How should we measure house prices after a natural disaster? Evidence from Hurricane Ian

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Hurricane Ian in the News

How Will Hurricane Ian Affect the Local Real Estate Market?

Home Buyers With Short Memories Are Driving Up Prices in Hurricane-Hit Town

Will Hurricane Ian cut Florida's Gulf Coast real estate boom short?

Why Ian May Push Florida Real Estate Out of Reach for All but the Super Rich

On Florida's Gulf Coast, developers eye properties ravaged by Hurricane Ian

What's the future of the housing market after Ian? Industry leaders have ideas.

Motivation

- Disasters (hurricanes, flooding, wildfires) damage homes, pose real risk for many stakeholders, and will likely increase in future (AAAS, USGS)

- Difficult to assess home value immediately after a disaster
  1. lack of comparable properties, few transactions
  2. risk updating, changes in preferences/supply/demand
  3. **lack of granular damages (treatment) data**
  4. **lack of a suitable control group**

- Research Questions:
  1. Using **publicly available** disaster damages data, how much can we learn about the causal effects of disasters on house prices?
  2. Can we find a suitable control for difference-in-difference (DiD) strategies, or should we construct one with a synthetic control approach?

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Brief Literature Review

1. Applied Disaster Literature (recent survey: Contat et al. (2023))
   - **Difference-in-Differences (DiD)**: treatment varies, usually granular
     - Flood Zone: Hallstrom Smith (2005), Kousky (2010), Muller Hopkins (2019), Zhang Leonard (2019), Hino Burke (2021), Fang et al (2023), ...
     - Damages: Gallagher Hartley (2017), McCoy Walsh (2018), Ortega Taspinar (2018), Gibson Mullins (2020), Fisher Rutledge (2021), Ellen Meltzer (2022), Zivin et al (2023), ...
     - Flood Zone + Damages: Atreya Ferreira (2015), Hennighausen Suter (2020), Yi Choi (2020), ...
   - **Synthetic Controls**: Keys Mulder (2020), Ho et al (2023), Kim Lee (2023), ...
2. Technical Literature
   - **Measurement Error**: Hyslop Imbens (2001), Negi Negi (2022), Denteh Kedagni (2022), ...
   - **Parallel Trends Issues**: Abadie Imbens (2011), Roth (2022), Rambachan Roth (2023), Roth et al (2023), Ham Miratrix (2023), ...

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Background and Data

- Hurricane Ian struck southwest Florida Sept 2022 (NOAA)
  - Category 4, max 150 mph winds
  - $109.5 billion in damages, 156 deaths in FL
  - costliest hurricane in FL's history (3rd costliest in US history)
- Multiple Listings Service (MLS) Data
  - housing characteristics: beds, baths, square feet, address, etc
  - ⋆ **not fully representative**
- FEMA Individuals and Household Program (IHP) Claims Data
  - serves underinsured/uninsured, excludes second homes
  - temporary housing, repairs, retrofits, and misc expenses
  - ⋆ **individual level data, but know only ZIP/county**
  - FEMA-determined real property and personal contents damages
  - Less than 15% of claims positive damages:
    Avg damage $17,500, only 24% flood insured

IHP Aggregate Damage (Treatment) Definitions

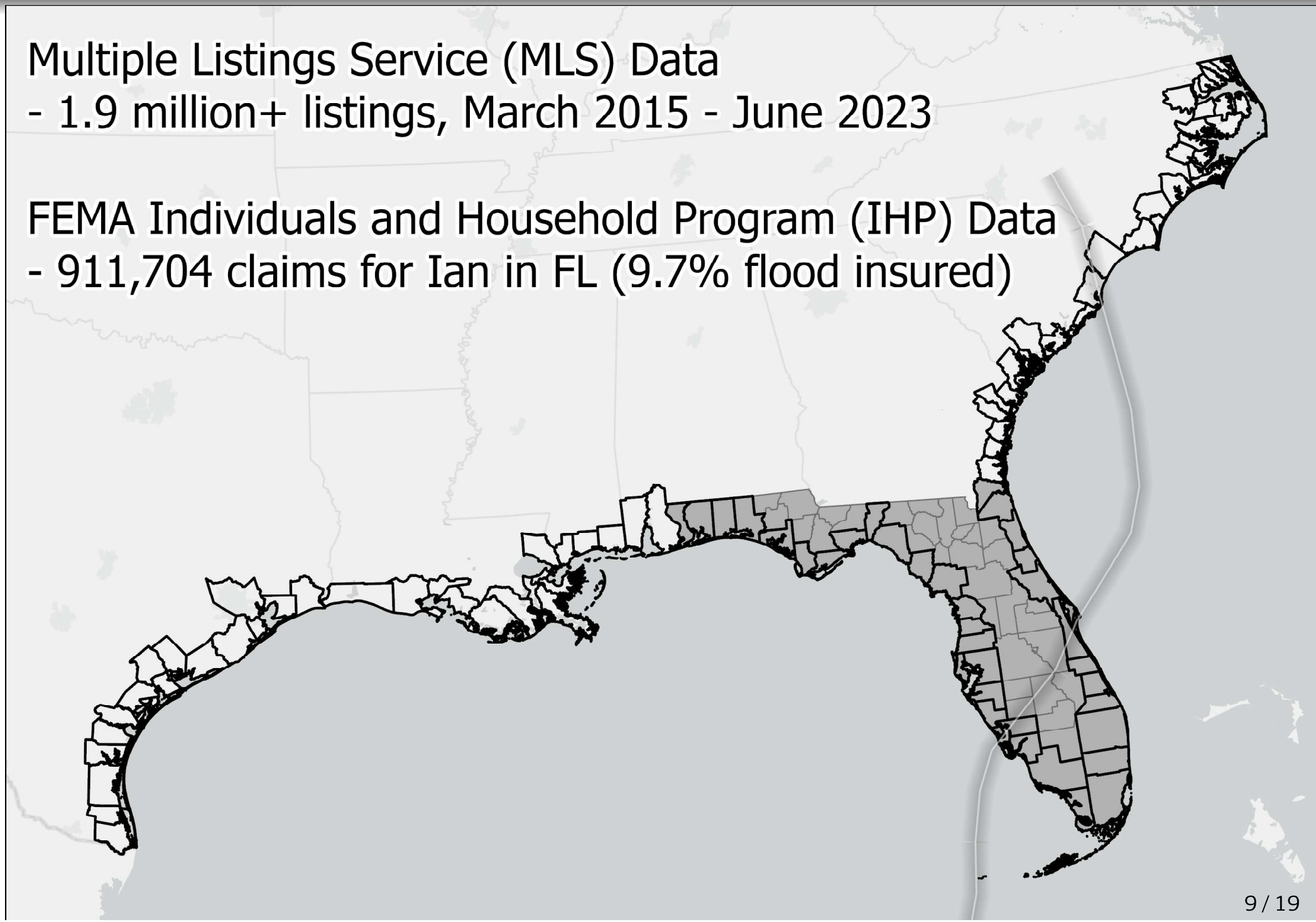
treatment	binary	definition
treat1	✓	any claims/real property damage
treat2	✗	average real property damages
treat3	✓	**real property damages above median**
treat4	✓	real property damages above 75th percentile
treat5	✓	real property damages above 90th percentile
treat6	✓	at least 1% of households real property damage
treat7	✓	at least 2% of households real property damage
treat8	✓	at least 5% of households real property damage

- Can't use property-level treatment D_{it}
- Instead use group-level D_{gt}, where g = county/zip code
- House i treated if lives in group that meets above definition

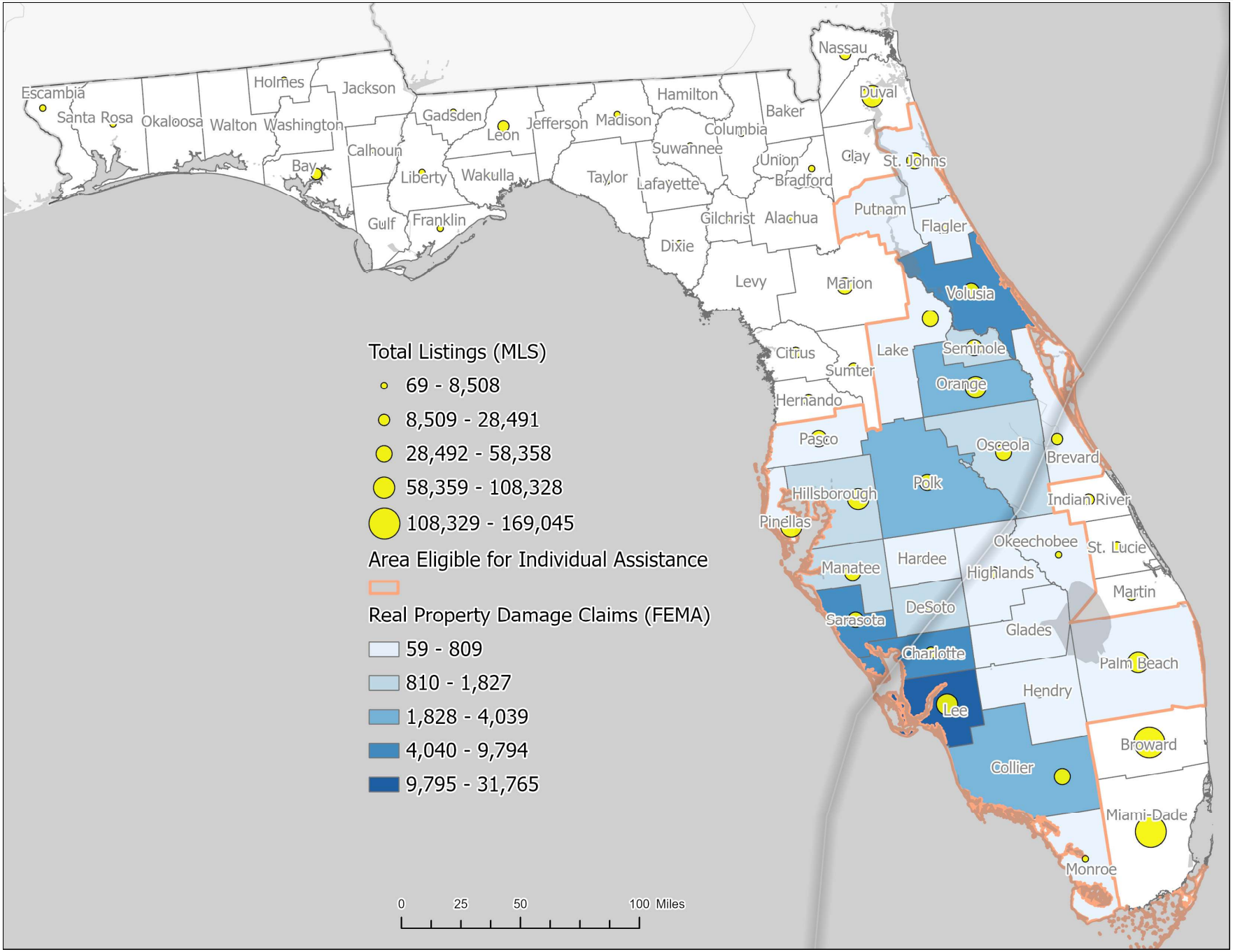
Coastal Counties Map

Multiple Listings Service (MLS) Data
- 1.9 million+ listings, March 2015 - June 2023

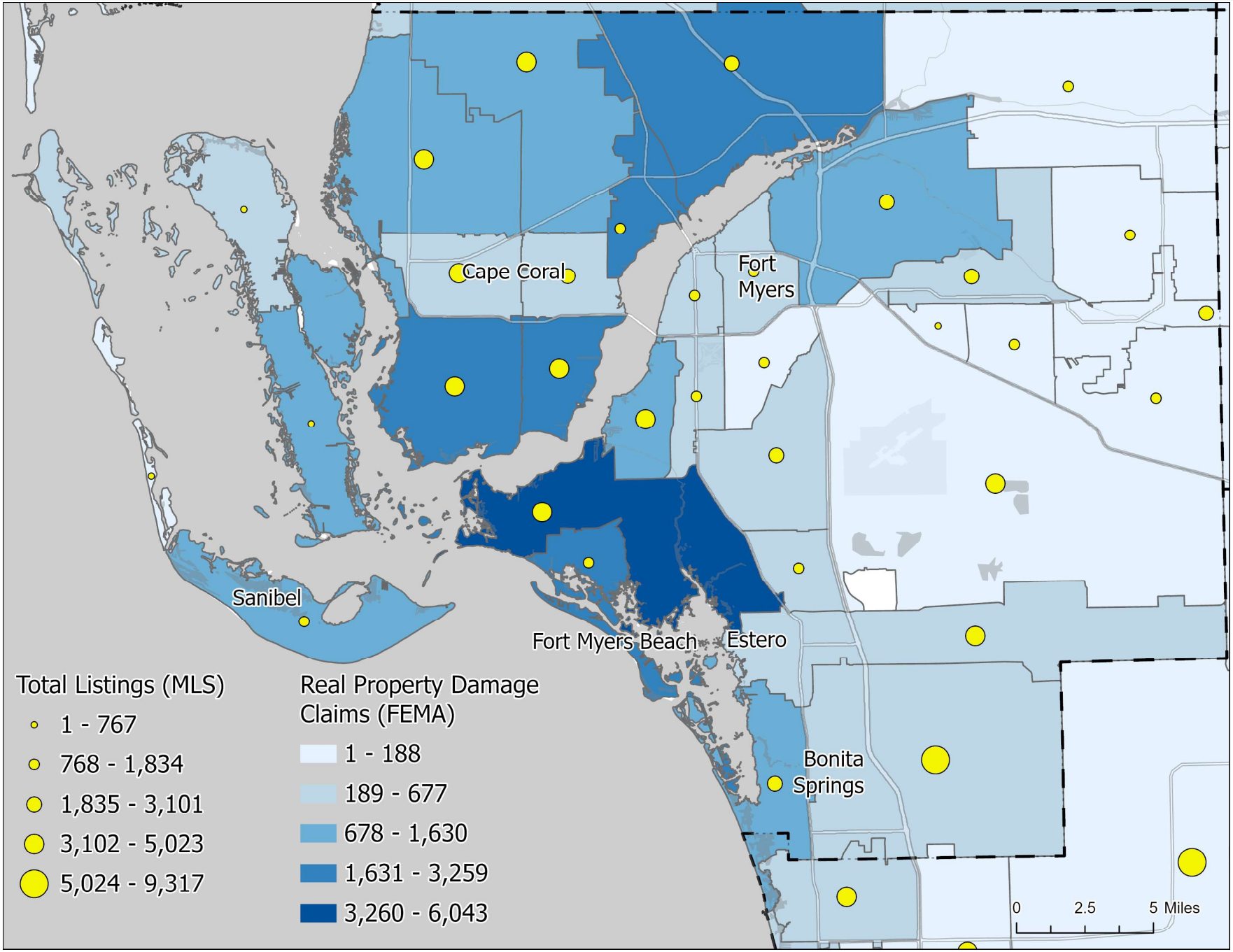
FEMA Individuals and Household Program (IHP) Data
- 911,704 claims for Ian in FL (9.7% flood insured)



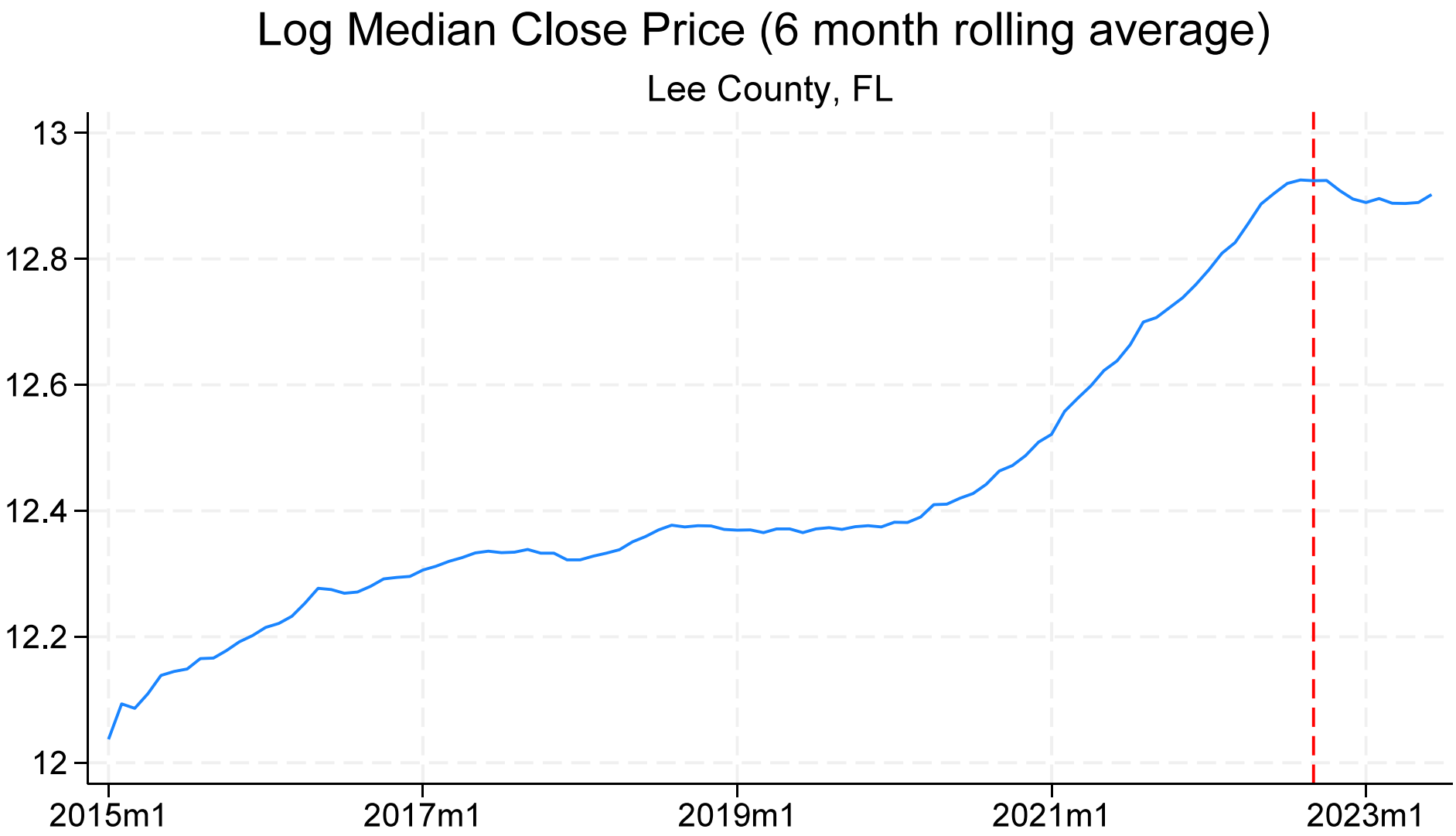
FL Counties Map



Lee County Zip Map



Descriptive Evidence



DiD Specification: Static and Dynamic

- We estimate the following two-way fixed effect specification:

$$ln(p_{igt}) = \alpha_g + \gamma_t + \sum_{\tau=\underline{T}}^{\overline{T}} \beta_\tau D_{g,t-\tau} + \theta x_{it} + u_{it}$$

  static effects (special case): restrict $\beta_\tau = 0$ for all $\tau \neq 0$

- If normalize treatment at $t = 0$ and let $\beta_{-1} = 0$,
  pre-trends test: $H_0 : \beta_{\underline{T}} = \cdots = \beta_{-2} = 0$

- Roth (2022) and Rambachan Roth (2023) propose more sophisticated pre-trends tests

DiD Static Results

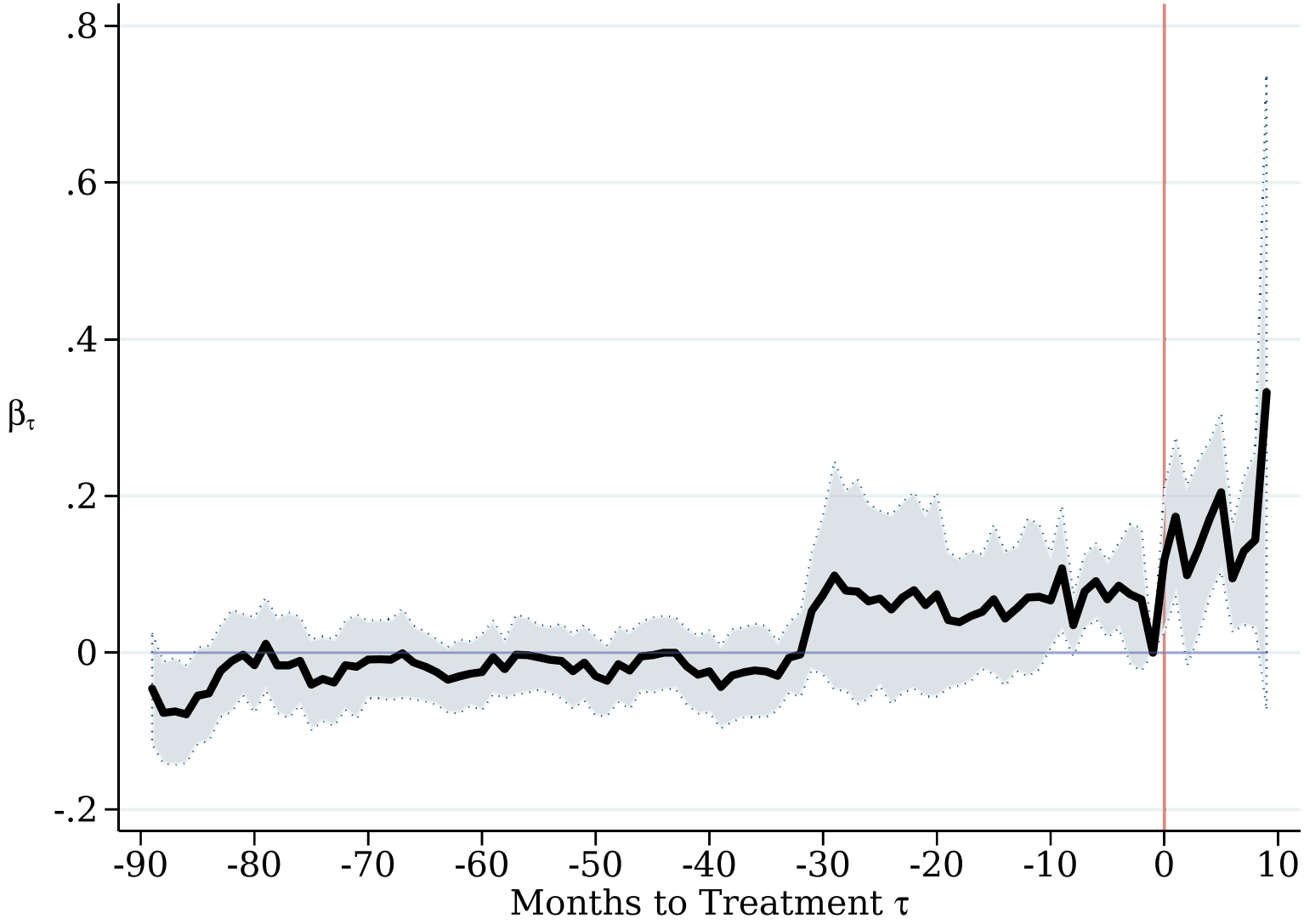
treatment = treat3 (above median real property damages)

	County ATT	ZIP Code ATT	No Anticipation (Granger Test), County	(Linear) Parallel Trends Test, County
β **(w/clust. errors)**	**0.128** **(0.045)**	0.115 (0.011)	Prob > F = 0.0000	Prob > F = 0.0774
β (w/agg. errors)	0.106 (0.036)	0.128 (0.010)	Prob > F = 1.0000	Prob > F = 0.0646

- Positive and statistically significant ATT
- But barely pass "pre-trends test"!
- Also may or may not fail other crucial assumption, depending upon error structure assumed for estimation

DiD Dynamic Results

Figure: Treatment = treat3 (above median property damages), County



Synthetic Control Methodology

- Y_{it} = log(median price) for county i in month t

$$\begin{aligned} Y_{it} &= D_{it} Y_{it}^{I} + (1 - D_{it}) Y_{it}^{N} \\ &= \tau_{it} D_{it} + Y_{it}^{N} \end{aligned}$$

- Let $i = 1$ be treated Lee County and $i > 2$ be untreated counties
- Estimate ATT using weighted averages of untreated units as counterfactual control

$$\widehat{\tau_{1t}} = Y_{1t} - \widehat{Y_{1t}^{N}} = Y_{1t}^{I} - \sum_{i \geq 2} \widehat{w_i} Y_{it}$$

where weights are chosen to make characteristics of treated unit Z_1 similar to those of untreated units Z_0: $\min_w \|Z_1 - Z_0 w\|$

- To max fit, use Z = pre-treatment outcomes (Ferman et al 2020)

Synthetic Control Estimation

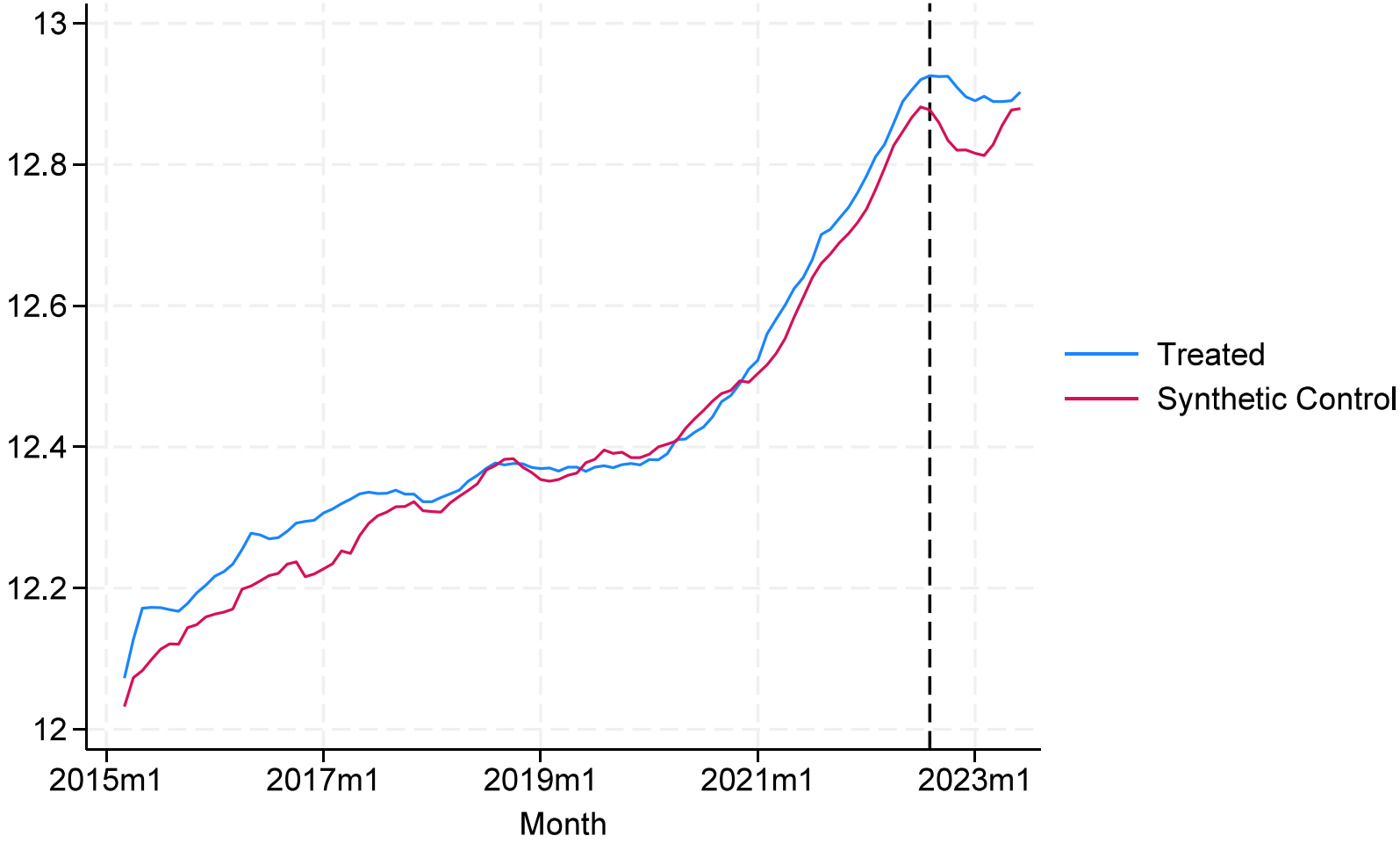
- **Need a balanced panel → drop unbalanced counties
  - after data cleaning, 89 counties → 51 counties
  - but 12/51 counties are treated and can't be used as controls!
- Estimation yields sparse weights:

	Hernando (FL)	Palm Beach (FL)	Saint Johns (FL)	Bryan (GA)	Glynn (GA)	Harris (TX)
$\widehat{w}_i$	0.25	0.02	0.394	0.248	0.074	0.013

Table: Lee County Weights, Treatment = Above Median Property Damages

Synthetic Control Results - Good Fit? Price Premium?

Figure: Lee County Syn. Control, Treatment = Above Median Property Damages



- However, p-values well above 0.05 for each $\widehat{\tau_{1t}}$!

Conclusions

- Evidence of price effects from Hurricane Ian?
  - DiD results show price premiums, but PARALLEL TRENDS LIKELY FAILS
  - Synthetic Controls show price premiums, but POOR FIT
- Public disaster data (OpenFEMA) is very valuable, but "standard" DiD and synthetic control approaches don't seem to work very well
  - more precise identification of suitable controls needed
  - econometric consequences (bias,inconsistency) also likely
- Better methodology is needed:
  1. Matching before DiD: Abadie Imbens (2011)
  2. Imputation for synthetic controls: Raghunathan et al (2001)
  3. Other price measures for synthetic controls: (hedonic)
  4. Other estimators: Synthetic DiD, Arkhangelsky et al (2021)
  5. Appropriate functional form of price: Kahn-Lang Lang (2020)
  6. Later: What about listings? Time on the market?