



The Search for Mechanisms: Retailer Density and Modeling

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allisonemyers.com



Center for Public Health
Systems Science

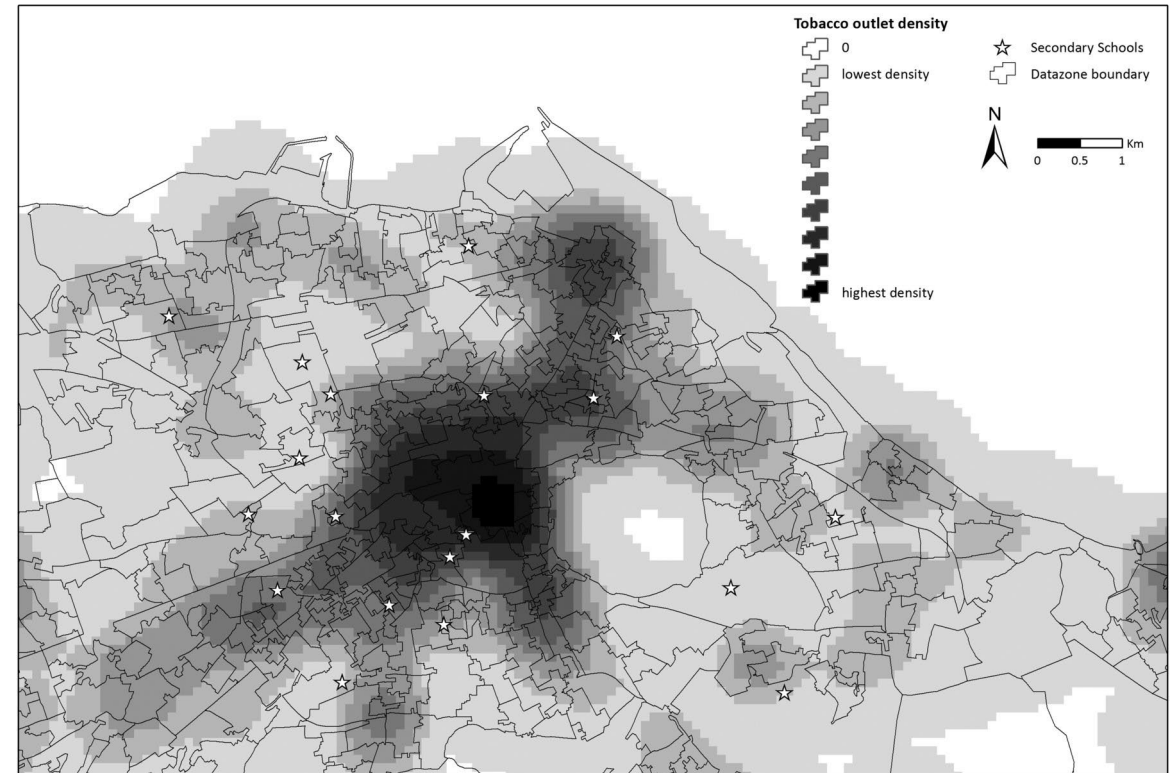
Brown School



Washington University in St. Louis

Goals

- Agent-based models for policy implementation research
- Tobacco Town examples
 - How it works
 - What we are learning
- Dashboards as dissemination tools for community stakeholders

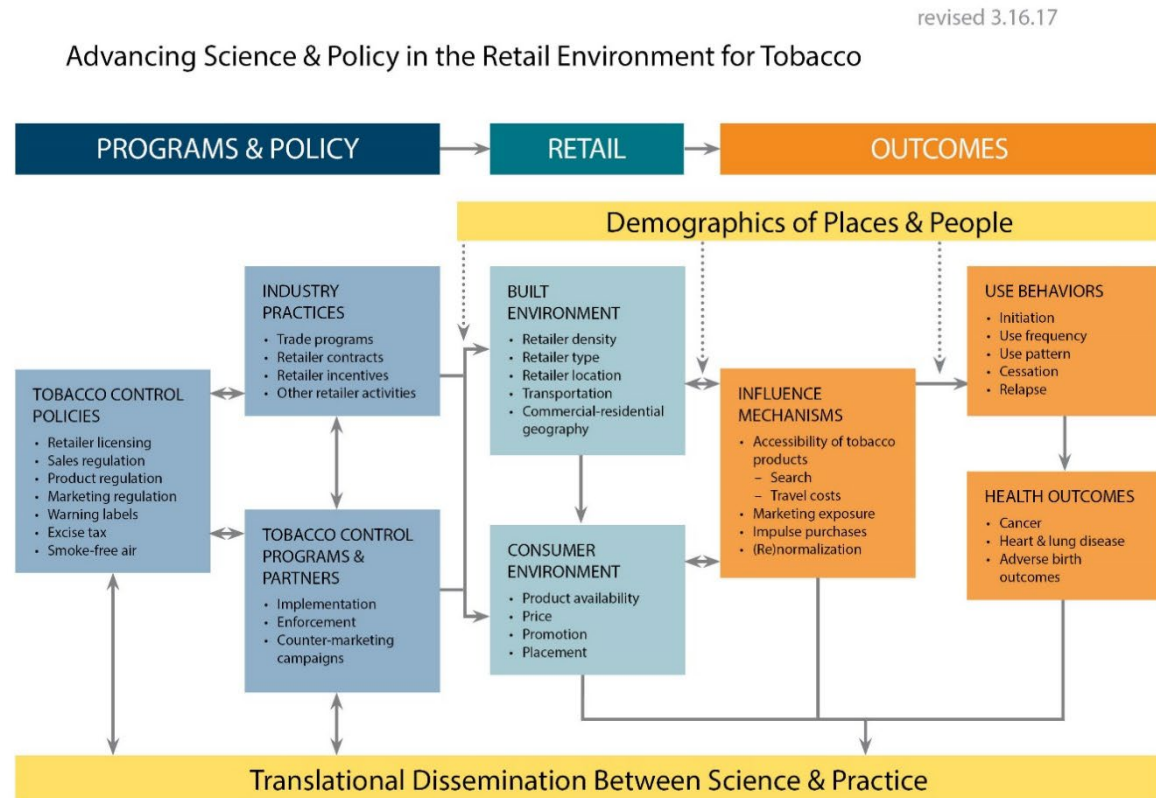


Retailer density in Edinburgh – from Shortt et al., 2014, Tobacco Control.



Importance of policy

- Policies are
 - social mechanisms
 - that shape environments
 - to affect behavior and health
- We use (effective) policies because of their
 - low cost
 - high reach
 - sustainability



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- Policies are
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However, we often don't know how or why certain policies work!



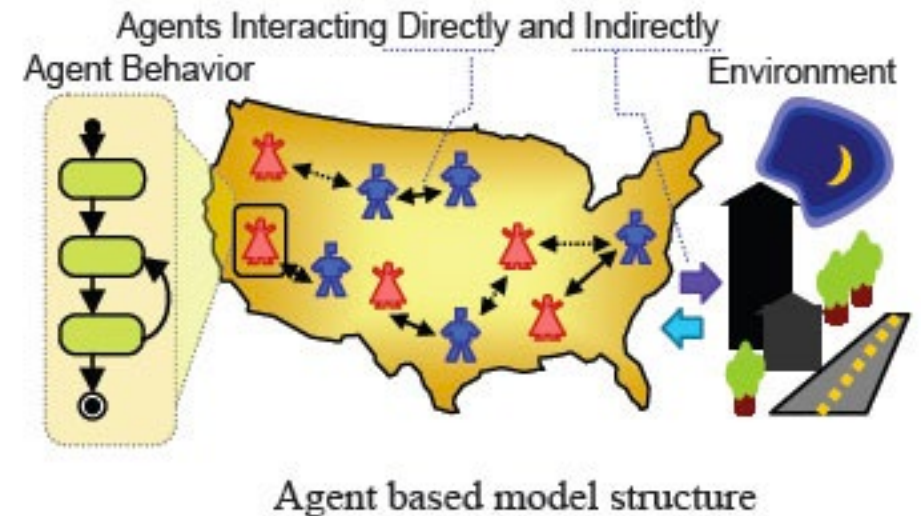
Agent-based Models

Powerful tools to explore behavioral dynamics within complex systems



What is an ABM?

- A bottom-up simulation approach that is used to study complex systems by exploring how individual elements (agents) of a system behave as a function of their characteristics and interactions with each other and the environment.
- Emphasizes
 - Heterogeneity
 - Environments that are physical or social
 - Emergent behavior
- Similar to microsimulations



Building an ABM - PARTE system

- Agent **P**roperties
- Agent **A**ctions
- Agent **R**ules
- **T**ime
- **E**nvironment

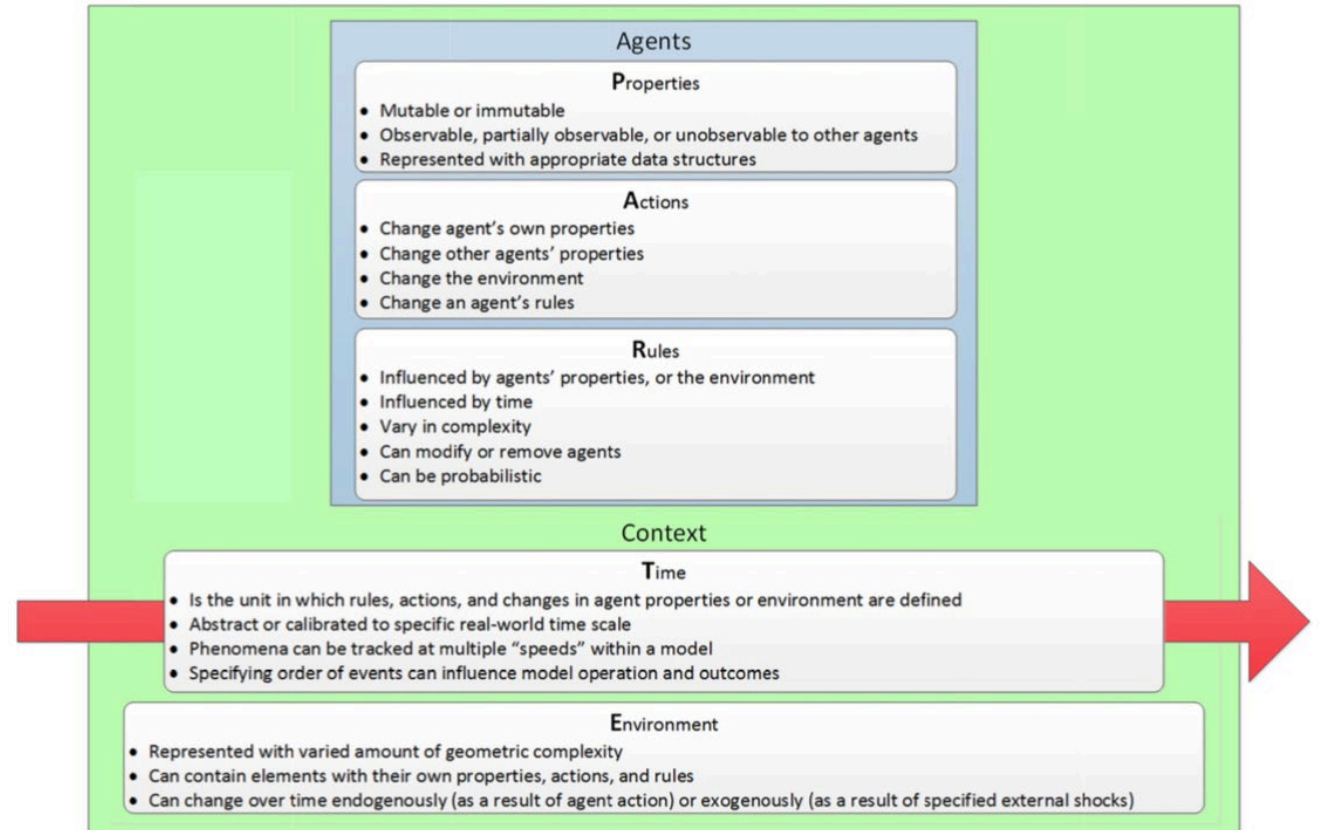
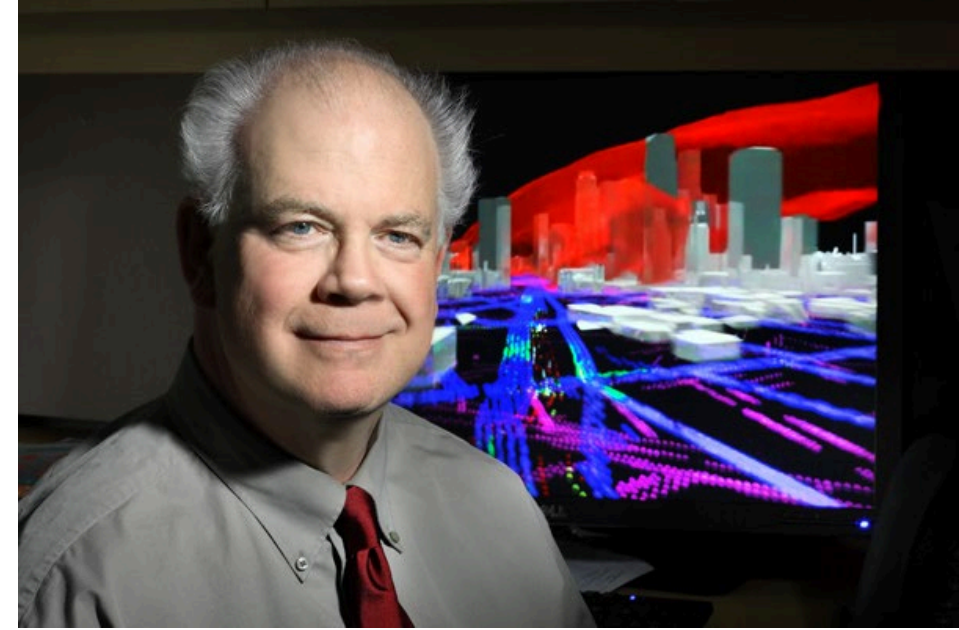


FIGURE A-1 PARTE framework.

Hammond, R. (2015) IOM Report

1 + 16 reasons to do complex systems modeling

- Prediction
- Other reasons
 - Explain
 - Guide data collection
 - Illuminate core dynamics
 - Suggest dynamical analogies
 - Discover new questions
 - Promote scientific habit of mind
 - Bound outcomes to plausible ranges
 - Illuminate core uncertainties
 - Offer crisis options in near-real time
 - Demonstrate tradeoffs
 - Challenge robustness of prevailing theory
 - Expose prevailing wisdom as incompatible with available data
 - Train practitioners
 - Discipline the policy dialogue
 - Educate the public
 - Reveal the simple to be complex, and vice versa



Tobacco Town

Using agent-based modeling as a policy laboratory in tobacco control

R21 CA172938 - NCI

U01 CA154281 - NCI

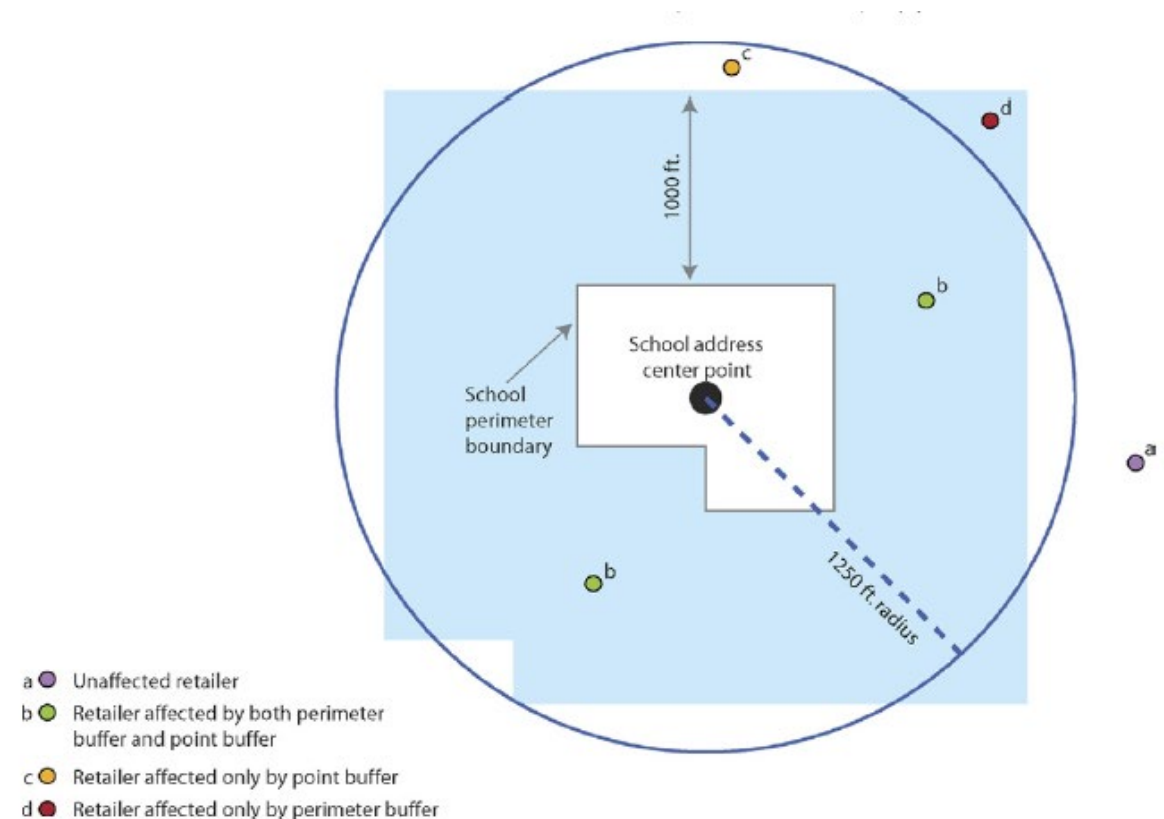
P01 CA225597 - NCI

(With Ross Hammond; Kurt Ribisl, UNC; Lisa Henriksen, Stanford)



Rationale for studying implementation of density reduction policies

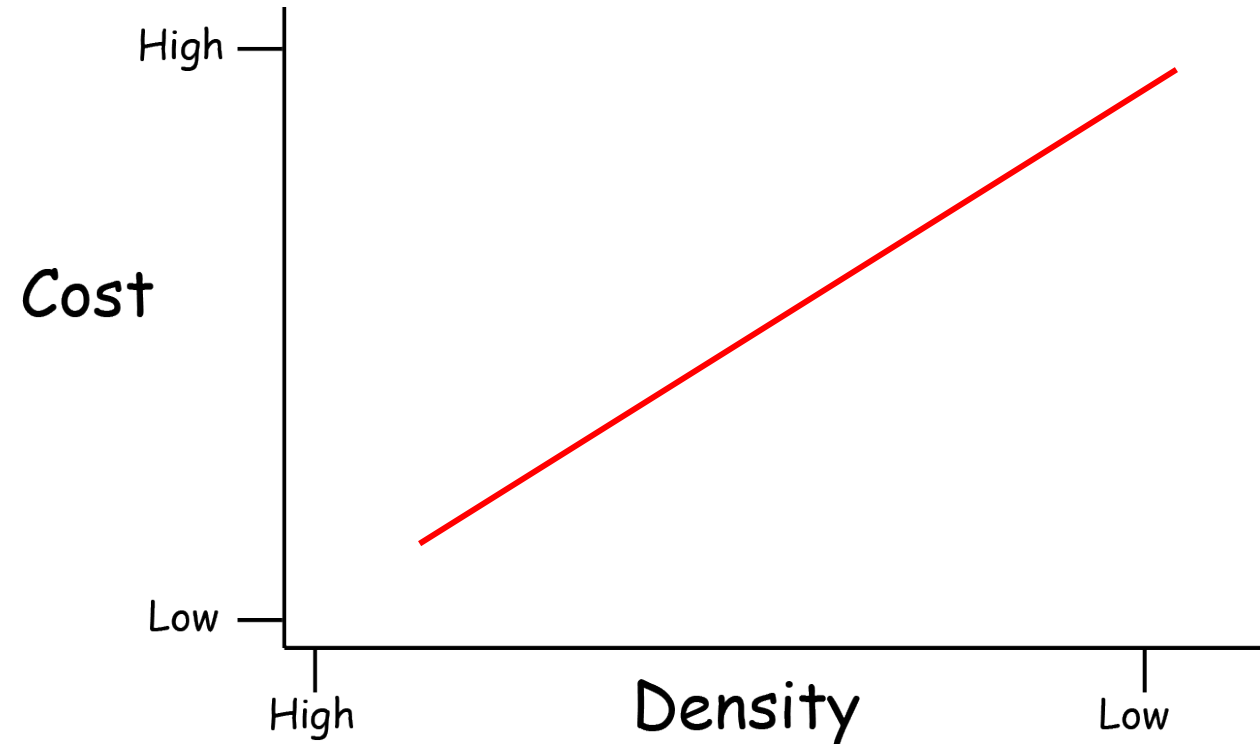
- Decrease availability
- Increase search cost of obtaining
- Decreases visibility of environmental cues to smoke
- Changes social norms, reduces “insidious ordinariness” of tobacco
- Reduces “Tobacco Swamps”



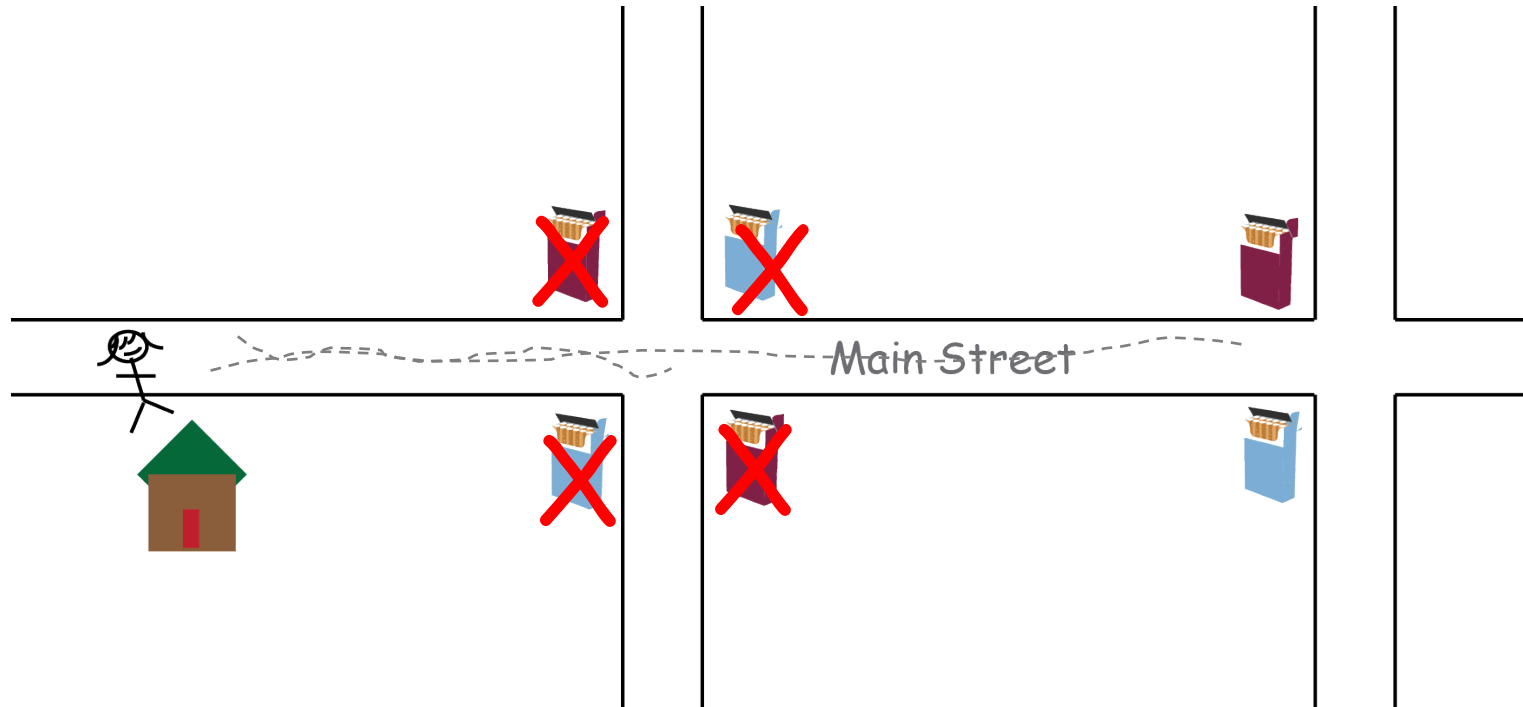
From Luke, et al, 2011, *Am J Prev Med*

Thinking about retailer density and cost...

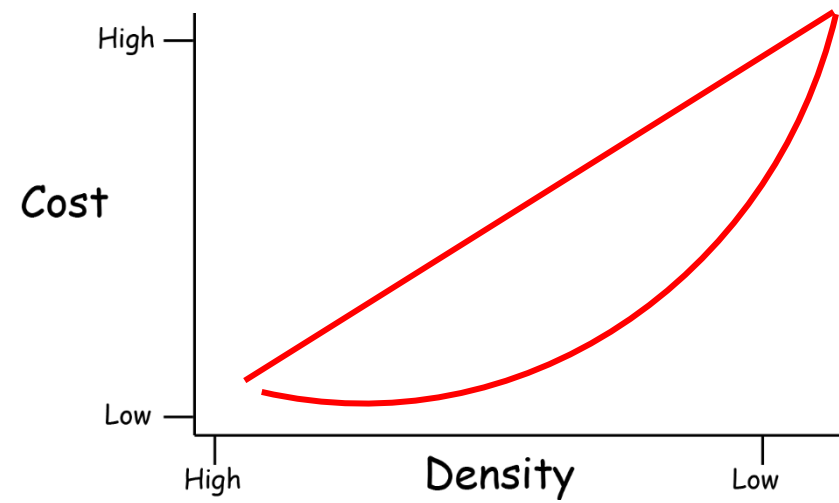
- We might assume...



How does reduced density actually affect behavior?



So, in reality...



Tobacco Town Goals

- Build a series of ***simulation models*** to identify interactions between the retail environment for tobacco and purchase and use behaviors



- Use the models as ***policy laboratories*** to explore potential impact of various retail policies across contexts and populations

- Work with stakeholders to ***tailor models to communities***, test the likely impact of prioritized policies and disseminate results



Tobacco Town - History



Tobacco Town 1 (2012-2015)

- Abstracted retailer density model
- 4 town types: poor/rich by suburban/urban



Tobacco Town - Minnesota (2016-2018)

- Focus on Minnesota policy considerations (esp. Menthol)
- Added rural town types, all based on representative Minnesota localities



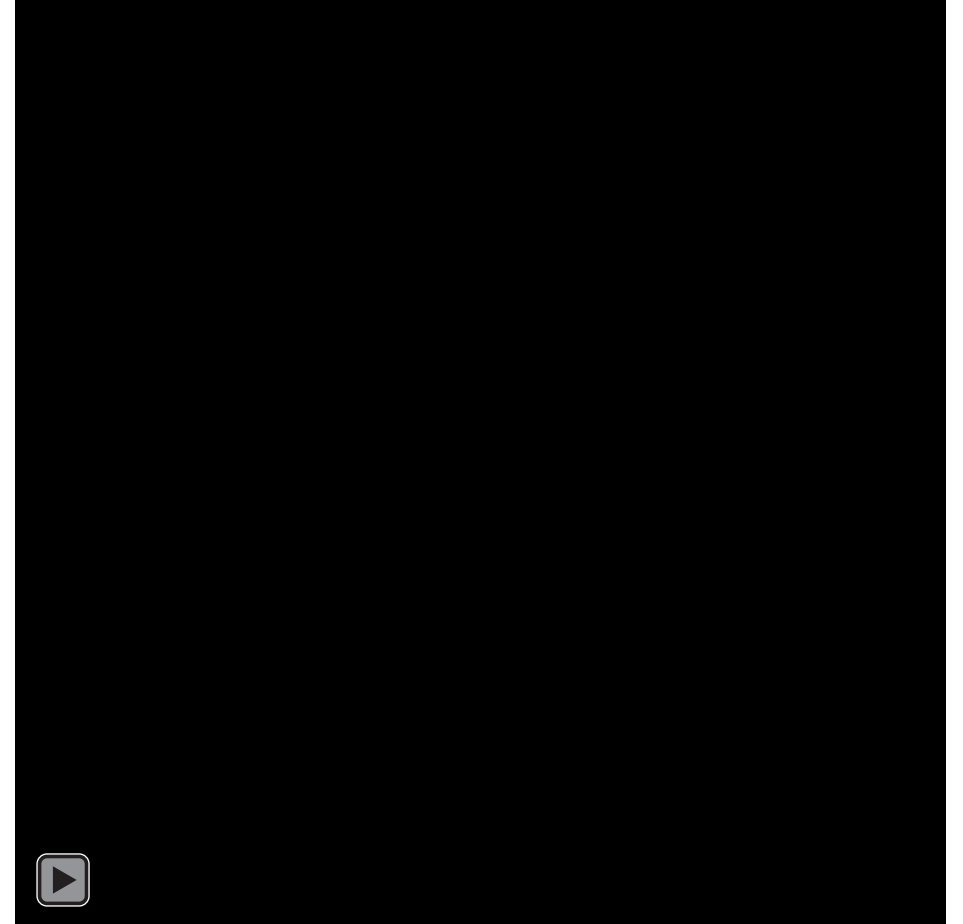
Tobacco Town - ASPiRE (2018-2023)

- Added retailer dynamics, specific tobacco products
- Building models using synthetic populations for 30 large cities



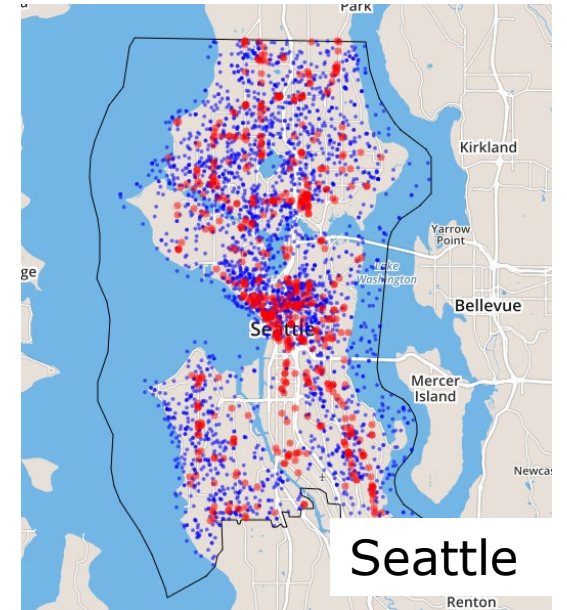
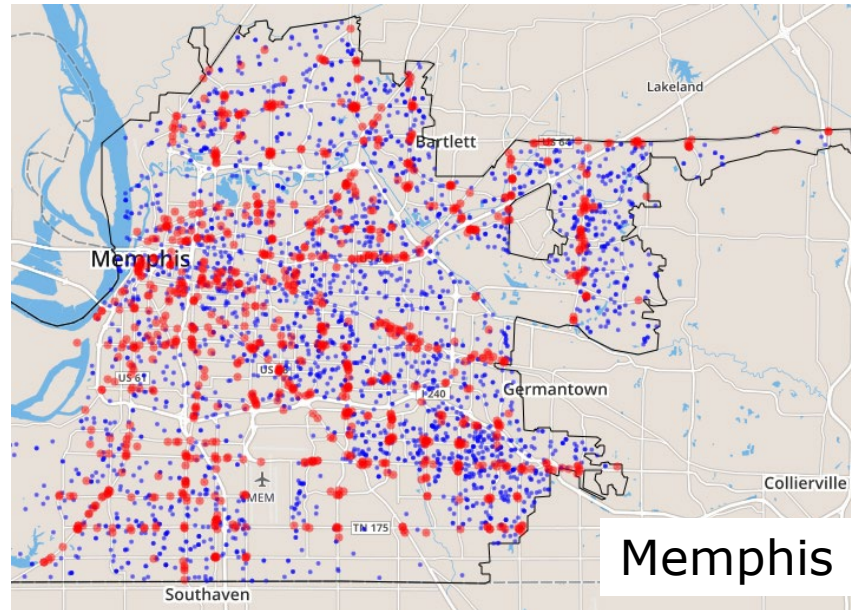
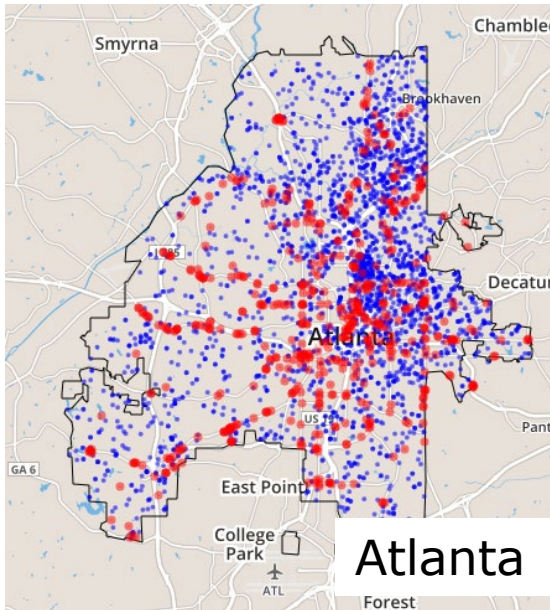
Tobacco Town model visualization

- Agent color = transportation type
- Box color = retailer type
- Box size = cigarette price
- Box flashes when agent purchases cigarettes



Tobacco Town - ASPiRE progress

- Built virtual environments for each of the 30 CAB member cities
 - Real-world geographies, tobacco retailer locations, synthetic populations



- Working with partners to identify prioritized policies for each city
- Developing dashboard to allow interactive exploration of policy effects

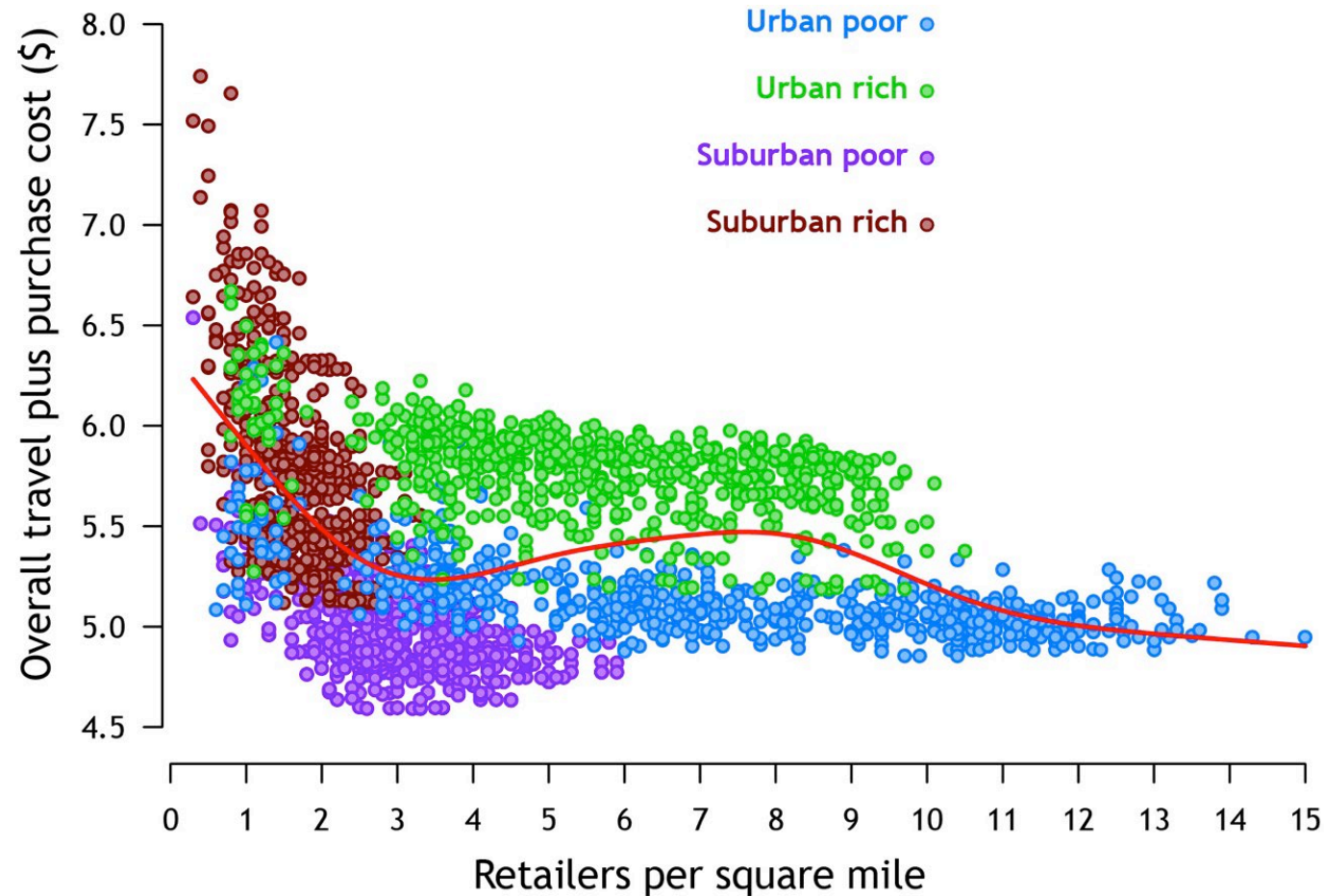


What Are We Learning?

- 1) Density reduction effects are non-linear
- 2) Strong policies, and multiple policies have larger effects
- 3) Policy effects are community-specific
- 4) Policies have different potential for affecting disparities & behavior
- 5) Density and proximity are not the same thing

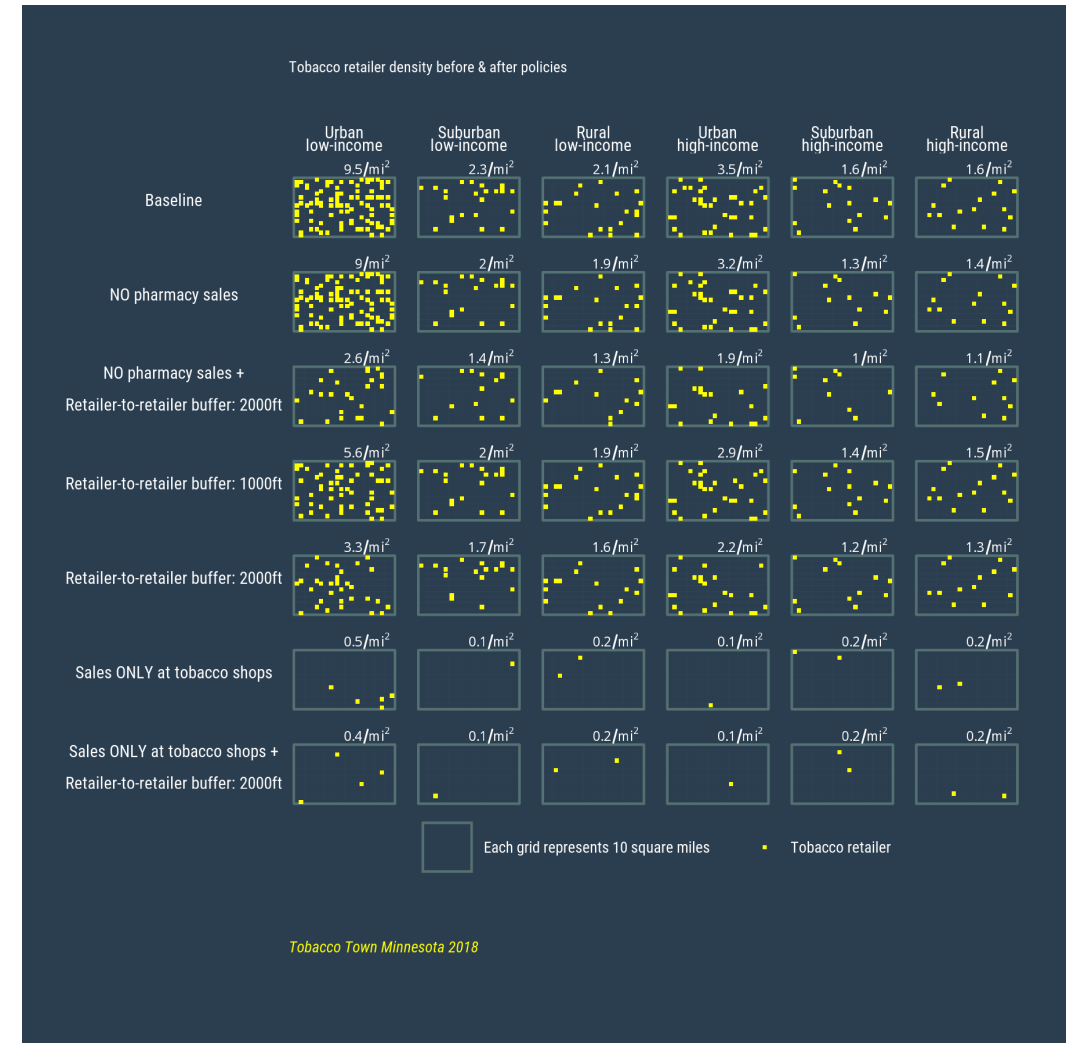


Density reduction may need to reach threshold before effects are seen



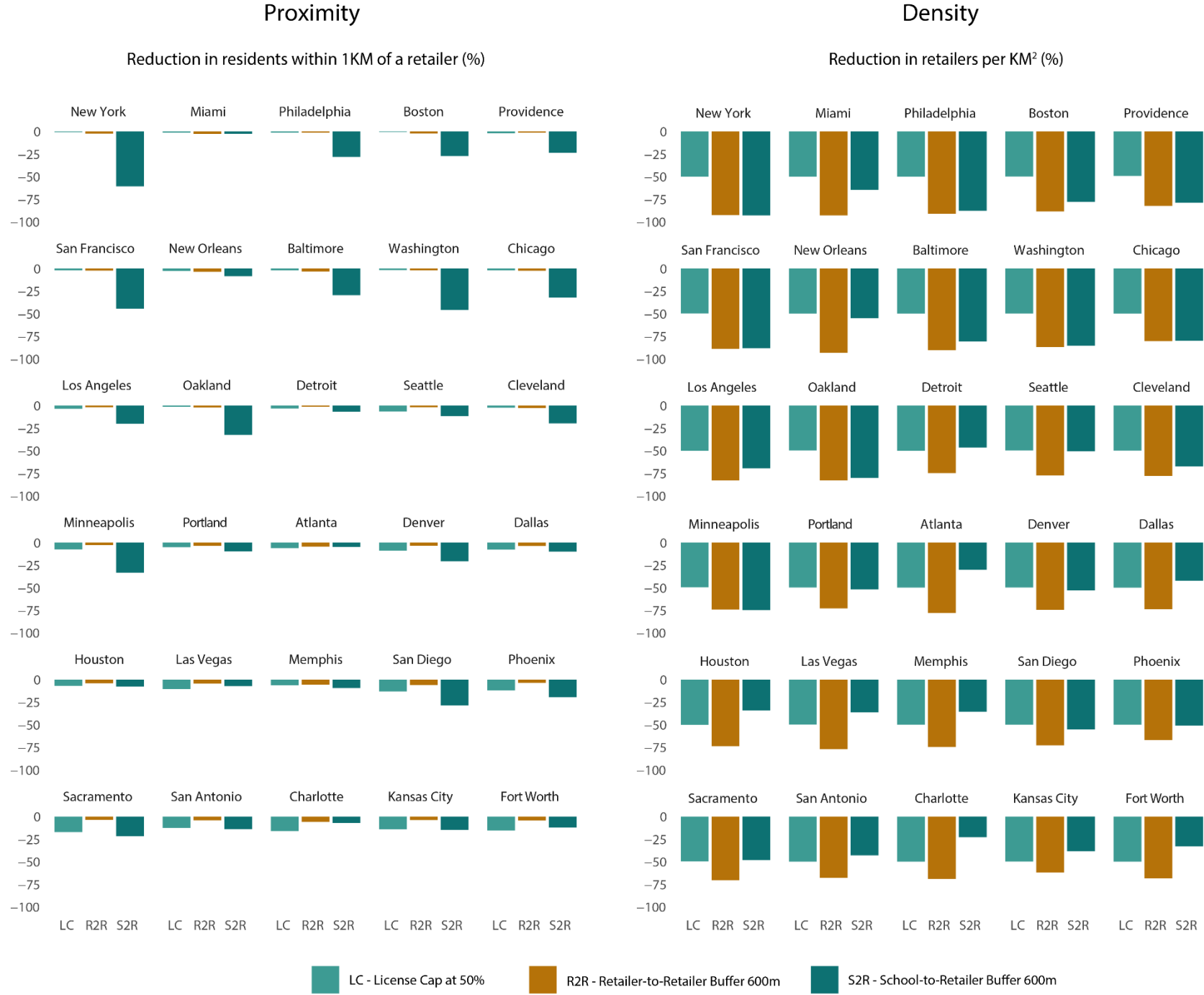
Policy effects depend on context

- No ‘one-size-fits-all’ policy
- Layering of policies may help remove community disparities



Tobacco Town Minnesota;
<https://tobaccotown.shinyapps.io/Minnesota/>

Policies have different potential for affecting retailer densities & resident-to-retailer proximities

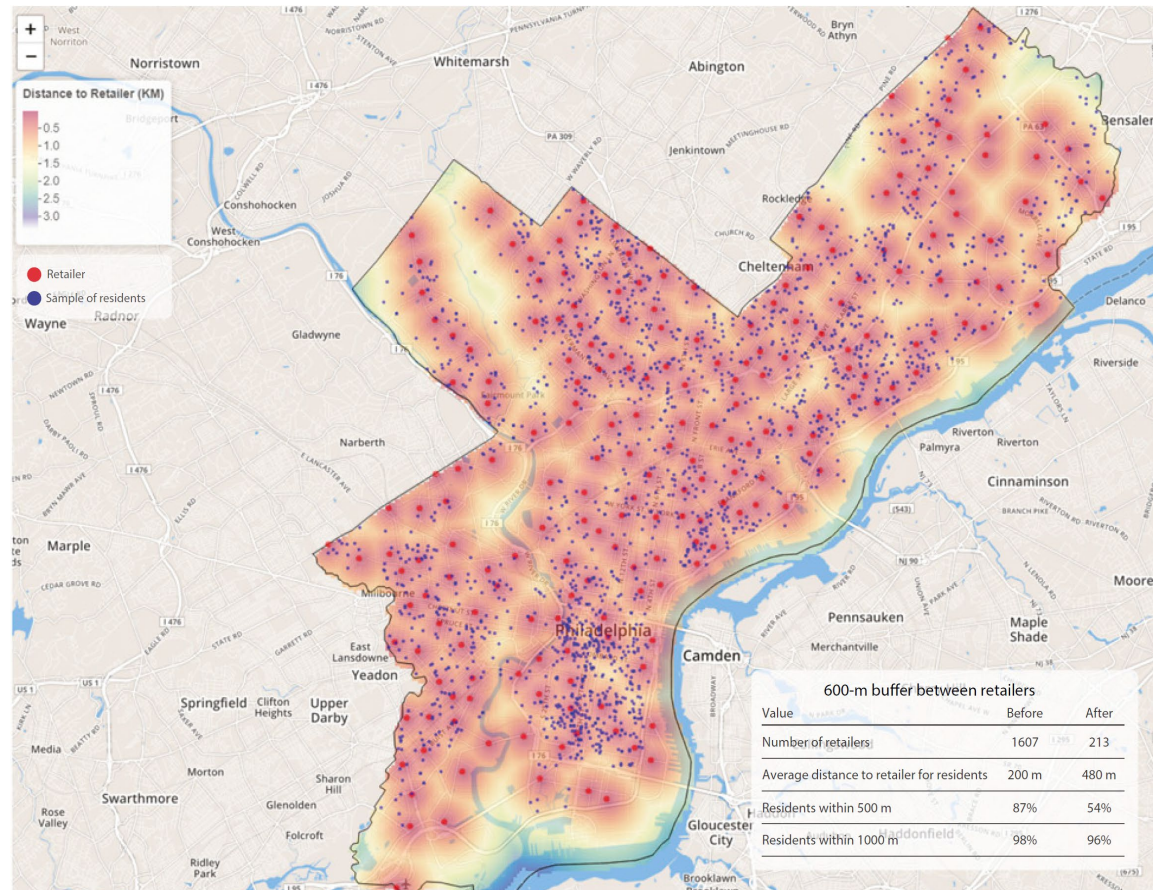


Notes: Cities ordered from highest to lowest baseline proximity measures (top to bottom, left to right). Longer bars indicate more reduction in density or proximity.

Density and proximity are not the same

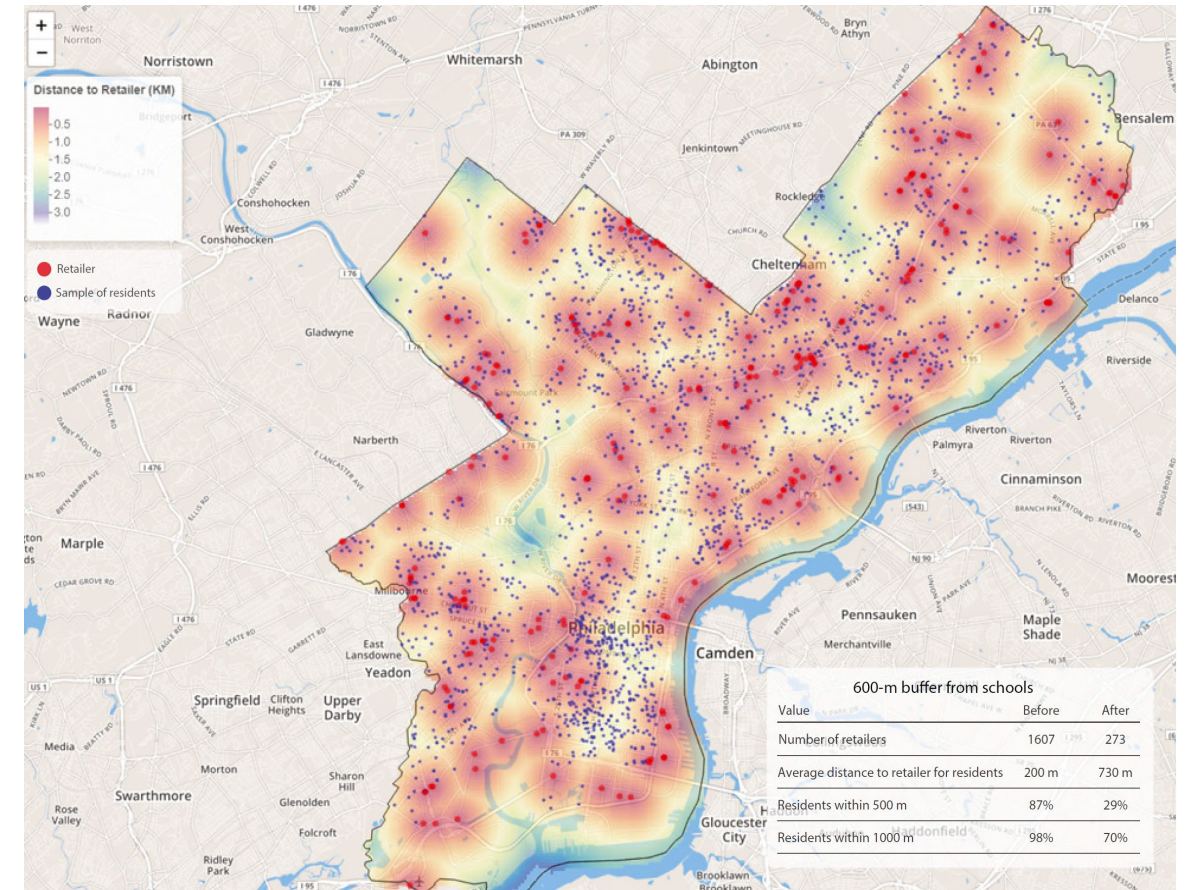
- 600m retailer buffer:

- Density: **4.5 \rightarrow 0.60** retailers/km²
- Proximity: **200 \rightarrow 480m** avg. distance resident \rightarrow retailer



- 600m school buffer

- Density: **4.5 \rightarrow 0.76** retailers/km²
- Proximity: **200 \rightarrow 730m** avg. distance resident \rightarrow retailer



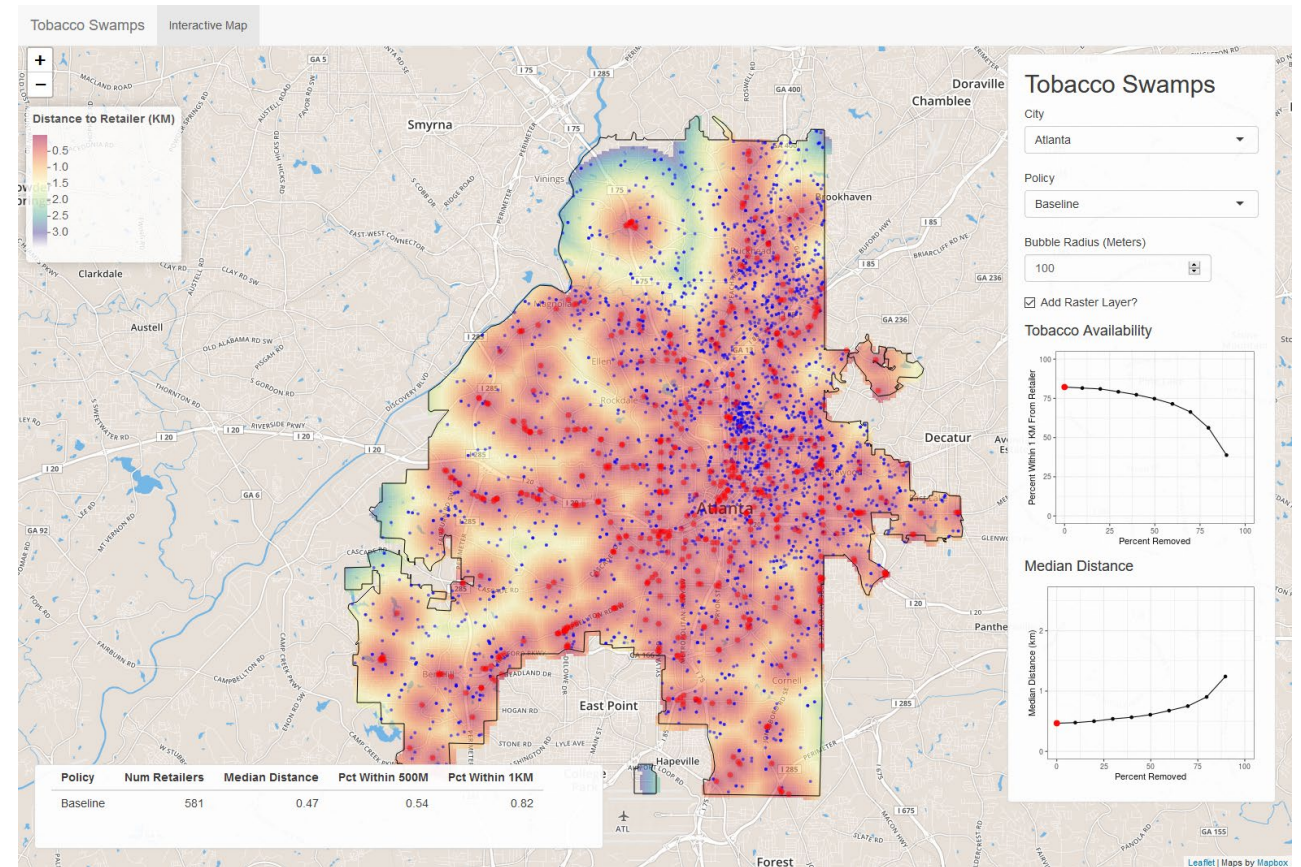
From Models to Tools

Developing dashboard tools that can be used by community partners to explore effects of retailer reduction policies



Dissemination – Systems tools for stakeholders

- Design for dissemination (Brownson, Dearing)
- Systems science results are very amenable to stakeholder discussions and action
 - Interactive community dashboards
- *Tobacco Swamps* examples
 - tobaccotown.shinyapps.io/Minnesota
 - Tobacco Swamps (ASPiRE)



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