SUPPLEMENTAL MATERIALS FOR "SINGLE-FAMILY RESIDENTIAL RECONSTRUCTION AFTER DISASTERS: BUILDING PERMITS SURVEY DATA AND SYNTHETIC CONTROLS"

Jack W. Baker, Nikola Blagojević, and Shujun Zhang

Stanford University

March 14, 2026

Supplemental figures

Figure S1 shows the nation-wide counts of building permits from the considered data set. The data shows strong macroeconomic trends (e.g., the pre-2008 housing boom and subsequent crash), and seasonality, motivating the use of synthetic controls to normalize for these effects.

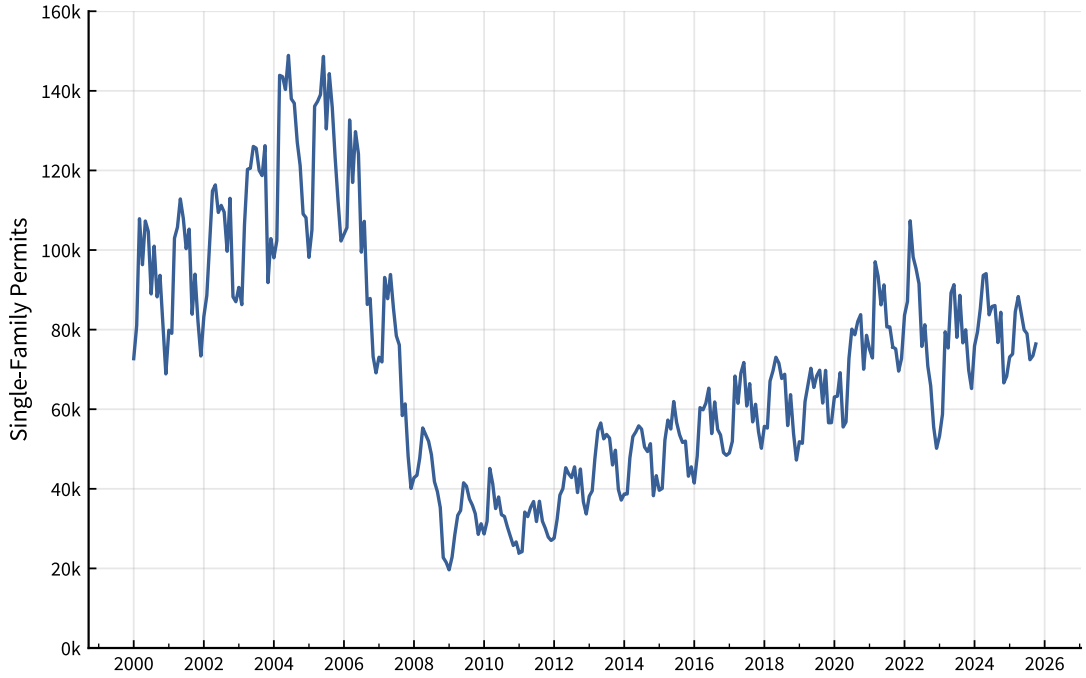

Fig. S1. Time series of BPS single-family building permits for all places and dates in the considered data set.

Figure S2 shows the number of donors with non-zero weights (Eq. 1) for each disaster-affected place. The number of donors ranges from 6 to 32, with a median of 13.

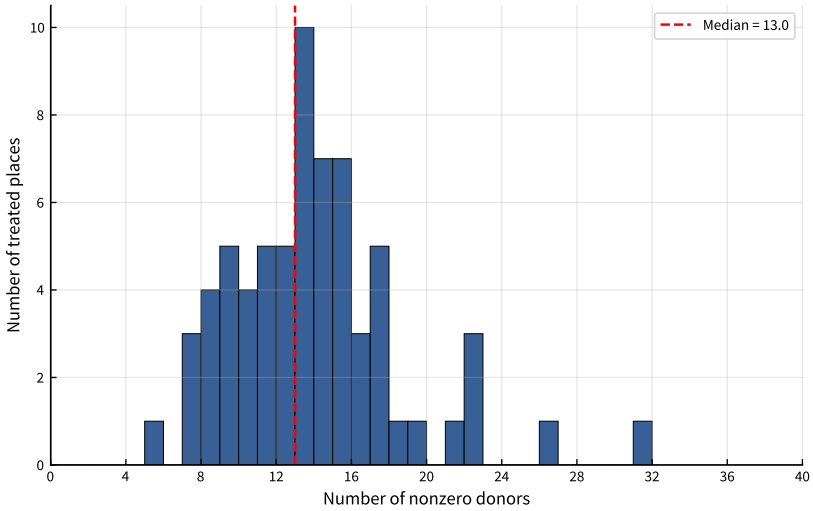

Fig. S2. Distribution of the number of nonzero donor weights across the 67 considered disaster-affected places.

Figure S3 shows the source states for synthetic control donors. Each row represents a state with disaster-affected places (n indicates the number of places). Each column represents a state with donor places. Cell shading and labels indicate the percentage of donor places coming from the state in that column. Because donors were only considered from within a Census Region, the affected places and donors can be grouped by Region. Donors from the disaster-affected state were excluded by rule.

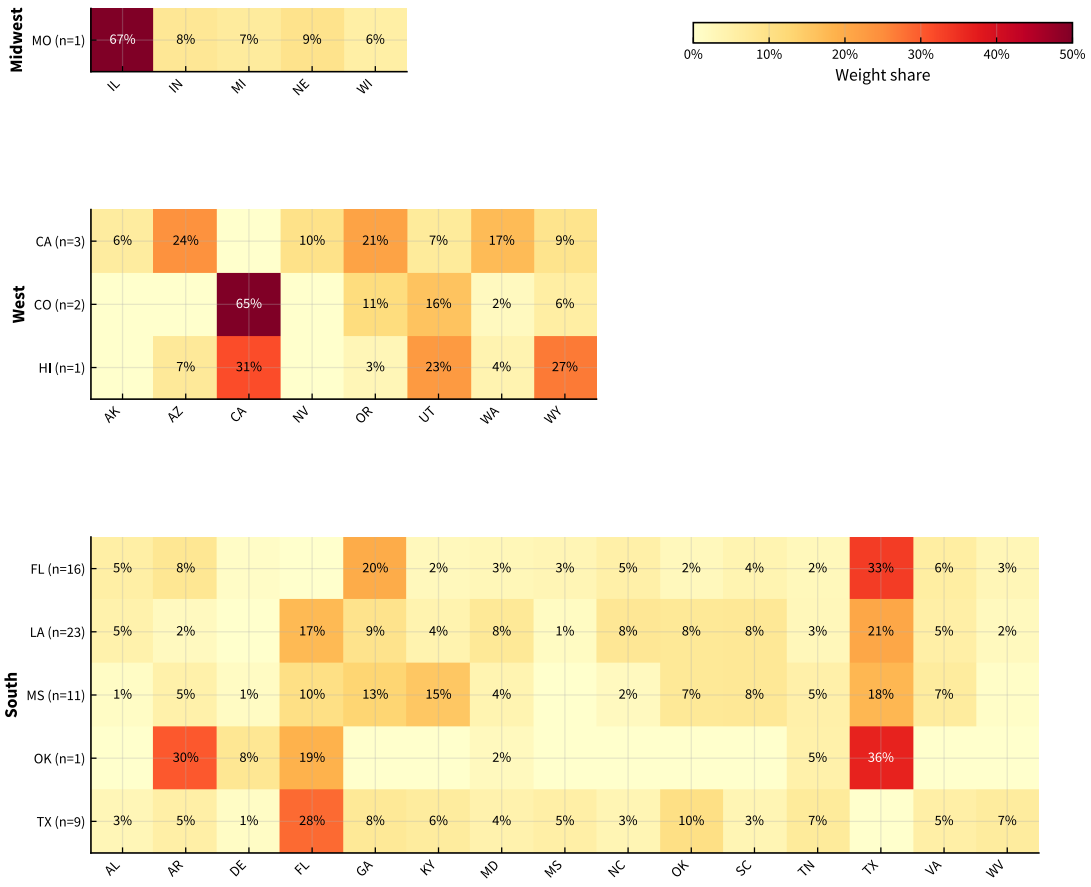

Fig. S3. Share of total donor weight by state, aggregated across treated places in each treated state. Both axes are sorted by Census region (West, South, Midwest), revealing a block-diagonal pattern: donors are drawn from other states in the same Census region, as specified by the donor pool construction. Cell values show the percentage of total weight contributed by each donor state; states contributing less than 5% in all rows are omitted.

Figures S4 through S15 show the individual actual-versus-synthetic time series for all 67 fitted places, grouped by disaster type. Thin lines show raw monthly permit counts; bold lines show 12-month moving averages. Gray dashed lines show the synthetic control. Red dashed vertical lines mark disaster dates with FEMA IA statistics (registrations and assessed damage). Purple dotted lines mark excluded second events for places affected by two hurricanes in the study period. Gray shading indicates periods when the place was absent from the BPS monthly survey.

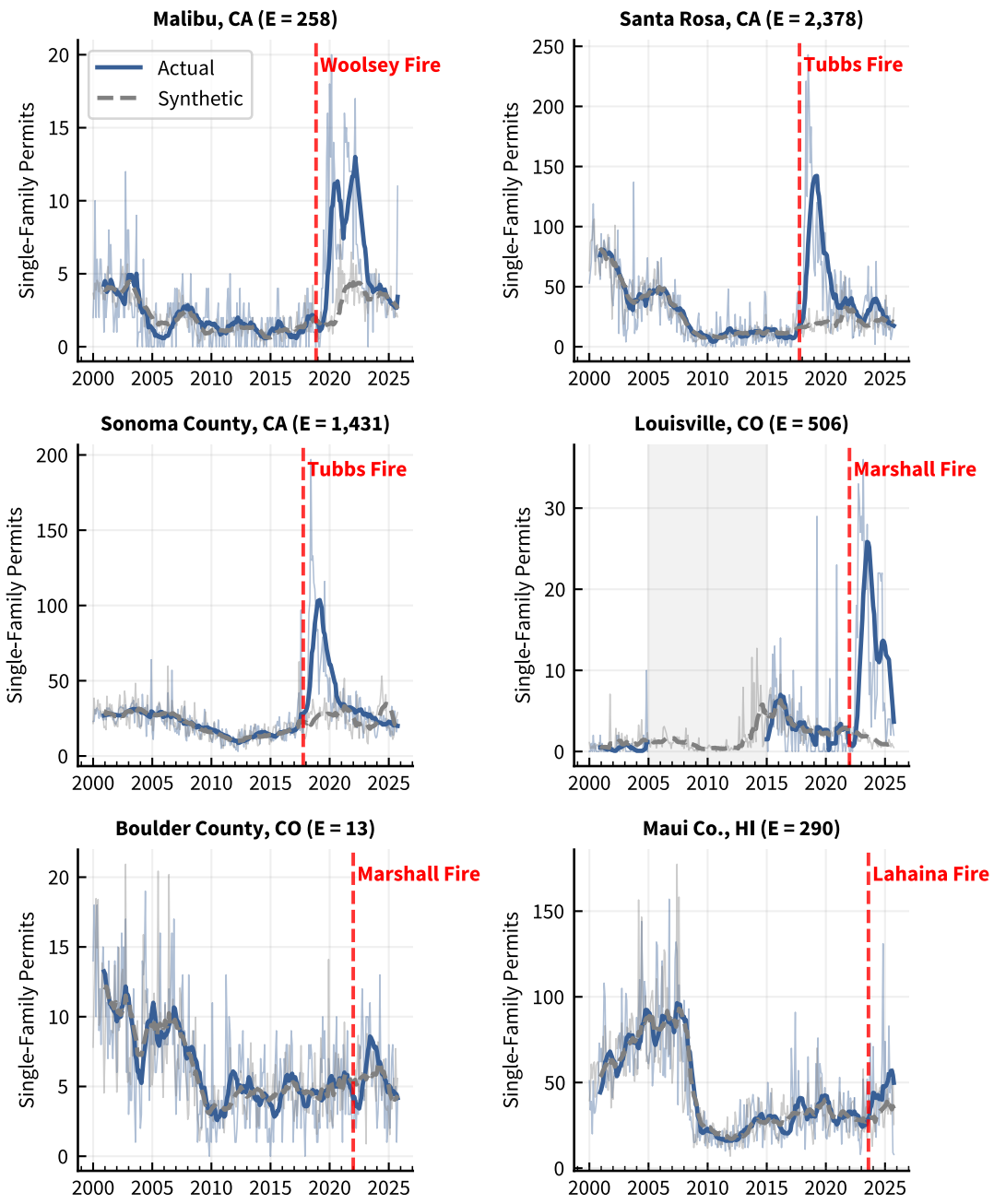

Fig. S4. Wildfire places: actual vs. synthetic single-family permits. Thin lines show raw monthly data; bold lines show 12-month moving averages. Red dashed lines mark disaster dates. Gray shading indicates BPS survey gaps.

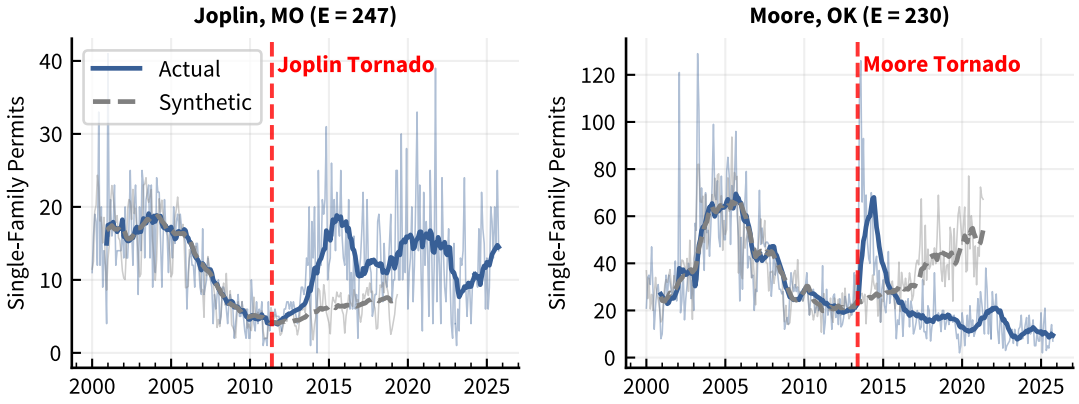

Fig. S5. Tornado places: actual vs. synthetic single-family permits. Thin lines show raw monthly data; bold lines show 12-month moving averages. Red dashed lines mark disaster dates.

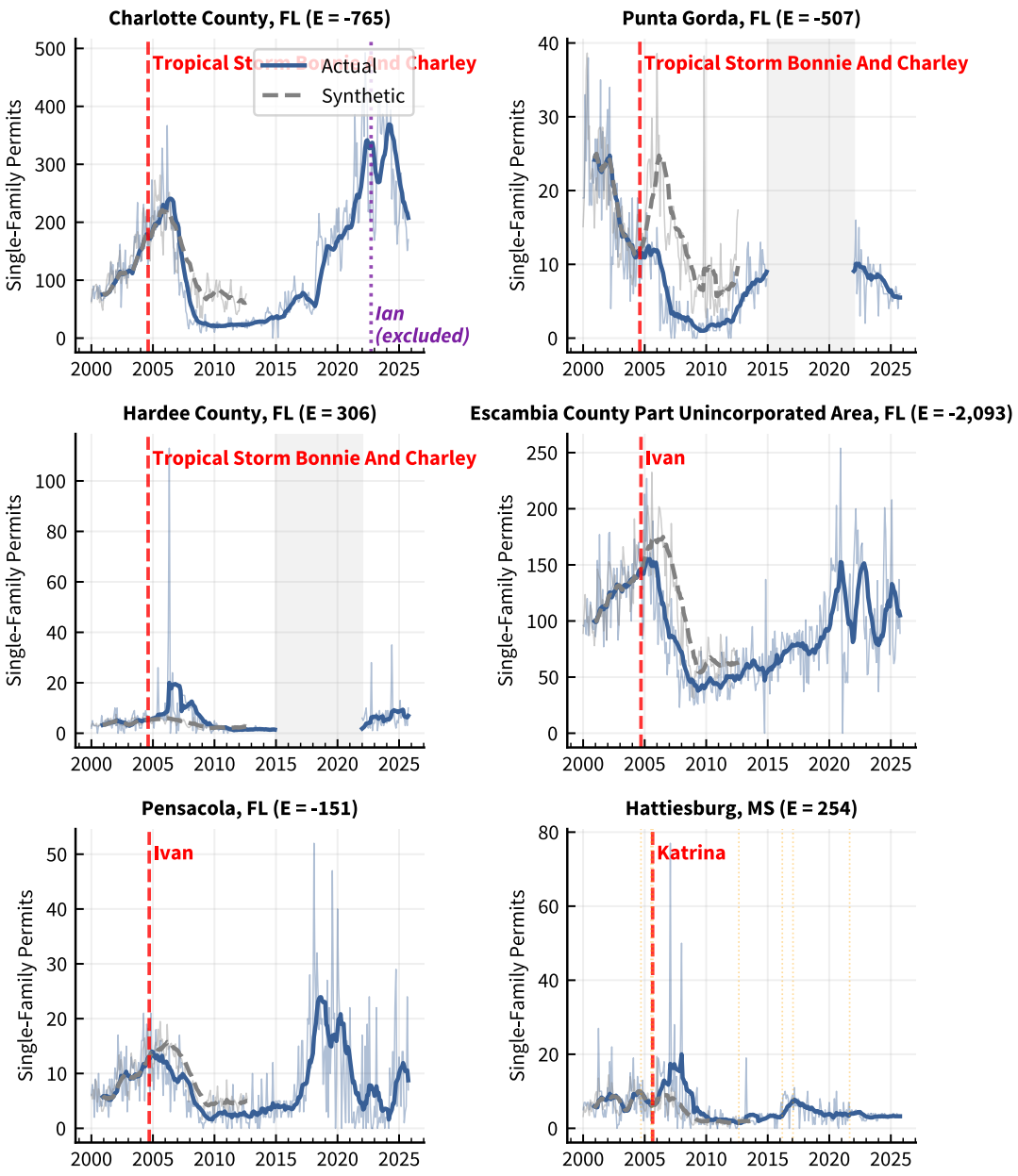

Fig. S6. Hurricane places (1 of 10): actual vs. synthetic single-family permits. Red dashed lines mark disaster dates. Purple dotted lines mark excluded second hurricane events. Gray shading indicates BPS survey gaps.

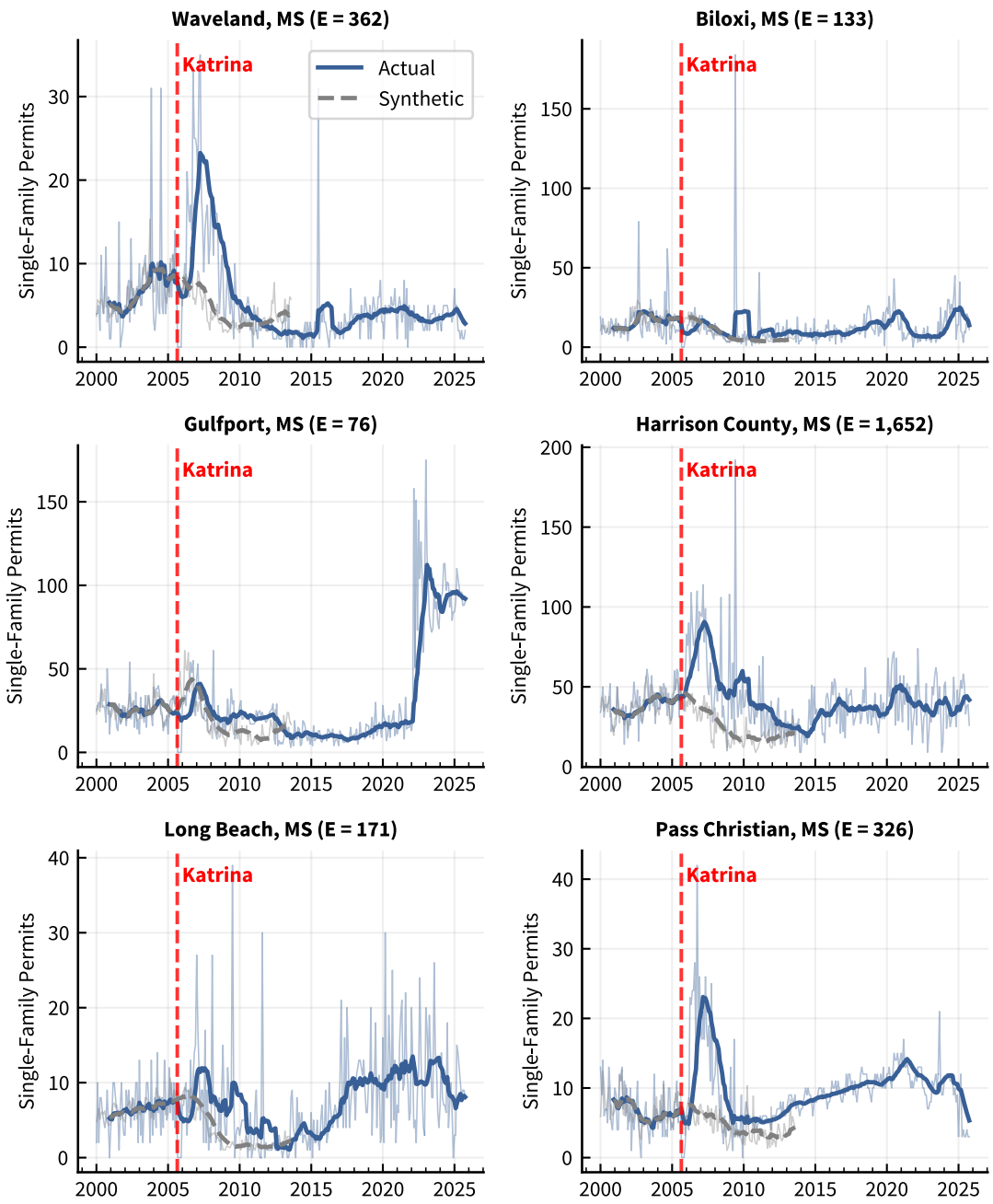

Fig. S7. Hurricane places (2 of 10).

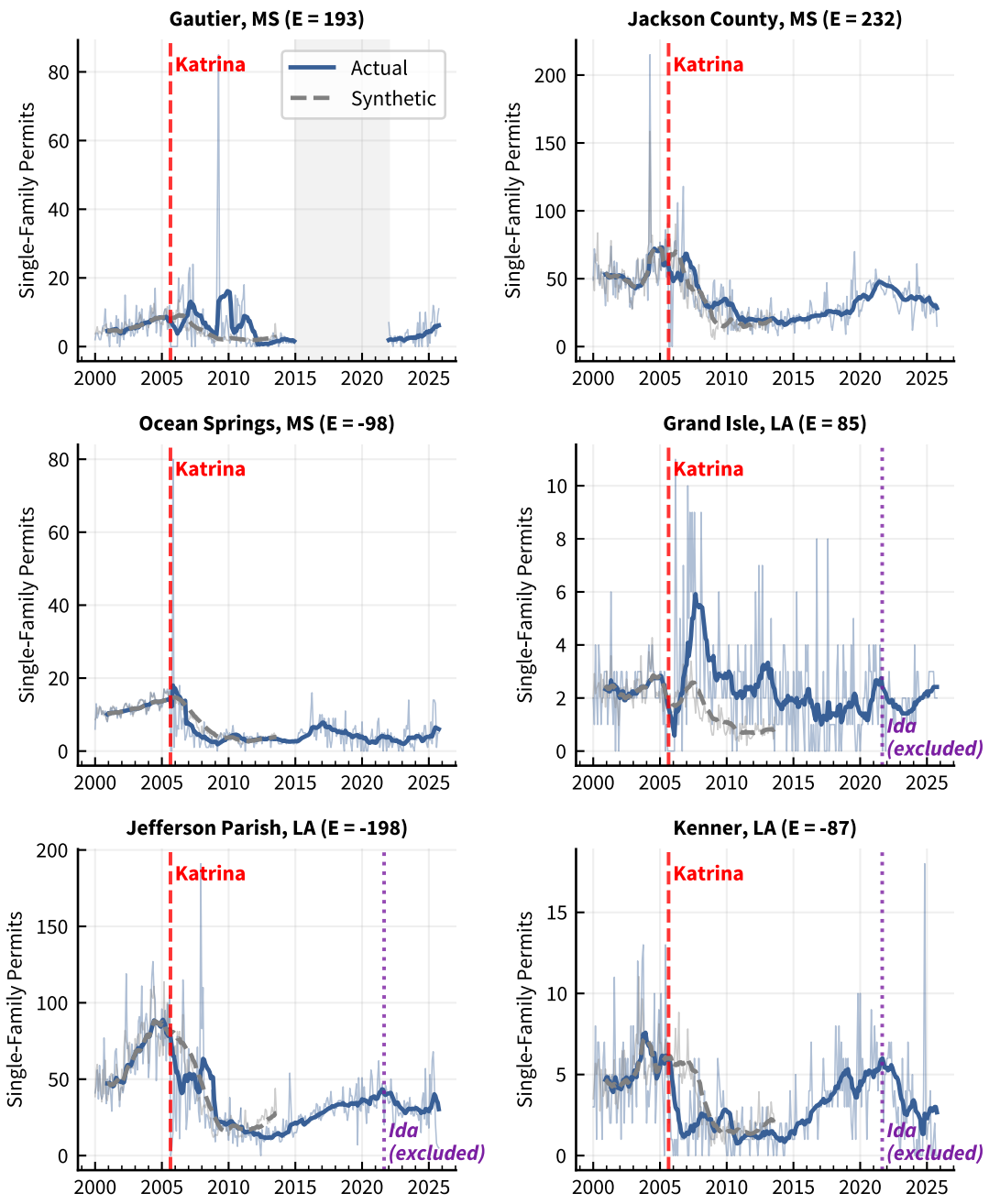

Fig. S8. Hurricane places (3 of 10).

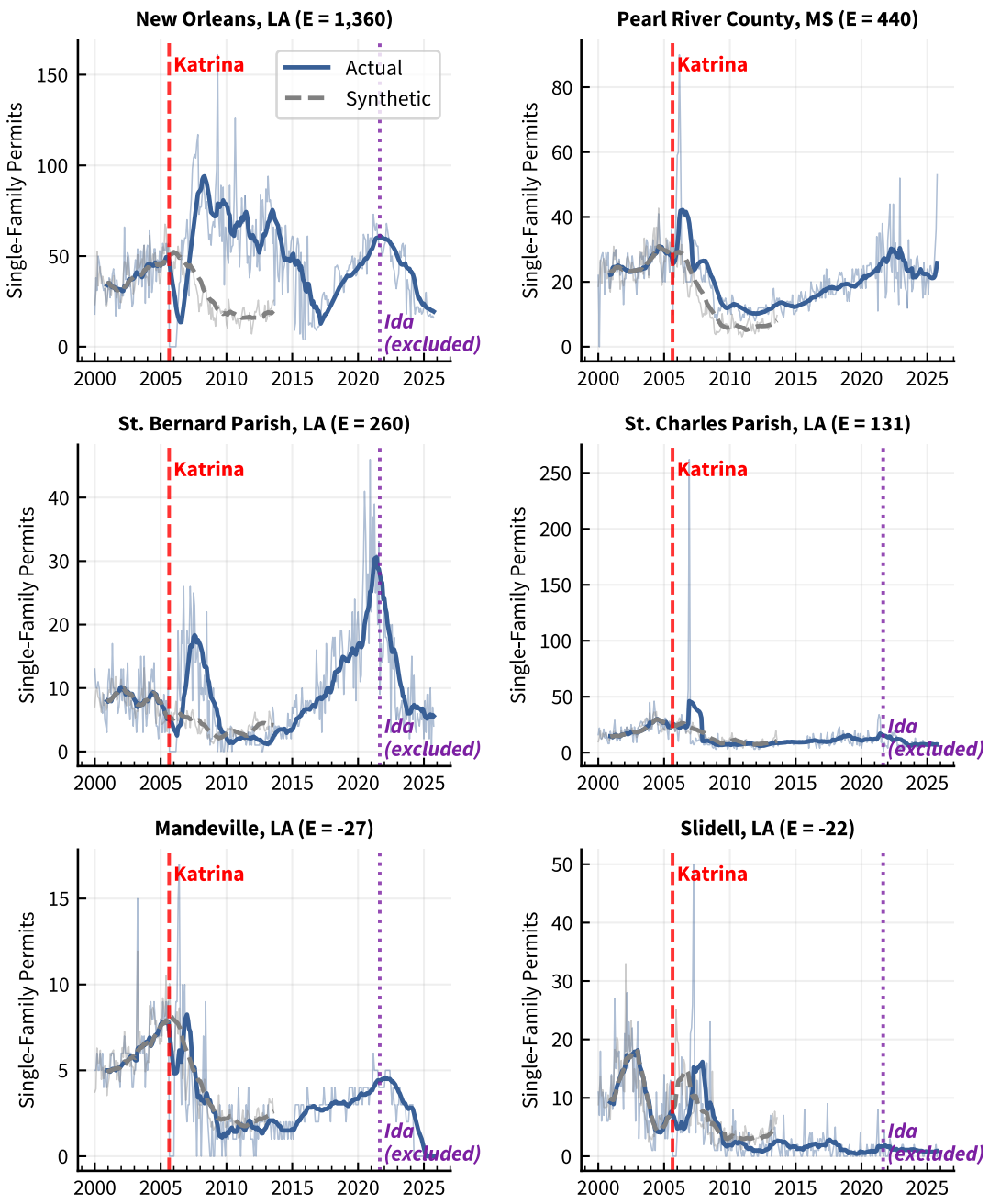

Fig. S9. Hurricane places (4 of 10).

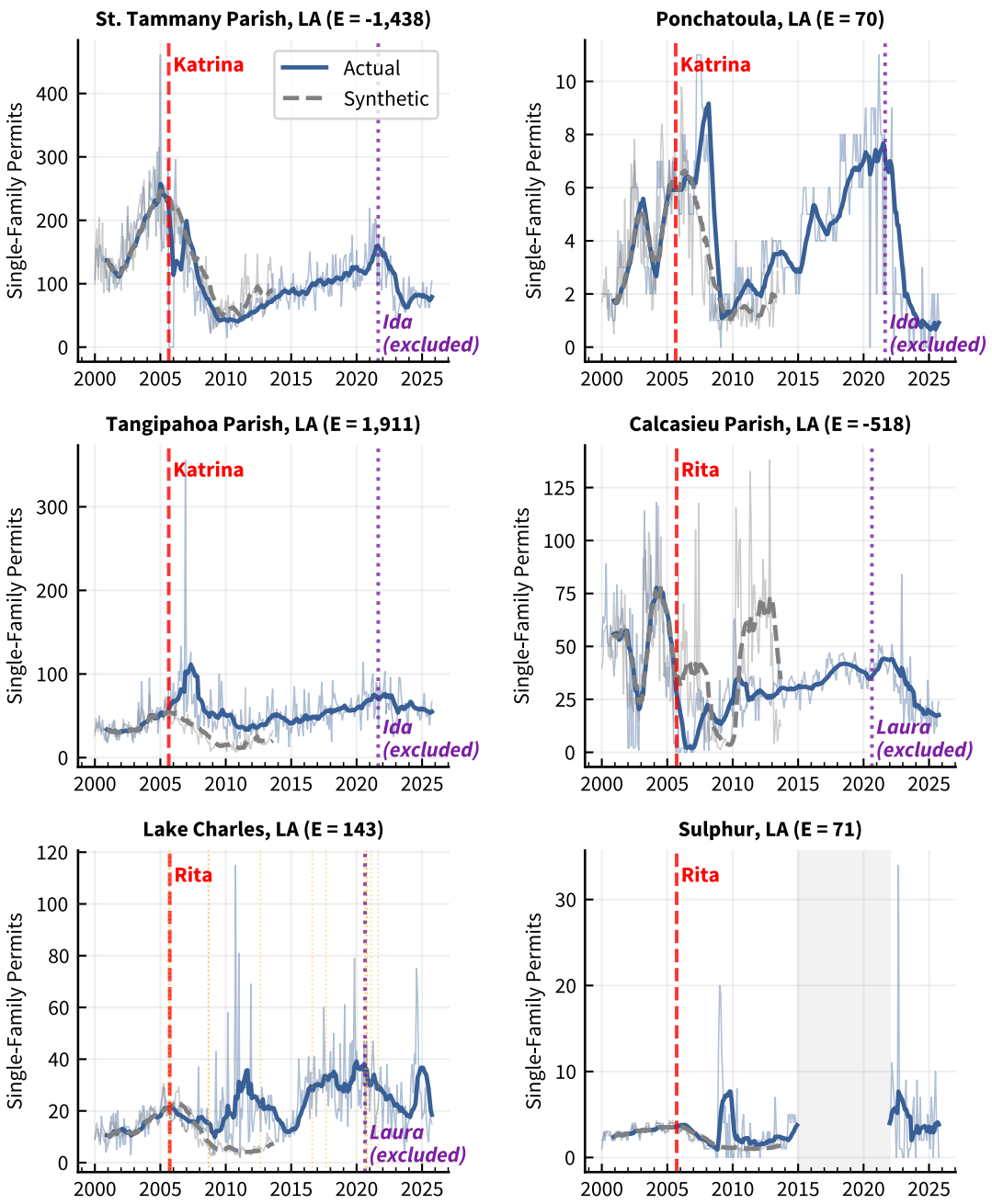

Fig. S10. Hurricane places (5 of 10).

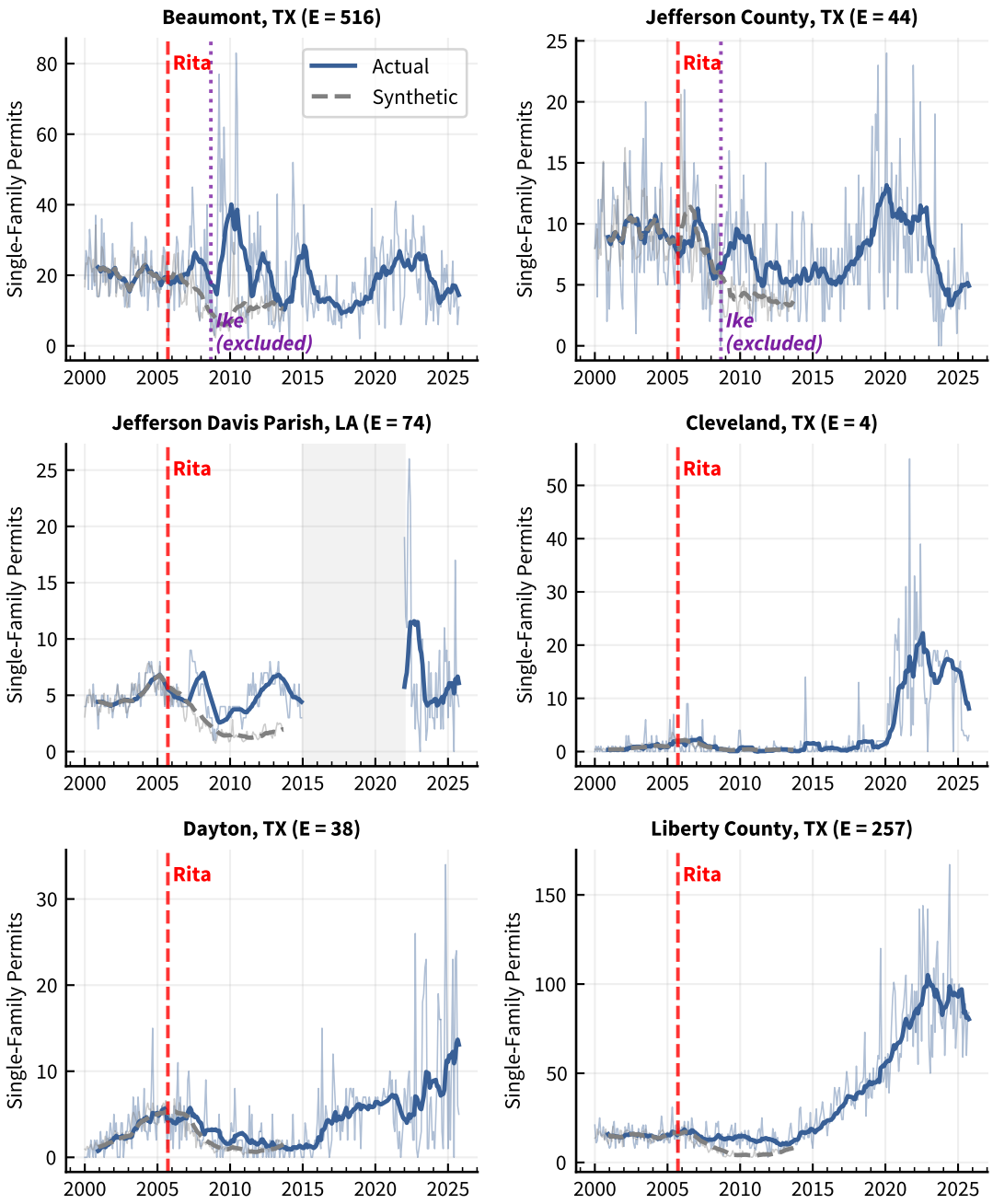

Fig. S11. Hurricane places (6 of 10).

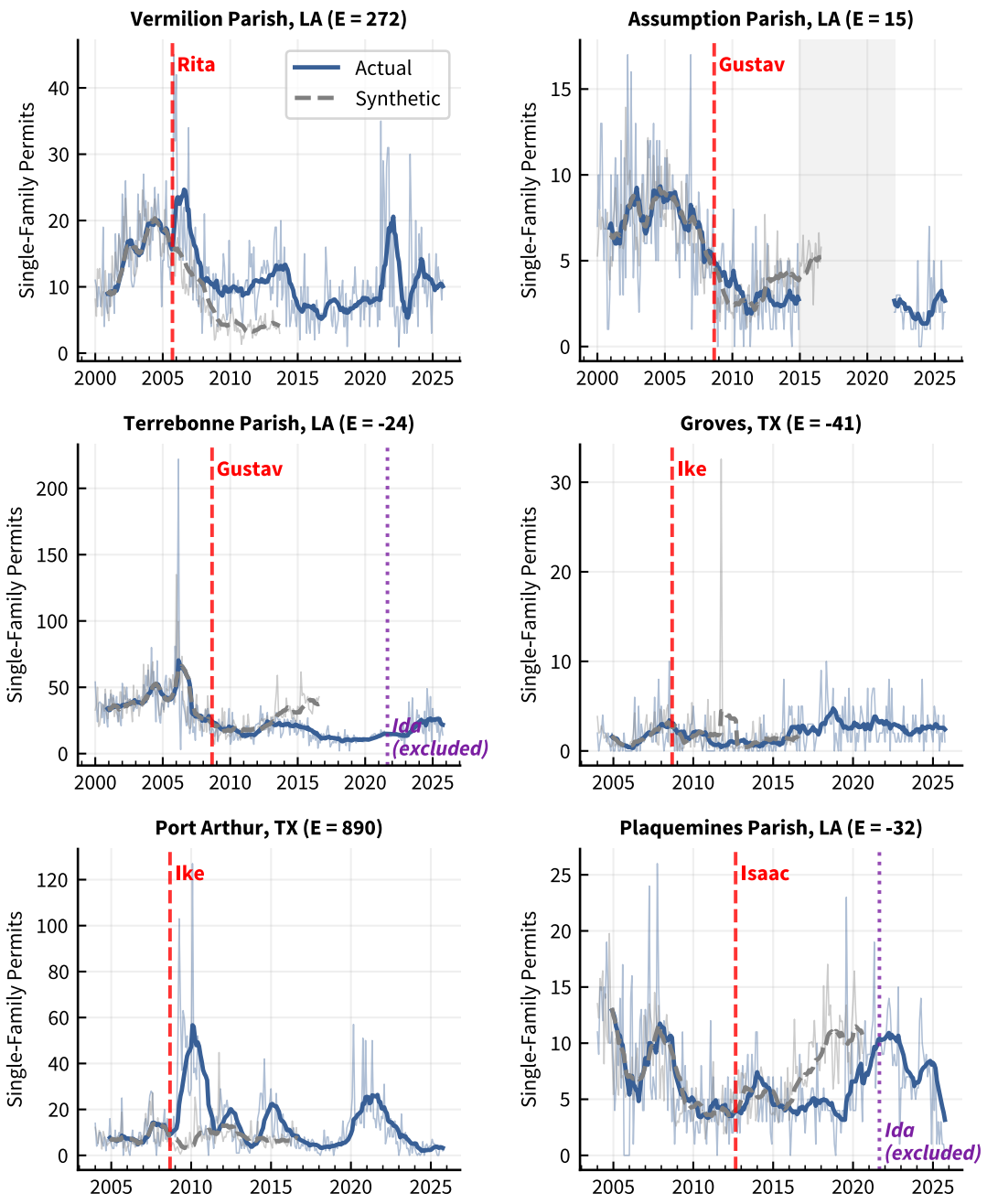

Fig. S12. Hurricane places (7 of 10).

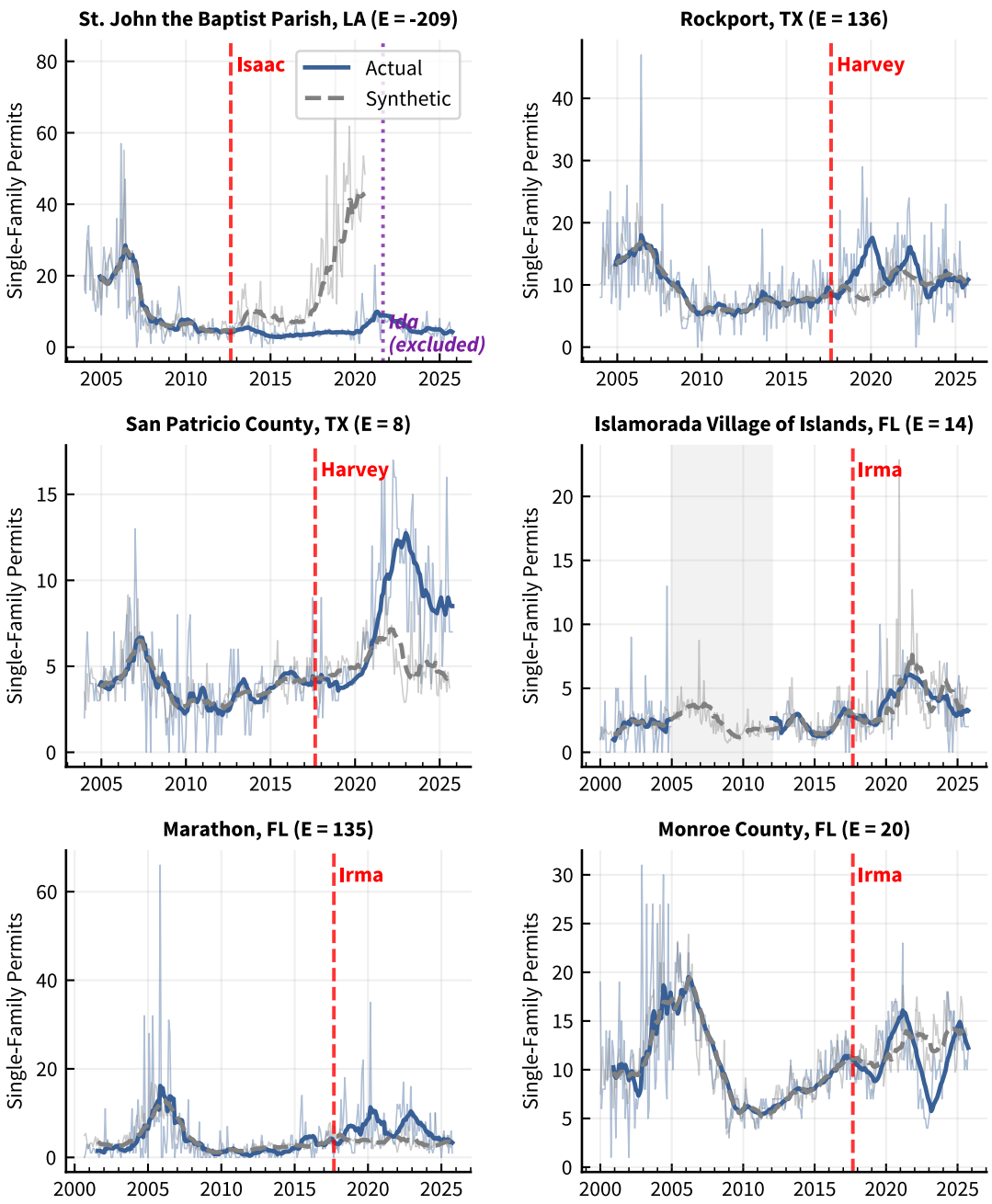

Fig. S13. Hurricane places (8 of 10).

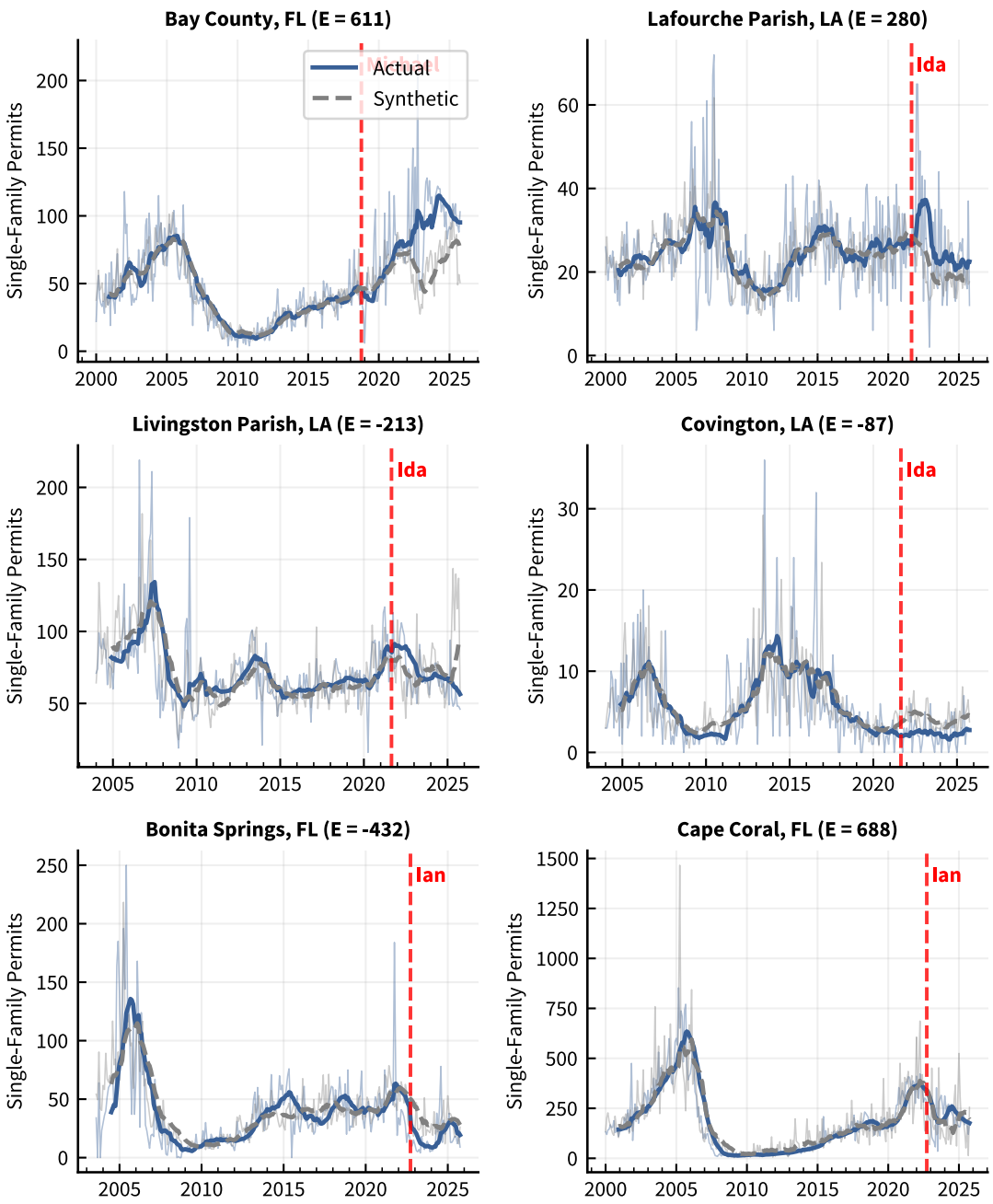

Fig. S14. Hurricane places (9 of 10).

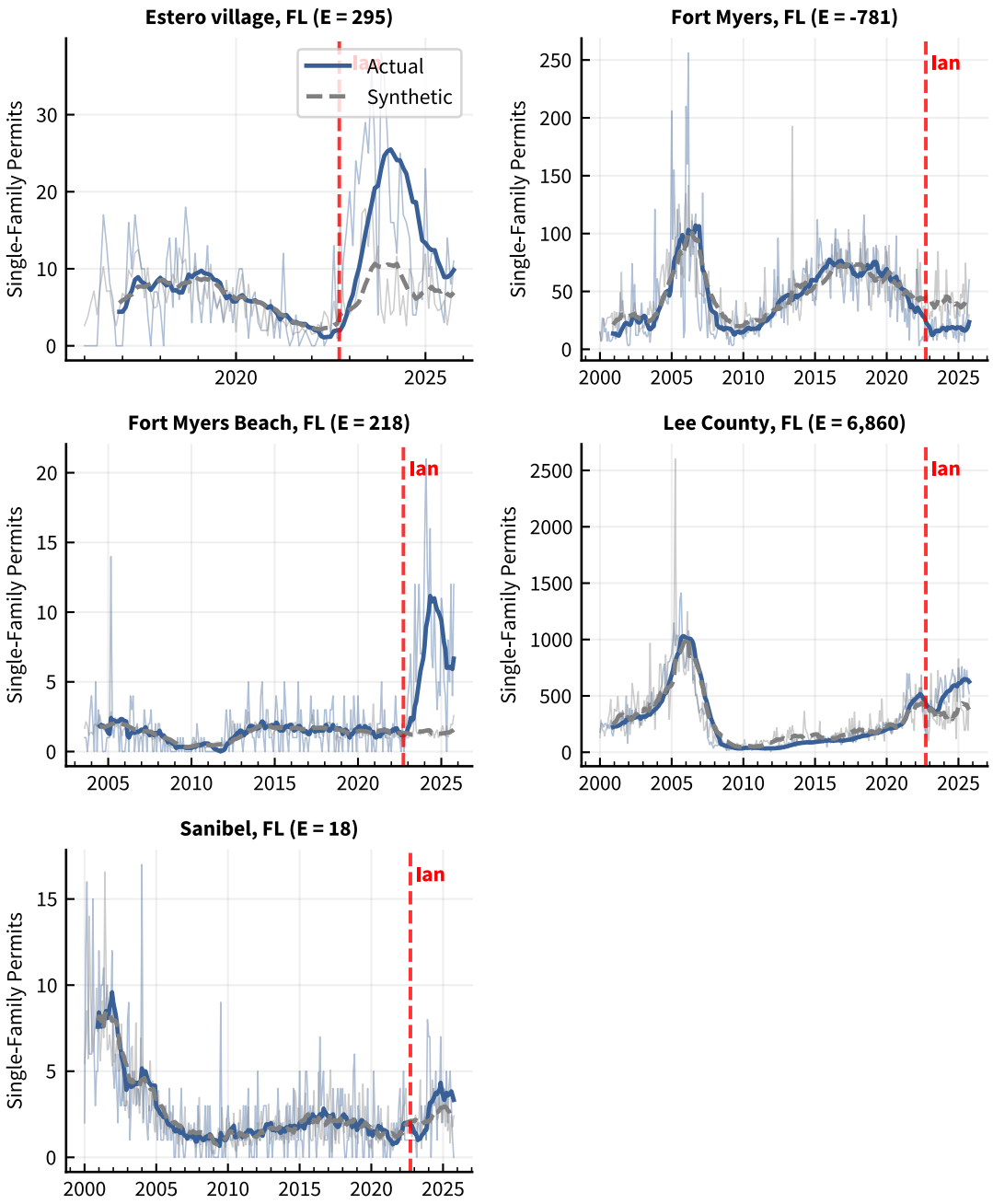

Fig. S15. Hurricane places (10 of 10).

Figures S16 and S17 show time series for wildfires and earthquakes that were considered but excluded from analysis. Most have BPS survey gaps adjacent to the disaster event, and Ventura has evidence of reporting inconsistencies, as discussed in the paper. No synthetic controls were produced due to these data issues, and so none are shown on the figures.

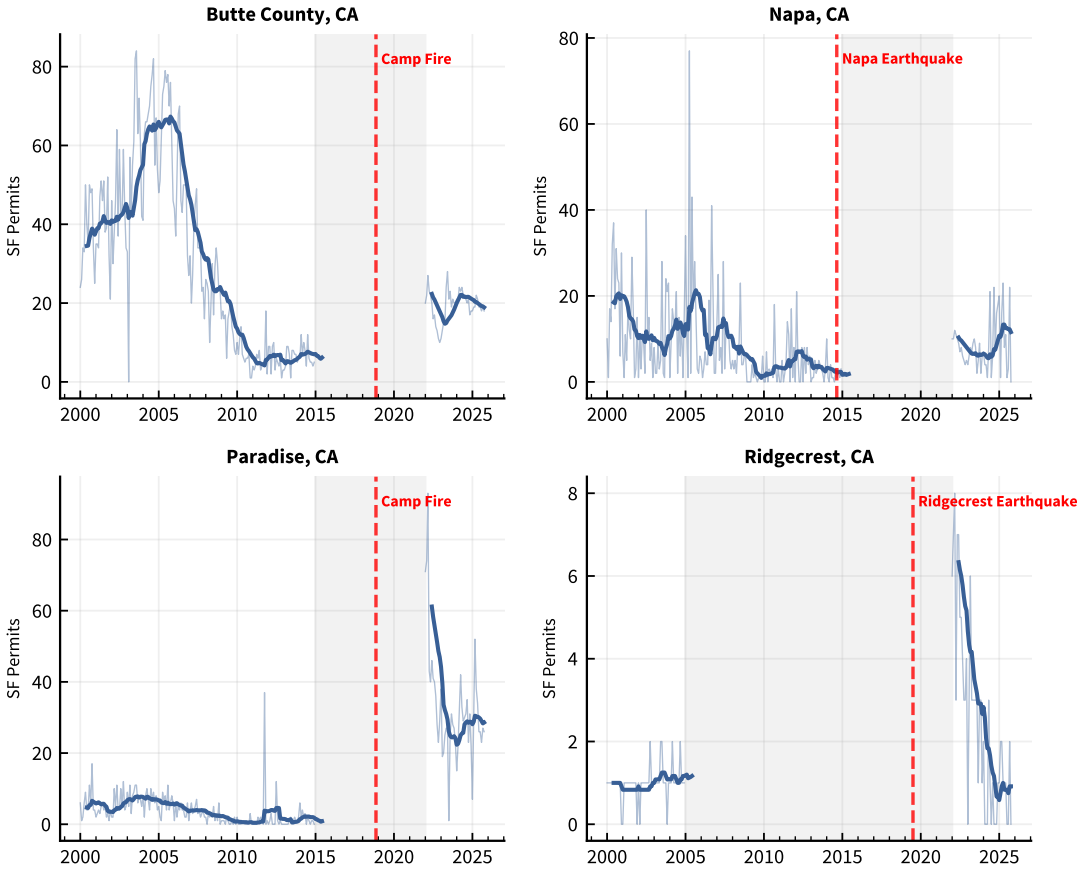

Fig. S16. Excluded places (1 of 2): Raw single-family permit time series for the places that were considered but excluded from the synthetic control analysis due to BPS survey limitations (data gaps or reporting inconsistencies).

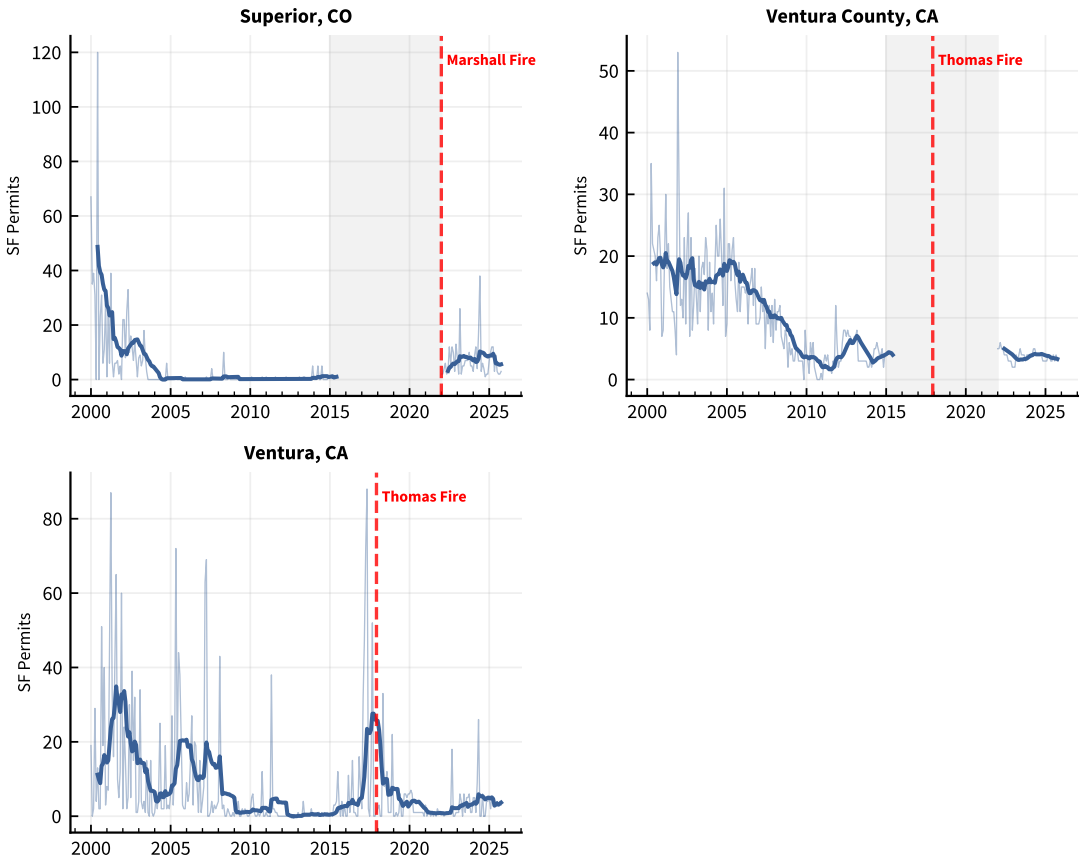

Fig. S17. Excluded places (2 of 2).

Supplemental table

Table 2 summarizes the computed Excess Permits for each considered place, and the reported number of destroyed buildings in each place, with sources for the reported numbers. These results are provided for reference, but a number of significant limitations should be noted:

1. **Geographic scope mismatches.** Several figures are county- or parish-level totals rather than place-level counts. For example, the Harrison County figure (7,618) aggregates destruction across Gulfport, Biloxi, Long Beach, and Pass Christian; the Jefferson Parish figure (4,677) encompasses Kenner and surrounding communities.
2. **Structure type.** Some figures count all structure types (residential, commercial, and other), while others count residential structures only. CAL FIRE damage inspection totals are all-structure counts. Marshall Fire figures are residential only, per the Boulder County Office of Disaster Management assessment. The Joplin Tornado figure (3,181) is the number of residential structures assessed as destroyed in the NIST technical investigation.
3. **Definition of "destroyed."** Damage-state classifications differ across sources. CAL FIRE uses its own post-fire inspection categories; the HUD Gulf Coast report uses "Severe" damage as the proxy for destroyed; and NHC tropical cyclone reports use FEMA damage assessment classifications.
4. **Lower-bound estimates.** The NHC report for Hurricane Michael states that more than

1,500 structures were destroyed in Bay County; the reported value is therefore a lower bound rather than a precise count.

5. **Missing values.** Many hurricane-affected places have no destruction count in the table. Sometimes this is due to a lack of identifiable source, and sometimes because the damage was predominantly repairable and no reliable "destroyed" count is available from standard post-event assessments. This absence of data is somewhat consistent with hurricane damage being less visible to new-construction permit records.

Table 2. Excess building permits and reported structures destroyed for disaster-affected places.

Place	Disaster	E	Destroyed	Source
Santa Rosa (CA)	Tubbs Fire	2,378	3,043	https://www.srcity.org/DocumentCenter/View/24254/Summary-of-Residential-Destruction-Resulting-from-October-2017-Wildfires_41919
Sonoma Co. (CA)	Tubbs Fire	1,431	5,636	https://www.fire.ca.gov/incidents/2017/10/8/tubbs-fire-central-lnu-complex
Malibu (CA)	Woolsey Fire	258	488	https://malibupermits.ci.malibu.ca.us/WoolseyRebuildStats.aspx?returnId=901
Louisville (CO)	Marshall Fire	506	550	https://bouldercounty.gov/news/boulder-county-releases-updated-list-of-structures-damaged-and-destroyed-in-the-marshall-fire/
Boulder Co. (CO)	Marshall Fire	13	156	https://bouldercounty.gov/news/boulder-county-releases-updated-list-of-structures-damaged-and-destroyed-in-the-marshall-fire/
Maui Co. (HI)	Lahaina Fire	290	2,207	https://www.mauicounty.gov/m/newsflash/Home/Detail/12683?arc=17713
Joplin (MO)	Joplin Tornado	247	3,181	https://nvlpubs.nist.gov/nistpubs/NCSTAR/NIST.NCSTAR.3.pdf
Moore (OK)	Moore Tornado	230	1,128	https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.1164.pdf
Charlotte Co. (FL)	Bonnie & Charley	-765	—	
Hardee Co. (FL)	Bonnie & Charley	306	—	
Punta Gorda (FL)	Bonnie & Charley	-507	—	
Escambia Co. (FL)	Ivan	-2,093	—	
Pensacola (FL)	Ivan	-151	—	
Grand Isle (LA)	Katrina	85	—	
Jefferson Par. (LA)	Katrina	-198	4,677	https://www.huduser.gov/publications/pdf/gulfcoast_hsngdmgest.pdf
Kenner (LA)	Katrina	-87	—	
Mandeville (LA)	Katrina	-27	—	
New Orleans (LA)	Katrina	1,360	—	
Ponchatoula (LA)	Katrina	70	—	
Slidell (LA)	Katrina	-22	—	
St. Bernard Par. (LA)	Katrina	260	13,748	https://www.huduser.gov/publications/pdf/gulfcoast_hsngdmgest.pdf

Place	Disaster	E	Destroyed	Source
St. Charles Par. (LA)	Katrina	131	51	https://www.huduser.gov/publications/pdf/gulfcoast_hsngdmgest.pdf
St. Tammany Par. (LA)	Katrina	-1,438	1,682	https://www.huduser.gov/publications/pdf/gulfcoast_hsngdmgest.pdf
Tangipahoa Par. (LA)	Katrina	1,911	130	https://www.huduser.gov/publications/pdf/gulfcoast_hsngdmgest.pdf
Biloxi (MS)	Katrina	133	—	
Gautier (MS)	Katrina	193	—	
Gulfport (MS)	Katrina	76	—	
Harrison Co. (MS)	Katrina	1,652	7,618	https://www.huduser.gov/publications/pdf/gulfcoast_hsngdmgest.pdf
Hattiesburg (MS)	Katrina	254	—	
Jackson Co. (MS)	Katrina	232	2,043	https://www.huduser.gov/publications/pdf/gulfcoast_hsngdmgest.pdf
Long Beach (MS)	Katrina	171	—	
Ocean Springs (MS)	Katrina	-98	—	
Pass Christian (MS)	Katrina	326	—	
Pearl River Co. (MS)	Katrina	440	218	https://www.huduser.gov/publications/pdf/gulfcoast_hsngdmgest.pdf
Waveland (MS)	Katrina	362	—	
Calcasieu Par. (LA)	Rita	-518	620	https://www.huduser.gov/publications/pdf/gulfcoast_hsngdmgest.pdf
Jefferson Davis Par. (LA)	Rita	74	46	https://www.huduser.gov/publications/pdf/gulfcoast_hsngdmgest.pdf
Lake Charles (LA)	Rita	143	—	
Sulphur (LA)	Rita	71	—	
Vermilion Par. (LA)	Rita	272	207	https://www.huduser.gov/publications/pdf/gulfcoast_hsngdmgest.pdf
Beaumont (TX)	Rita	516	—	
Cleveland (TX)	Rita	4	—	
Dayton (TX)	Rita	38	—	
Jefferson Co. (TX)	Rita	44	321	https://www.huduser.gov/publications/pdf/gulfcoast_hsngdmgest.pdf
Liberty Co. (TX)	Rita	257	56	https://www.huduser.gov/publications/pdf/gulfcoast_hsngdmgest.pdf

Place	Disaster	E	Destroyed	Source
Assumption Par. (LA)	Gustav	15	—	
Terrebonne Par. (LA)	Gustav	-24	—	
Groves (TX)	Ike	-41	—	
Port Arthur (TX)	Ike	890	—	
Plaquemines Par. (LA)	Isaac	-32	—	
St. John the Baptist Par. (LA)	Isaac	-209	—	
Rockport (TX)	Harvey	136	30% destroyed	https://www.weather.gov/crp/hurricane_harvey
San Patricio Co. (TX)	Harvey	8	580	https://www.weather.gov/crp/hurricane_harvey
Islamorada (FL)	Irma	14	—	
Marathon (FL)	Irma	135	—	
Monroe Co. (FL)	Irma	20	727	https://www.monroecounty-fl.gov/726/Hurricane-Irma-Recovery
Bay Co. (FL)	Michael	611	1,500	https://www.nhc.noaa.gov/data/tcr/AL142018_Michael.pdf
Covington (LA)	Ida	-87	—	https://www.nhc.noaa.gov/data/tcr/AL092021_Ida.pdf
Lafourche Par. (LA)	Ida	280	—	
Livingston Par. (LA)	Ida	-213	—	
Bonita Springs (FL)	Ian	-432	—	
Cape Coral (FL)	Ian	688	—	
Estero (FL)	Ian	295	—	
Fort Myers (FL)	Ian	-781	—	
Fort Myers Beach (FL)	Ian	218	900	https://www.nhc.noaa.gov/data/tcr/AL092022_Ian.pdf
Lee Co. (FL)	Ian	6,860	5,369	https://www.nhc.noaa.gov/data/tcr/AL092022_Ian.pdf
Sanibel (FL)	Ian	18	—	https://www.nhc.noaa.gov/data/tcr/AL092022_Ian.pdf