic menthol buffer	1000 feet from randomly selected points (use school density)	All	50	300
Geographic menthol buffer	1500 feet from randomly selected points (use school density)	All	50	300
Menthol restriction + Retailer buffer	Only tobacconists allowed + 1000 feet buffer	All	50	300
Menthol restriction + Retailer buffer	Total restriction + 1000 feet buffer	All	50	300
Store type restriction + Retailer buffer	No pharmacies + 1000 feet buffer	All	50	300
Store type restriction + Retailer buffer	Only tobacconists + 1000 feet buffer	All	50	300
Store type restriction + geographic menthol buffer	No pharmacies + 1000 feet buffer	All	50	300
Menthol restriction + Retailer buffer	Only tobacconists allowed + 2000 feet buffer	All	50	300
Menthol restriction + Retailer buffer	Total restriction + 2000 feet buffer	All	50	300
Store type restriction + Retailer buffer	No pharmacies + 2000 feet buffer	All	50	300
Store type restriction + Retailer buffer	Only tobacconists + 2000 feet buffer	All	50	300
				Total runs = 57000

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Sensitivity Analyses

In order to explore the sensitivity of model output to changes in specific parameters, sensitivity analyses were performed. Variations in the following parameters were explored:

1. **Agent decision rule:** The decision rule determines the way in which agents consider available retailers when purchasing tobacco. All three decision rule variants assume agents have perfect information about all retailer prices and locations. In two-phase rule variants, agents use a heuristic to limit the set of retailers they consider.
    a. **Rational rule:** Agents have perfect information about retailer locations and prices and consider every retailer when making a purchase decision.
    b. **Two-phase price rule:** Agents only consider retailers selling cigarettes below a specified per-pack price threshold ($8 for poor agents and $8.50 for rich agents).
    c. **Two-phase distance rule:** Agents only consider retailers within 2 miles of their home location.
2. **Price sensitivity:**
    a. **Low:** For rich and poor agents, respectively: β = .05 and .1; θ = -2.5 and -2.75.
    b. **Normal:** For rich and poor agents, respectively: β = .1 and .15; θ = -2.75 and -3.
    c. **High:** For rich and poor agents, respectively: β = .15 and .2; θ = -3 and -3.5.
3. **Trembling hand:** The trembling hand parameter (ε) specifies the probability with which an agent selects the retailer, of those available, that minimizes their total cost. A lower value of ε indicates a greater likelihood of selecting the cost-optimal retailer.
    a. **Normal:** ε = .025
    b. **High:** ε = .005

Model Output

The Tobacco Town model is run 50 times with different random seeds for each of the parameter combinations explored. The model produces aggregate data describing the state of the simulated town at the end of the 90-day run. Metrics reported include the average costs experienced by cigarette purchasers, cost subcategories (travel cost, pack cost), distance traveled, quantity purchased, and retailer density post-intervention. The model also allows time-series or agent-level data to be reported, to observe dynamics and distributions; these datasets are larger, and so their use is limited to parameterizations of particular interest.

Model Input

The integration of empirical data into the model is structured as follows. Model inputs derived directly from empirical data are encoded into text files particular to each town type, and read into the model upon initialization. These files include general town properties (population, breakdown of transit modes, speeds of those transit modes, and demographic distribution of agents), retailer frequency by type, distribution of retailer prices by type (we assume this to be a truncated normal distribution), and agent-related files, giving the distribution of smoking rate and menthol preference, conditional on demographics. Estimates

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of fuel prices and gas mileage (used in calculating the monetary component of driving cost) are hard-coded in the agent's decision rules. Finally, some parameters for which we do not have specific empirical data, such as the learning rate and the carton cap, are implemented as model parameters, so that they can be easily varied as we explore the model.

Data and Sources

Tables A-5 through A-9 contain descriptive statistics and data sources used as model inputs. For many of the environmental parameters (retailer type distributions and densities, school, workplace, and population densities, mode of transport distributions) the Minnesota cities listed served as prototypes for the town types, *e.g.,* the suburban poor town type was initialized using retailer, population, and school density data from Duluth, MN. These Minnesota town prototypes were chosen as representatives of income quartiles for urban, suburban, and rural areas, due to complete and available data on retailers, and in consultation with in-state tobacco control experts. The price data for the town types are national averages for urban, suburban, and rural US Census Places in the respective income quartiles and come from an NCI-funded U01 (CA154281), a larger project of which Tobacco Town is a part. Since the price data are nationally representative, we matched these with the observed wage distributions from urban and suburban US Census Places at the respective national quartiles of income. Finally, Tobacco Town Minnesota uses nationally representative data on transport speeds and smoking rates. The following is a list of data sources used to calibrate model parameters:

- **Transportation Speed:** Department of Transportation Survey of Travel Trends, 2009.
    - Disaggregated by rural, suburban, and urban.
- **Transportation Mode:** Department of Transportation Survey of Travel Trends 2009.
    - Disaggregated by Minnesota prototype town, race, and income.
- **Transportation Prices:** US Department of Energy (GasBuddy.com), Metro Transit: 2014 Metro Transit Rider Survey, Metro Transit Website
- **Retailer Data:** CounterTools Tobacco Retailer Audit and Mapper Data; calls to stores.
- **Fuel Efficiency:** Bureau of Transportation Statistics, 2016
- **Carton Multiplier:** National Adult Tobacco Survey (NATS), 2012-2014 (pooled).
- **Discount Rate:** Calibrated to carton purchase data from NATS 2012-2014.
- **Cessation:** NATS 2012-2014
- **Initiation:** NATS 2012-2014
- **Menthol Preferences:** NATS 2012-2014
- **Smoking Rate:** NATS 2012-2014
- **Income Groups:** General Social Survey, 2012-2014; American Community Survey (5-year), 2015
- **Workplace Density:** US Economic Census, 2014
- **Population Density:** American Community Survey (5-year), 2015
- **School Density:** American Community Survey (5-year), 2015

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Table A-5. Retailer statistics from Minnesota prototypes

	Town type					
	Urban Rich	Urban Poor	Suburban Rich	Suburban Poor	Rural Rich	Rural Poor
Input						
MN Prototypes	*Minneapolis*	*Minneapolis*	*Rogers*	*Duluth*	*Rice*	*Wadena*
Zip Codes	*55417 & 55419*	*55414 & 55454*				
Retailer densities	Retailers per square mile					
• Convenience	1.81	5.25	0.62	1.16	0.53	0.93
• General	0.52	2.44	0.25	0.25	0.53	0.56
• Liquor	0.68	0.83	0.25	0.35	0.18	0.19
• Pharmacy	0.34	0.41	0.25	0.29	0.18	0.19
• Tobacconist	0.13	0.46	0.12	0.13	0.18	0.19
• Total	3.48	9.39	1.49	2.18	1.6	2.06
Regular pack price ($)	National mean (sd) [min] by town and store type					
• Convenience	8.70 (0.49) [7.59]	8.79 (0.38) [8.16]	8.43 (0.48) [7.5]	7.44 (0.37) [5.99]	7.46 (0.61) [5.19]	7.31 (0.44) [6.06]
• General	10.38 (0.75) [9.5]	10.31 (1.14) [9.5]	10.2 (1.7) [8.6]	9.46 (1.65) [7.5]	8.74 (1.6) [6.81]	8.25 (1.49) [6.98]
• Liquor	9.63 (1.04) [8.6]	9.46 (0.68) [8.5]	9.02 (0.15) [8.89]	7.97 (1.12) [6]	8.29 (1.23) [6.1]	8.39 (1.17) [7.1]
• Pharmacy	8.50 (0.02) [8.46]	9.01 (0.69) [8.52]	8.52 (0.01) [8.51]	7.54 (0.42) [6.91]	8.14 (0.55) [7.48]	7.98 (0.63) [7.42]
• Tobacconist	8.61 (0.1) [8.5]	8.48 (0.14) [8.38]	8.62 (0.17) [8.44]	7.09 (0.59) [6.19]	6.84 (0.76) [6.3]	6.97 (0.7) [6.17]
Menthol pack price ($)	National mean (sd) [min] by town and store type					
Convenience	8.87 (0.32) [8.46]	9 (0.57) [8.53]	8.61 (0.38) [7.5]	7.62 (0.66) [5.19]	7.6 (0.73) [5.19]	7.47 (0.62) [5.19]
General	10.13 (0.63) [9.5]	10.5 (1) [10]	10.3 (1.57) [8.9]	9.9 (1.01) [8.52]	8.8 (1.52) [7.03]	8.35 (1.48) [6.98]
Liquor	10.03 (1.45) [8.8]	9.8 (0.66) [8.7]	9.29 (0.36) [8.99]	8.17 (0.98) [6.75]	8.45 (1.18) [6.1]	9.02 (0.92) [7.49]
Pharmacy	8.59 (0.03) [8.55]	9.06 (0.63) [8.61]	8.61 (0) [8.6]	7.71 (0.59) [6.91]	8.33 (0.41) [7.62]	8.07 (0.57) [7.49]
Tobacconist	8.78 (0.29) [8.45]	8.63 (0.06) [8.58]	8.42 (0.22) [8.24]	7.14 (0.64) [6.19]	6.99 (0.98) [6.3]	7.09 (0.86) [6.17]

Source: Counter Tools 2018.

Table A-6. Transportation and place statistics from Minnesota prototypes

	Town type						
	Urban Rich	Urban Poor	Suburban Rich	Suburban Poor	Rural Rich	Rural Poor	
Input							**Source/Notes**
Minnesota Prototype	*Minneapolis*	*Minneapolis*	*Rogers*	*Duluth*	*Rice*	*Wadena*	
Zip Codes	*55417 & 55419*	*55414 & 55454*					
							Densities are per square mile
School density	1.74	1.86	0.62	0.59	0.53	0.74	ACS 2015
Workplace density	91.1	233.4	15.34	31.42	1.23	1.77	USEC 2014
Population density	370.7	680.0	70.86	96.93	14.46	68.33	ACS 2015
Transport mode							DOT Survey of Travel Trends, 2009
Car proportion	0.915	0.472	0.958	0.874	0.985	0.956	
Walk proportion	0.017	0.257	0.003	0.067	0.015	0.027	
Bike proportion	0.013	0.074	0.0	0.008	0.0	0.0	
Transit Proportion	0.055	0.197	0.039	0.051	0.0	0.017	
Transport speed (mph)							DOT Survey of Travel Trends, 2009
Car	21.1	21.1	23.0	23.0	26.4	26.4	
Bike	6.6	6.6	6.4	6.4	6.3	6.3	
Walk	2.9	2.9	3.0	3.0	3.1	3.1	
Transit	9.3	9.3	11.5	11.5	12.8	12.8	

Sources: American Community Survey 2015; US Economic Census 2014.

Table A-7. Demographic distributions by town type

Source: American Community Survey (5-year), 2015; General Social Survey, 2012-2014

			Town type					
			Urban Rich	Urban Poor	Suburban Rich	Suburban Poor	Rural Rich	Rural Poor
Input								
Minnesota Prototype			*Minneapolis*	*Minneapolis*	*Rogers*	*Duluth*	*Rice*	*Wadena*
Race	**LGBT**	**Wage** ($1,000s)						
Non-black	Non-LGBTQ+	<10	0.04	0.17	0.03	0.12	0.02	0.1
Non-black	Non-LGBTQ+	15	0.03	0.08	0.02	0.08	0.02	0.12
Non-black	Non-LGBTQ+	25	0.08	0.14	0.09	0.15	0.05	0.28
Non-black	Non-LGBTQ+	35	0.08	0.1	0.07	0.13	0.1	0.12
Non-black	Non-LGBTQ+	50	0.13	0.1	0.1	0.16	0.21	0.19
Non-black	Non-LGBTQ+	75	0.1	0.06	0.1	0.11	0.23	0.08
Non-black	Non-LGBTQ+	100	0.09	0.03	0.11	0.07	0.19	0.05
Non-black	Non-LGBTQ+	150	0.15	0.03	0.17	0.07	0.1	0.02
Non-black	Non-LGBTQ+	200	0.06	0.01	0.13	0.02	0.04	0
Non-black	Non-LGBTQ+	>200	0.07	0.01	0.09	0.02	0.01	0.02
Black	Non-LGBTQ+	<10	0.02	0.08	0	0.01	0	0
Black	Non-LGBTQ+	15	0.01	0.02	0	0	0	0
Black	Non-LGBTQ+	25	0.01	0.04	0	0.01	0	0
Black	Non-LGBTQ+	35	0.01	0.02	0	0	0	0
Black	Non-LGBTQ+	50	0.01	0.02	0	0	0	0
Black	Non-LGBTQ+	75	0.01	0.01	0.01	0	0	0
Black	Non-LGBTQ+	100	0.01	0	0	0	0	0
Black	Non-LGBTQ+	150	0	0	0	0	0	0
Black	Non-LGBTQ+	200	0	0	0	0	0	0
Black	Non-LGBTQ+	>200	0	0	0	0	0	0
Non-black	LGBTQ+	<10	0	0.02	0	0.01	0	0
Non-black	LGBTQ+	15	0	0.01	0	0	0	0
Non-black	LGBTQ+	25	0.01	0.01	0.01	0.01	0	0.01
Non-black	LGBTQ+	35	0.01	0.01	0	0.01	0	0
Non-black	LGBTQ+	50	0.01	0.01	0.01	0.01	0	0.01
Non-black	LGBTQ+	75	0.01	0.01	0.01	0.01	0.01	0
Non-black	LGBTQ+	100	0.01	0	0.01	0	0.01	0
Non-black	LGBTQ+	150	0.02	0	0.01	0	0	0
Non-black	LGBTQ+	200	0.01	0	0.01	0	0	0
Non-black	LGBTQ+	>200	0.01	0	0.01	0	0	0
Black	LGBTQ+	<10	0	0.01	0	0	0	0
Black	LGBTQ+	15	0	0	0	0	0	0
Black	LGBTQ+	25	0	0	0	0	0	0
Black	LGBTQ+	35	0	0	0	0	0	0
Black	LGBTQ+	50	0	0	0	0	0	0
Black	LGBTQ+	75	0	0	0	0	0	0
Black	LGBTQ+	100	0	0	0	0	0	0
Black	LGBTQ+	150	0	0	0	0	0	0
Black	LGBTQ+	200	0	0	0	0	0	0
Black	LGBTQ+	>200	0	0	0.039	0	0	0

Source: American Community Survey 2015.

Table A-8. Cigarettes per day for smokers (invariant across town types)

Cigarettes Per Day	Black, LGBTQ+, higher-income	Black, LGBTQ+, lower-income	Black, non-LGBTQ+, higher-income	Black, non-LGBTQ+, lower-income	Non-Black, LGBTQ+, higher-income	Non-Black, LGBTQ+, lower-income	Non-Black, non-LGBTQ+, higher-income	Non-Black, non-LGBTQ+, lower-income
1	0	0	0	0	0	0	0	0.01
2	0	0	0.01	0.01	0.01	0.01	0.01	0.02
3	0	0.04	0.05	0.06	0.02	0.05	0.02	0.03
4	0	0.19	0.11	0.12	0.04	0.1	0.04	0.05
5	0.07	0.33	0.22	0.18	0.08	0.13	0.08	0.09
6	0.07	0.43	0.27	0.23	0.09	0.16	0.11	0.12
7	0.11	0.54	0.3	0.29	0.11	0.2	0.13	0.14
8	0.24	0.61	0.34	0.34	0.13	0.23	0.16	0.16
9	0.26	0.61	0.35	0.35	0.14	0.24	0.16	0.17
10	0.51	0.74	0.61	0.62	0.32	0.42	0.35	0.38
11	0.51	0.74	0.61	0.62	0.32	0.42	0.36	0.38
12	0.51	0.76	0.65	0.66	0.37	0.46	0.39	0.41
13	0.52	0.76	0.65	0.66	0.37	0.47	0.39	0.41
14	0.52	0.76	0.66	0.67	0.37	0.47	0.4	0.42
15	0.77	0.87	0.74	0.73	0.53	0.55	0.53	0.51
16	0.8	0.87	0.74	0.73	0.54	0.55	0.54	0.52
17	0.8	0.87	0.75	0.73	0.54	0.55	0.54	0.52
18	0.8	0.89	0.75	0.74	0.55	0.57	0.56	0.53
19	0.8	0.89	0.75	0.74	0.55	0.57	0.56	0.53
20	1	1	0.95	0.95	0.87	0.85	0.86	0.85
25	1	1	0.96	0.96	0.88	0.87	0.89	0.88
30	1	1	0.97	0.98	0.92	0.92	0.95	0.94
35	1	1	0.97	0.98	0.93	0.92	0.95	0.94
40	1	1	0.98	1	0.96	0.97	0.99	0.99
45	1	1	0.98	1	0.97	0.97	0.99	0.99
50	1	1	0.99	1	0.98	0.98	0.99	0.99
55	1	1	0.99	1	0.98	0.98	0.99	0.99
60	1	1	1	1	1	1	1	1

Source: National Adult Tobacco Survey (CDC) 2012 & 2014.

Table A-9. Menthol Preferences

Menthol Preference	Black, LGBTQ+, higher-income	Black, LGBTQ+, lower-income	Black, non-LGBTQ+, higher-income	Black, non-LGBTQ+, lower-income	Non-Black, LGBTQ+, higher-income	Non-Black, LGBTQ+, lower-income	Non-Black, non-LGBTQ+, higher-income	Non-Black, non-LGBTQ+, lower-income
Always ($\alpha = 0.95$)	52.46	65.68	59.99	59.39	24.9	29.82	20.59	21.86
Mostly ($\alpha = 0.75$)	10.02	20.03	10.31	15.02	6.94	6.81	4.58	4.95
Sometimes ($\alpha = 0.5$)	9.62	1.08	10.96	8.98	9.66	6.18	4.48	6
Rarely ($\alpha = 0.25$)	1.24	10.16	6.46	6.01	19.45	25.47	18.69	21.12
Never ($\alpha = 0.01$)	26.66	3.06	12.28	10.6	39.06	31.73	51.66	46.08

Source: National Adult Tobacco Survey (CDC) 2012 & 2014.

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