Adaptating to Natural Disaster through Better Information: Evidence from the Home Seller Disclosure Requirement

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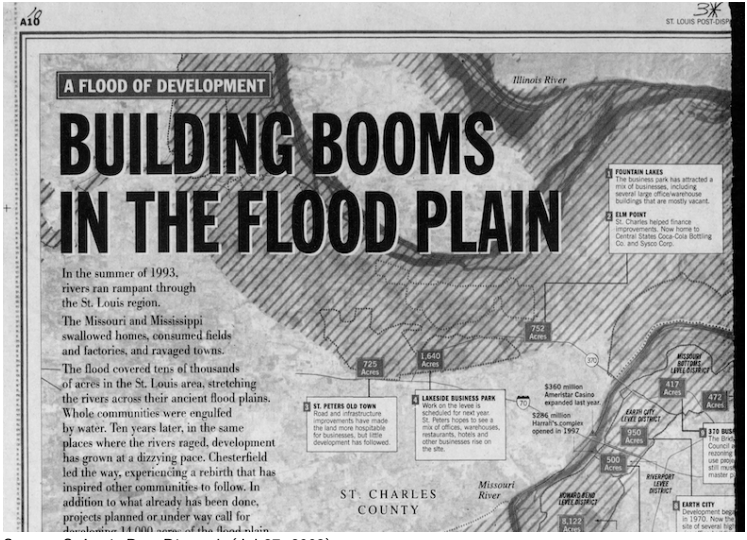
Flood damage = f(flood size, Num. people exposed to risk)

Dams and Levees vs. Harnessing Market Forces

- US flood policy focused on former (dams, levees) with little success
  - Complete control of flood water is impossible
  - Attracts more people to floodplain by giving false sense of security

Levee Attracts People to Floodplains



Source: St.Louis Post Dispatch (Jul 27, 2003)

Information provision can be an effective alternative?

- 26 states require home sellers to disclose property defects including flood risk
  - Is property on Special Flood Hazard Area?
  - Binary and straightforward language
- Raise home buyer's risk awareness $\rightarrow$ Encourage adaptation
  - e.g., safer location, more insurance, better flood-proofing, etc
  - Potential reduction in flood damage

Can Disclosure Reduce Flood Damage?

- Research Questions
  1. Does the disclosure requirement deliver?
     - Estimate a causal effect of the disclosure on housing price
  2. How households respond to the disclosure requirement?
     - Estimate the policy impact on self-protection (population net flow) vs. market insurance (flood insurance)
  3. What is implication for flood damage?
     - Test if the disclosure policy reduces flood damage

Exploit Staggered Adoption and Spatial Discontinuity

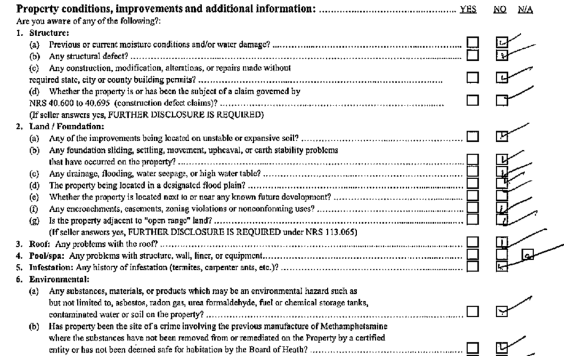
- Variation
  - Staggered adoption of home seller disclosure requirement at state level
  - Spatial discontinuity in disclosure requirement
- Data
  - Q1/2: Property level sales data, flood insurance policy counts, and census block demographics
  - Q3: Damage records from flood insurance adjuster's report
  - Q3: Construct objective measure of flood history using water gauge records
  - Q1-Q3: Disclosure policy changes from state legislation

Disclosure Affects Home Values and Location Choice

1. Price of the properties in high risk area drops by 4.5% ($15K)
    - Suggests that the policy is binding
2. Disclosure policy encourages self protection
    - 7% reduction in population. Vacancy rate 9.5% $\rightarrow$ 10.9%
    - Negligible change in insurance take-up
    - Less population in high risk area $\rightarrow$ Less exposure to flood risk
3. So what happens to flood damage?

Demo

Simple and Timely Information Delivery



Property conditions, improvements and additional information: ..... YES NO N/A

Are you aware of any of the following?:

1. **Structure:**
   - (a) Previous or current moisture conditions and/or water damage? ..... ☐ ☑
   - (b) Any structural defect? ..... ☐ ☑
   - (c) Any construction, modification, alterations, or repairs made without required state, city or county building permits? ..... ☐ ☑
   - (d) Whether the property is or has been the subject of a claim governed by NRS 40.600 to 40.695 (construction defect claims)? ..... ☐ ☑

   (If seller answers yes, FURTHER DISCLOSURE IS REQUIRED)
2. **Land / Foundation:**
   - (a) Any of the improvements being located on unstable or expansive soil? ..... ☐ ☑
   - (b) Any foundation sliding, settling, movement, upheaval, or earth stability problems that have occurred on the property? ..... ☐ ☑
   - (c) Any drainage, flooding, water seepage, or high water table? ..... ☐ ☑
   - (d) The property being located in a designated flood plain? ..... ☐ ☑
   - (e) Whether the property is located next to or near any known future development? ..... ☐ ☑
   - (f) Any encroachments, easements, zoning violations or nonconforming uses? ..... ☐ ☑
   - (g) Is the property adjacent to "open range" land? ..... ☐ ☑

   (If seller answers yes, FURTHER DISCLOSURE IS REQUIRED under NRS 113.065)
3. **Roof:** Any problems with the roof? ..... ☐ ☑
4. **Pool/spa:** Any problems with structure, wall, liner, or equipment? ..... ☐ ☑
5. **Infestation:** Any history of infestation (termites, carpenter ants, etc.)? ..... ☐ ☑
6. **Environmental:**
   - (a) Any substances, materials, or products which may be an environmental hazard such as but not limited to, asbestos, radon gas, urea formaldehyde, fuel or chemical storage tanks, contaminated water or soil on the property? ..... ☐ ☑
   - (b) Has property been the site of a crime involving the previous manufacture of Methamphetamine where the substances have not been removed from or remediated on the Property by a certified entity or has not been deemed safe for habitation by the Board of Health? ..... ☐ ☑

Source: Home Seller Disclosure Form (NV)

- Simple and timely information
- Unlikely to be correlated with state's flood risk or history
- 5 "placebo" states have disclosure policy w/o question on flood $\rightarrow$ useful for robustness checks

Damage Function Estimation

- Damage function: mapping from flood size to flood damage
- How would damage function change after the disclosure policy?
- But how to measure flood size?

Construct Flood History Data Using USGS/NOAA Gauge Station Records

- Existing data (e.g., NWS) are prone to subjectivity (Gourley et al. 2013)
- I construct flood history data using USGS/NOAA gauge station records
  - Flood size is measured by recurrence interval (ASCE 1996)
  - Expected number of years for a given flood size to come back
- Calculate the maximum flood size for each gauge-year and match it to community

Setup: Non-Parametric Damage Function

$$\text{Per Housing Unit Damage} = \sum_k [\beta_1^k F^k + \beta_2^k F^k I + \beta_3^k F^k D + \beta_4^k F^k ID]$$

- F_{mt}^k: 1 if maximum flood size for community m at year t is in bin k
  - $k \in \{2-10,\ \ 10-20,\ \ 20-30,\ \ 30-40,\ \ 40-50\}$

- Allow different slope for treated/control groups for pre/post periods
  - $\hat{\beta}_1^k$: estimated prob. of damage incurred for k for control group in the pre period relative to baseline ($k = 1-2$)
  - $\hat{\beta}_2^k$, $\hat{\beta}_3^k$, and $\hat{\beta}_4^k$ informs about additional impacts for other groups

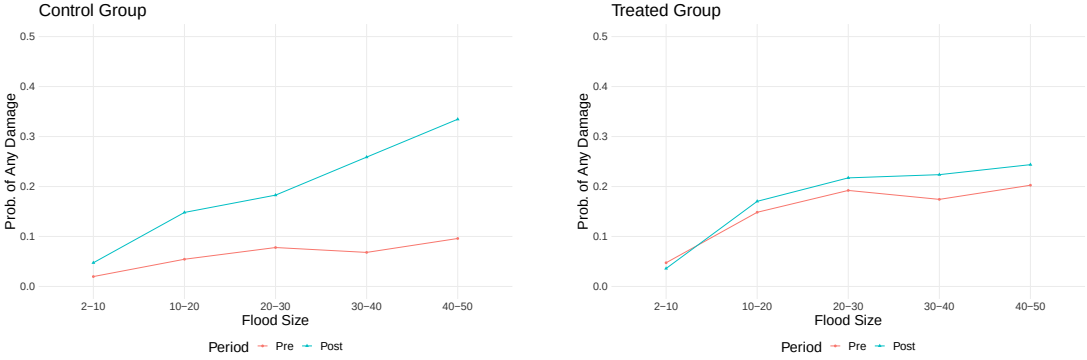
⏩ Depth-Damage Function

Estimation

- Stacked DD: address potential bias from staggered adoption (Goodman-Bacon 2021)
  - Construct data with "clean" controls (not-yet-treated) for each treatment year and stack over (Cengiz et al. 2019)

- To account for mass zeros in damage (Y) variable, separately estimate (1) $P(Y > 0)$ and (2) $Y|Y > 0$ (Chan and Roth 2022)
  - (1) is preferred for both generalizability and statistical power

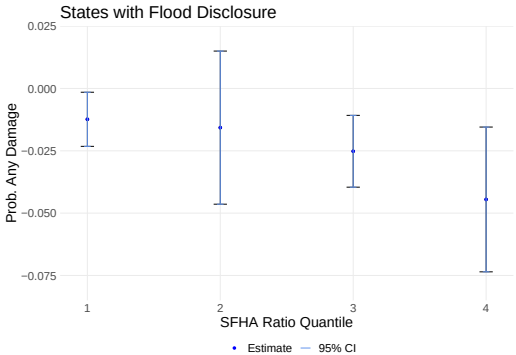
Disclosure Requirement Flattens the Damage Function

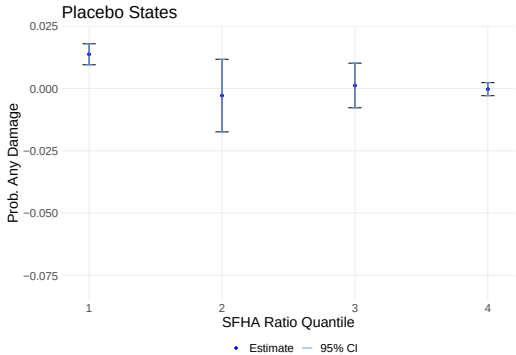


- Increase in damage (pre vs. post) is smaller for the treated group
- Annual expected damage: $\sum_{k=1}^{5} Pr(K = k) \times \hat{\beta}^k = -2.5\%$
  - 33% reduction from baseline (7.4%)

With CI

Effect Size is Larger for Communities with Higher % of SFHA



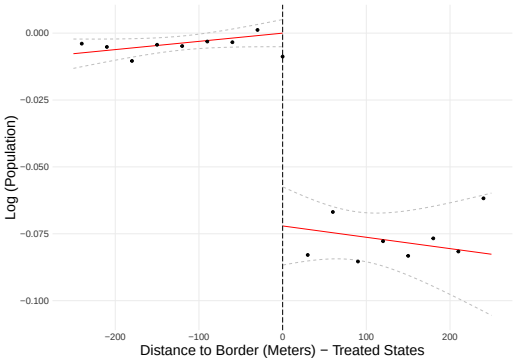


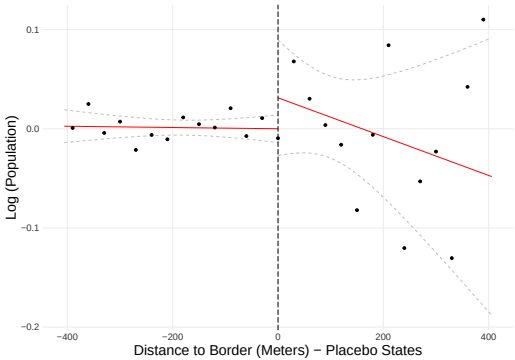
- Larger exposure to the policy → larger effects (flood disclosure states)
  - No such pattern for placebo states

Conclusion

- Growing damage from natural disasters $\rightarrow$ adaptation is important
- Key Findings
  1. Price of the properties in high risk area drops by 4.5% ($15K)
  2. Population in high flood risk area reduces by 7%
  3. Prob. of damage from small/moderate floods reduces by 33% from the baseline
- A policy that eases market friction could foster voluntary adaptation
  - Less HH in flood risky area reduces exposure to floor risk $\rightarrow$ lower damage
- Questions/comments: seunghoon.lee@missouri.edu

Disclosure → Less Pop in High-Risk Areas





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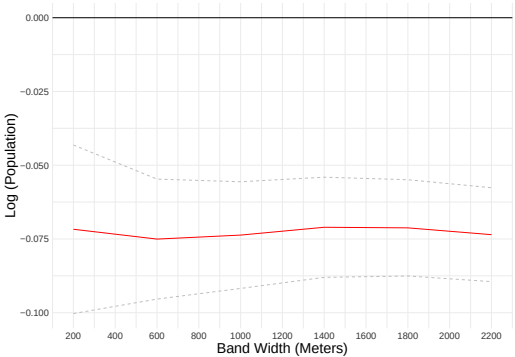
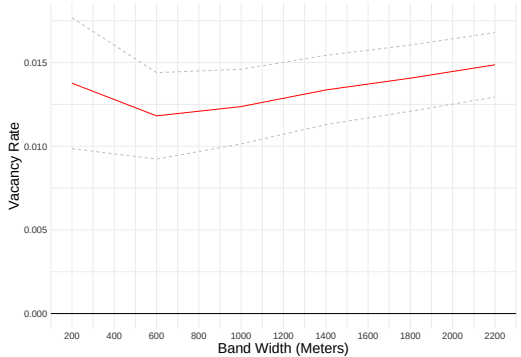
Policy Seems to Induce Meaningful Reduction in Risk Exposure

- Do people choose a marginally different house or move far enough?
  - Important from flood risk exposure perspective
  - Local moves will overestimate the RD estimate





Why Do We Need Another Damage Function?

- From a policy perspective, damage function at an aggregate level matters
  - e.g., when a city is hit by flood size of X, how large is the damage?
- Numerous engineering studies on property level damage function estimation but hard to learn aggregate damage b/c of data limitations (Meyer et al. 2013)
  - Detailed hydraulic study needed to assess each property inundation but very costly
  - Adaptation measures at each property are very hard to observe
- This paper takes a "reduced-form" approach and directly connects community level flood exposure and damage

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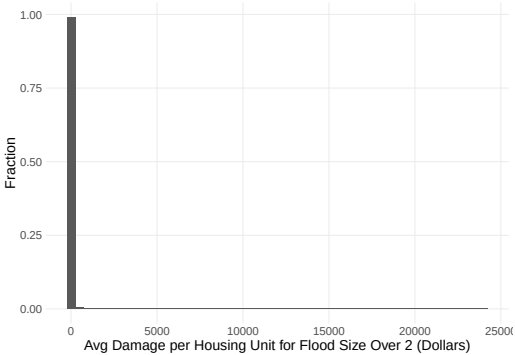
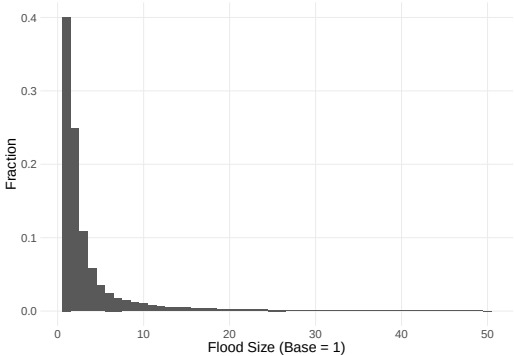
Distribution of Damage (Y) and Floods (X)





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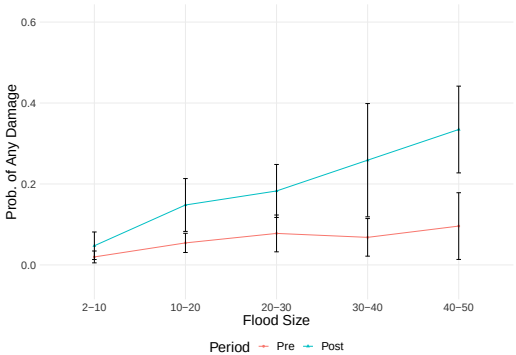

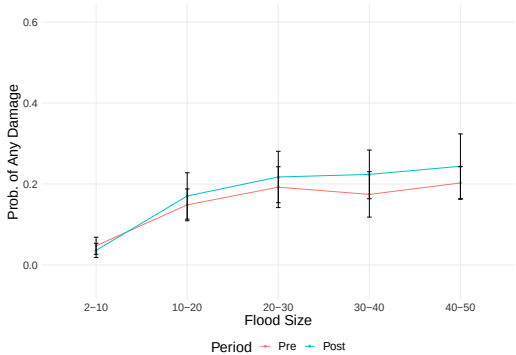

- Pre vs. post difference statistically significantly differs only for control group

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