THE INTERNATIONAL PUBLIC SAFETY DATA INSTITUTE

IPSDI

International Public Safety Data Institute

Partners

Economics of Fire Protection

- Study of tradeoffs between the cost of 'doing something' versus the value of loss from 'doing nothing' or 'something else'
  - Example: cost of sprinkler system vs damage from fire in unsprinklered structure
- Costs include expenditures on categories such as:
  - Prevention
  - Mitigation
  - Suppression
- Losses include monetary value of damage and can be categorized as:
  - Direct losses
  - Indirect losses

Optimal Level of Intervention
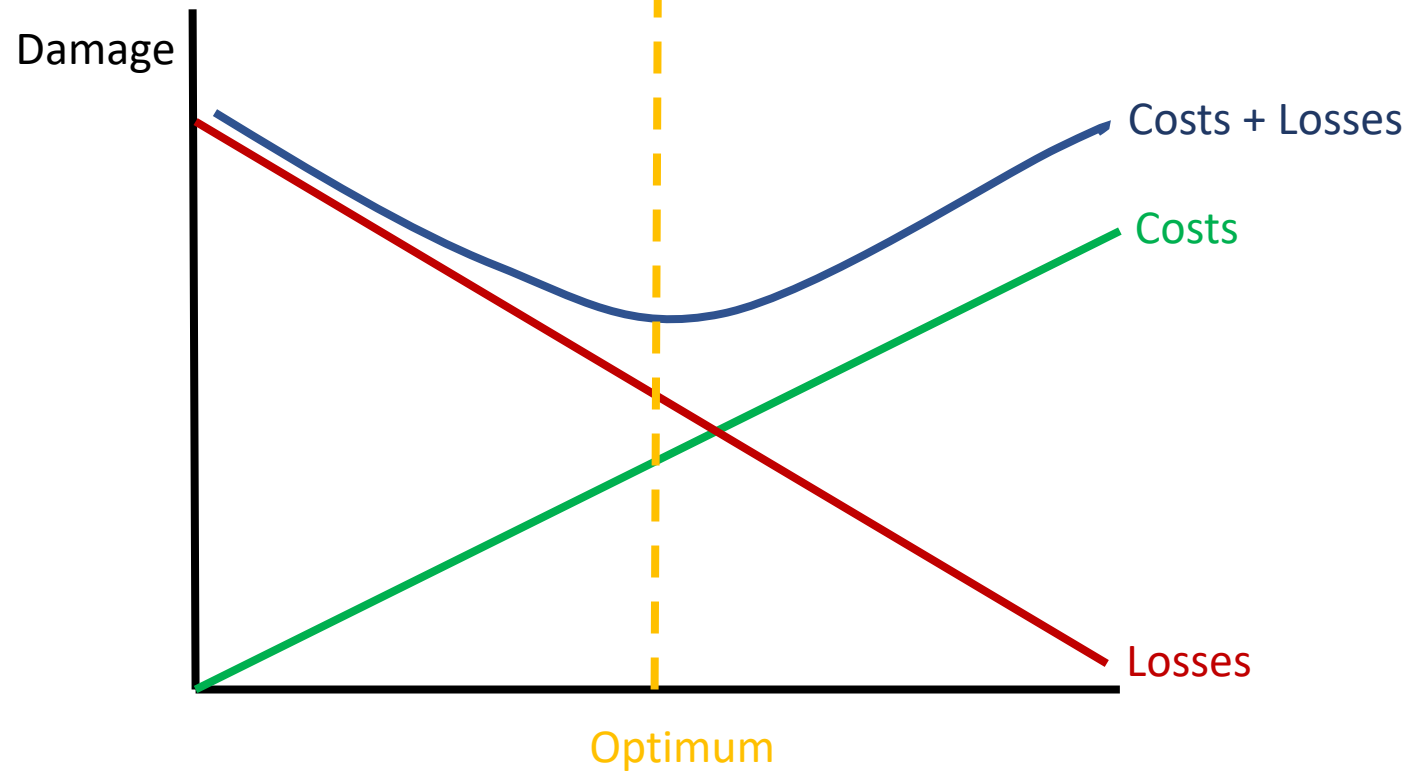
"If you cannot measure it, you cannot improve it."

-William Thomson

Some Measurement Challenges…

1. Accuracy of cost & loss estimates
    - Under-reporting
    - Errors in reporting
2. Many benefits (avoided losses) are unobservable & difficult to value
    - A comparison world without prevention, suppression, & mitigation doesn't exist
3. Uncertainties from a changing nation/world
    - Aging population
    - Population movement
    - Climate change
    - Emergent hazards
    - …
4. Lacking are risk models linking interventions to fire outcomes

NIST Applied Economics Office: Fire Research

https://www.nist.gov/el/applied-economics-office

- Prevention
  - Education
  - Policing
  - Technologies
- Suppression
  - Wildland firefighting
- Mitigation
  - Sprinklers
  - Prescribed fire
  - Detection
  - Occupant Evacuation Elevators

- Hazard Identification
  - Arson 'Hotspots'
  - WUI fire risk maps
  - Role of topography, weather, demographics
  - Building density
  - Vulnerable Populations & Neighborhoods
- Data Quality & Under-Reporting
  - Municipal WUI fires
  - NFIRS representation of fire problem
  - Data imputation

Smoke Alarms in Homes

And the Census

Objectives

- Determine the **effectiveness** of smoke alarms in homes
- Determine the **geographic distribution** of smoke alarms in homes

Study Motivation – Why?

- NFPA Data
  - Some 35% of reported fires are in homes without smoke alarms
  - But only about 5% of homes lack them
  - Suggesting homes without smoke alarms have a lot more fires
- Previous Research: smoke alarms have a big effect
- Evidence that Smoke Alarm surveys are biased
- Obvious questions:
  - How big is the effect?
  - How many smoke alarms are out there?
  - What are they?

Potential Impacts

- Research has found smoke alarm give-away programs reduce fire injuries significantly

- So, What areas lack smoke alarms?

Effectiveness – Factors to Account for

- Data Source: NFIRS
- Most fires are not reported to the fire department
- Some Fires have Casualties
- Reporting of Smoke Alarm Presence Differs:
  - From Department to Department
  - Depending on Casualties

Effectiveness Approach

- Using NFIRS Data
- Estimate:
  - Fire Reporting Rate (with and without smoke alarms)
  - Casualty Rate (with and without smoke alarms)
- Accounting for
  - Population
  - *Overall* Smoke Alarm Utilization
  - *Overall* Ignition Rate

Results

	Ignitions per 100 households	% Ignitions Reported	Casualties per 1000 Fires
Smoke Alarms	6.45	1.1%	0.33
No Smoke Alarms	15.09	4.1%	0.84
Improvement (%)	57.3%	72.7%	60.2%

Fire Economics

Geographic Distribution

- For Each Census Tract in the US (50 States + DC)
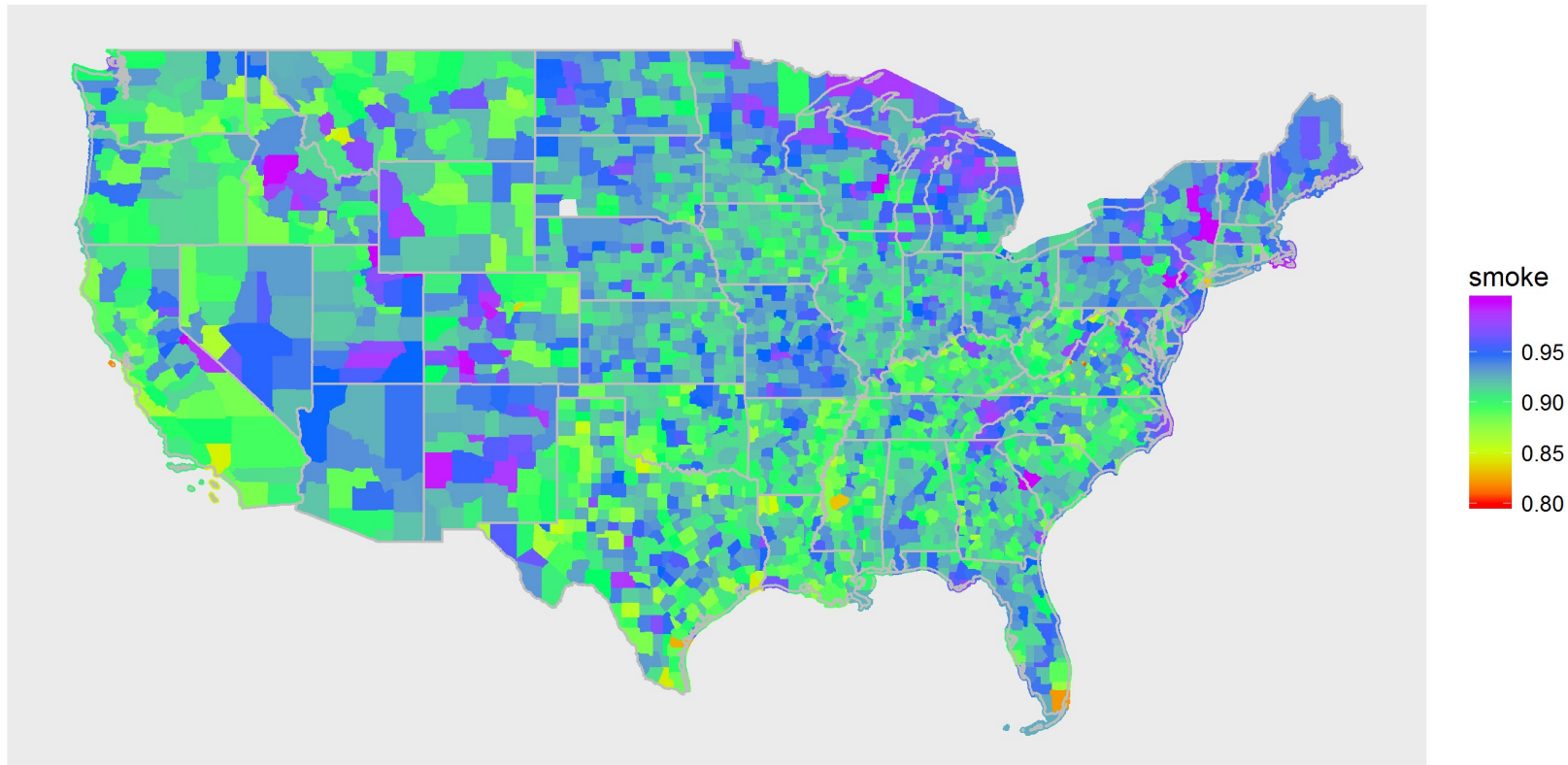- Determine % of households with smoke alarms

Census Data

- **American Housing Survey (AHS)**
  - Asked about smoke alarms in homes in 2007, 2009, 2011
  - Problem: Not enough data to estimate census tracts

- **American Community Survey (ACS)**
  - Data down to the Census Tract level
  - Problem: No information about smoke alarms
  - Problem: Only averages

- **Public Use Microdata Sample (PUMS)**
  - Individual Level Data
  - Problem: No information about smoke alarms
  - Problem: Not enough data to estimate census tracts
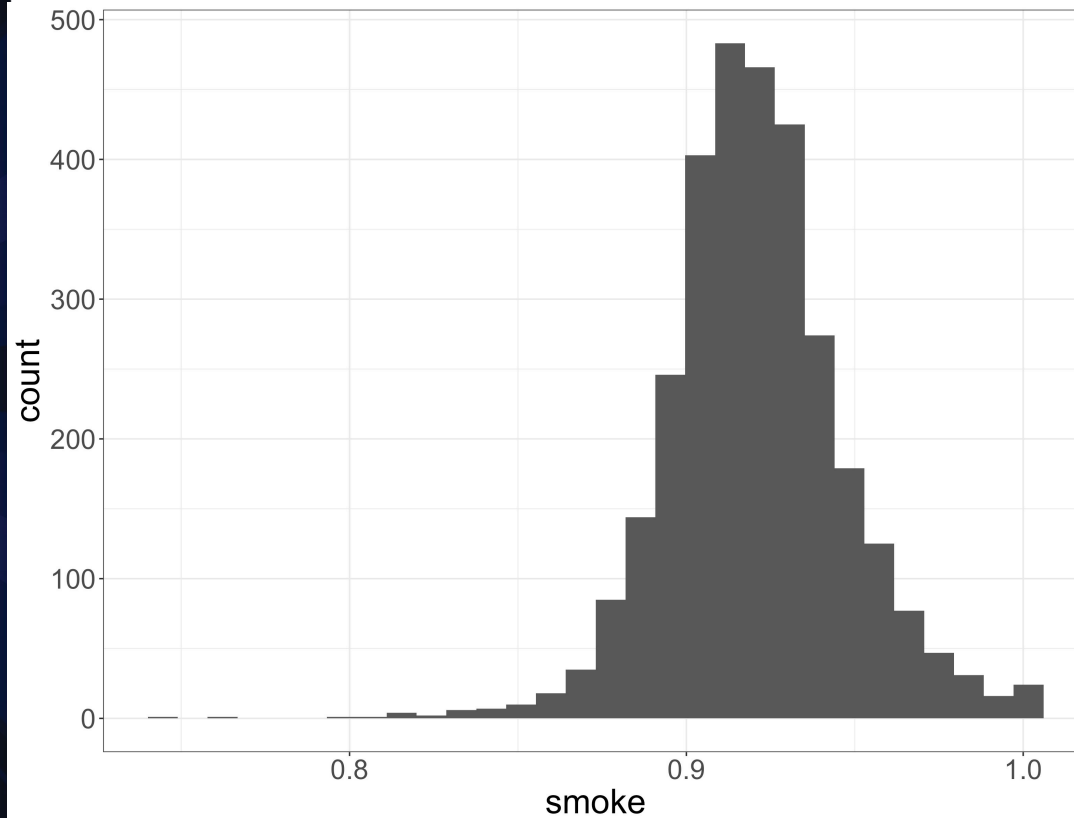
Approach (Small-Area Estimation)

- Using AHS – Model Smoke Alarm Usage

- Using ACS – Estimate the Model for each Census Tract

- Using PUMS – Perform an average correction
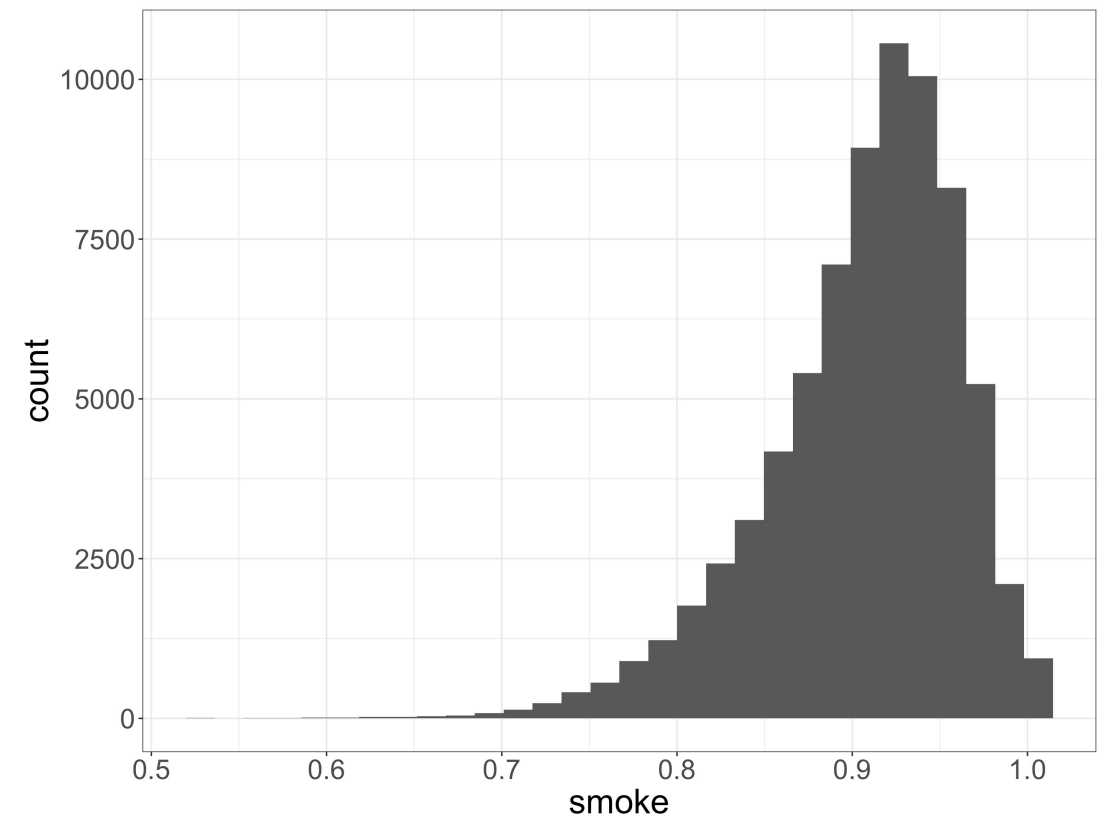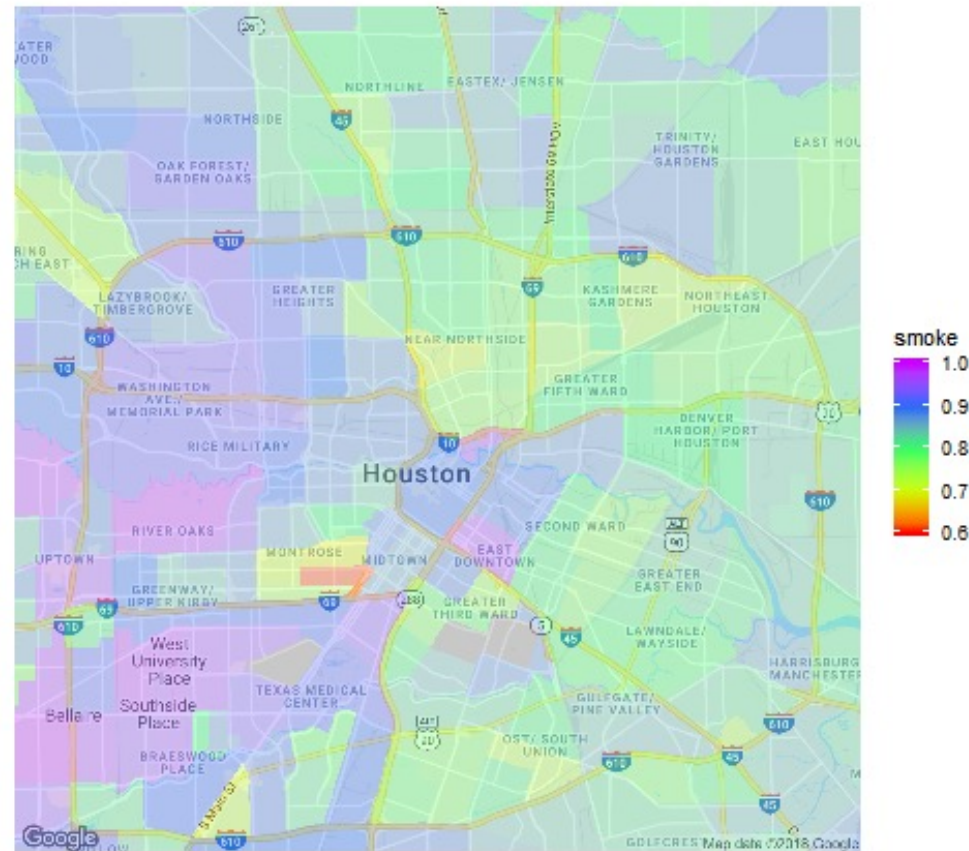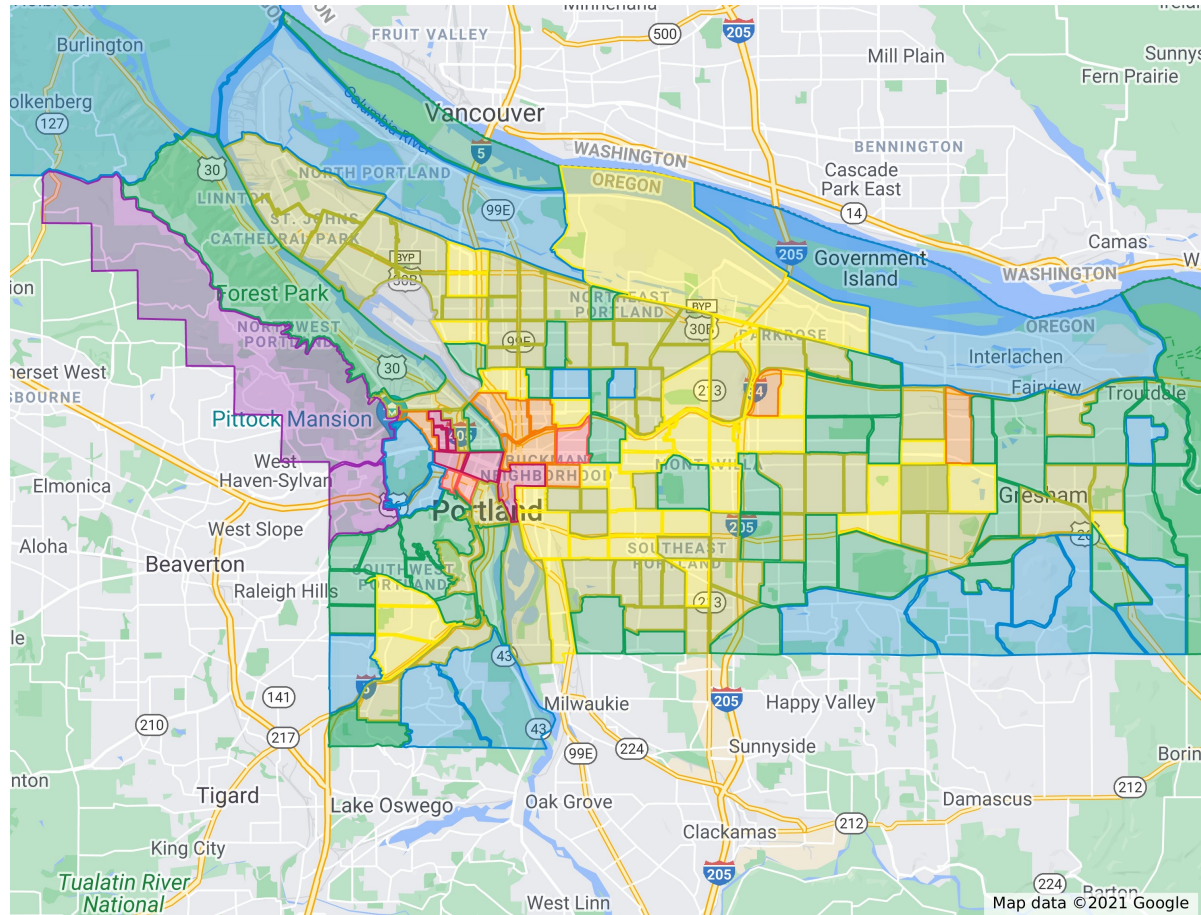
Results by County

Nationwide Results

Counties

Tracts

Kansas City

Houston

Portland

Map data ©2021 Google

Montgomery County, MD

Map data ©2021 Google

Fire Economics

Opportunities

- Usage:
  - Target areas needing smoke alarms
  - A few fires and injuries prevented could pay back the cost of a prevention program

- Research
  - Survey areas to validated and calibrate the data

Sources

- Gilbert, S.W. Estimating Smoke Alarm Effectiveness in Homes. *Fire Technol* **57,** 1497–1516 (2021).
  - https://doi.org/10.1007/s10694-020-01072-z
- Gilbert, S. (2018), Estimating Smoke Detector Effectiveness and Utilization in Homes, Technical Note (NIST TN), National Institute of Standards and Technology, Gaithersburg, MD.
  - https://doi.org/10.6028/NIST.TN.2020
- GIS Data Set ("Shape" Files) of Smoke Alarm Distribution
  - doi:10.18434/M31973
- FireCARES.org (Coming soon)
- This Training:
  - https://i-psdi.org/training.html

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