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Unpriced climate risk and the potential consequences of overvaluation in US housing markets

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SUPPLEMENTAL MATERIALS

Title

Unpriced climate risk and the potential consequences of overvaluation in US housing markets

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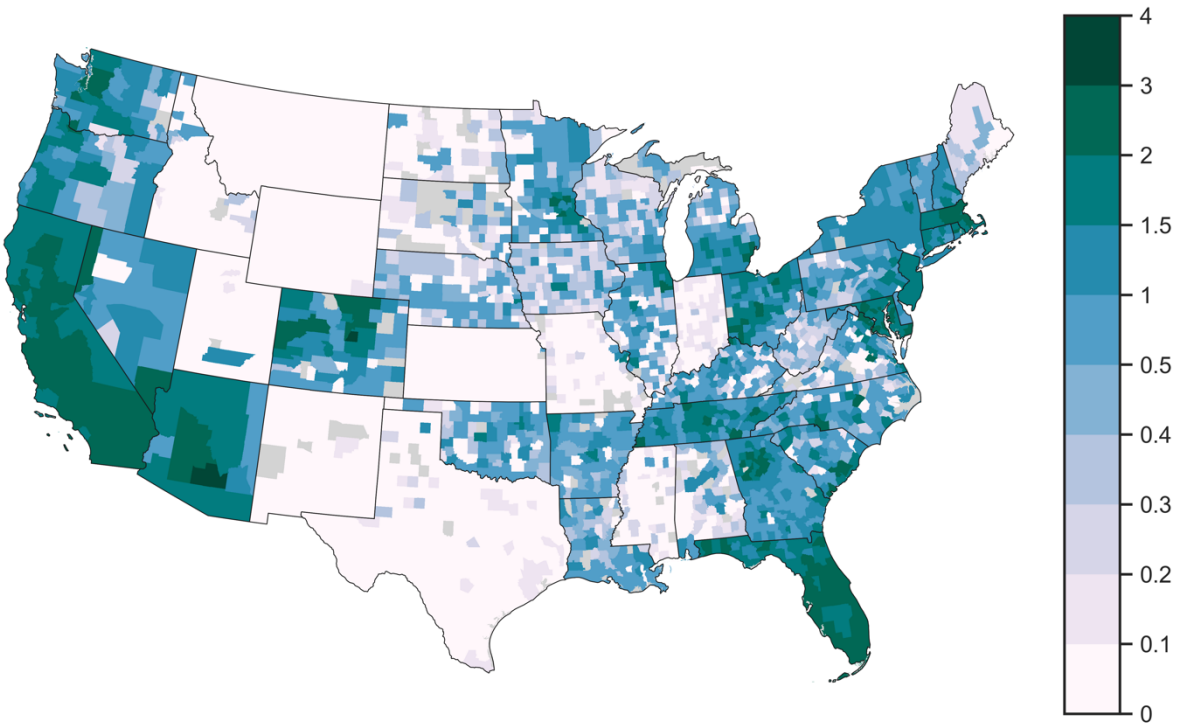

Fig. S1 | Number of ZTRAX transactions per parcel by county.

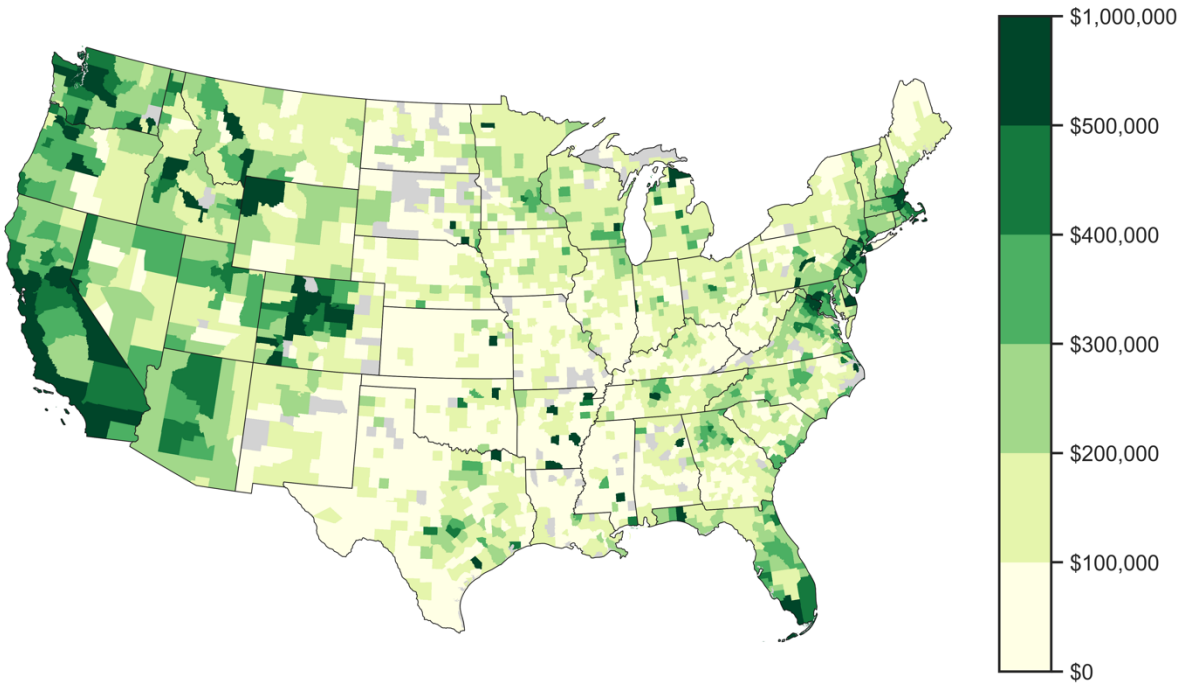

Fig. S2 | Median fair market property values by county.

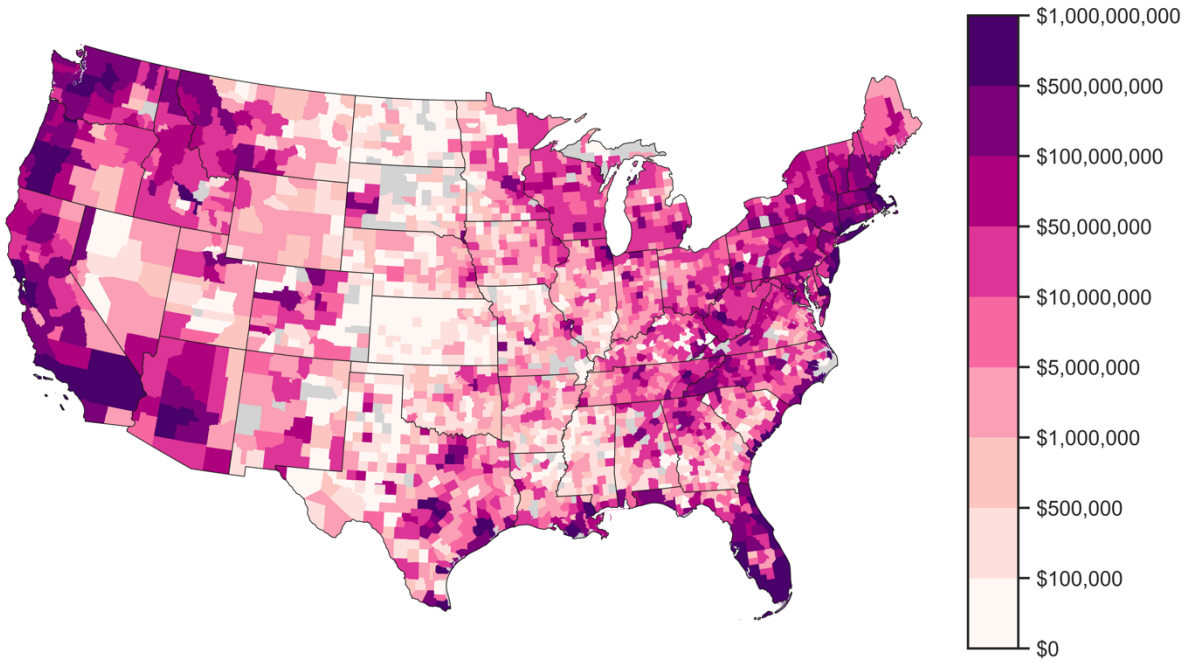

Fig. S3 | Total net present value of average annual flood losses by county.

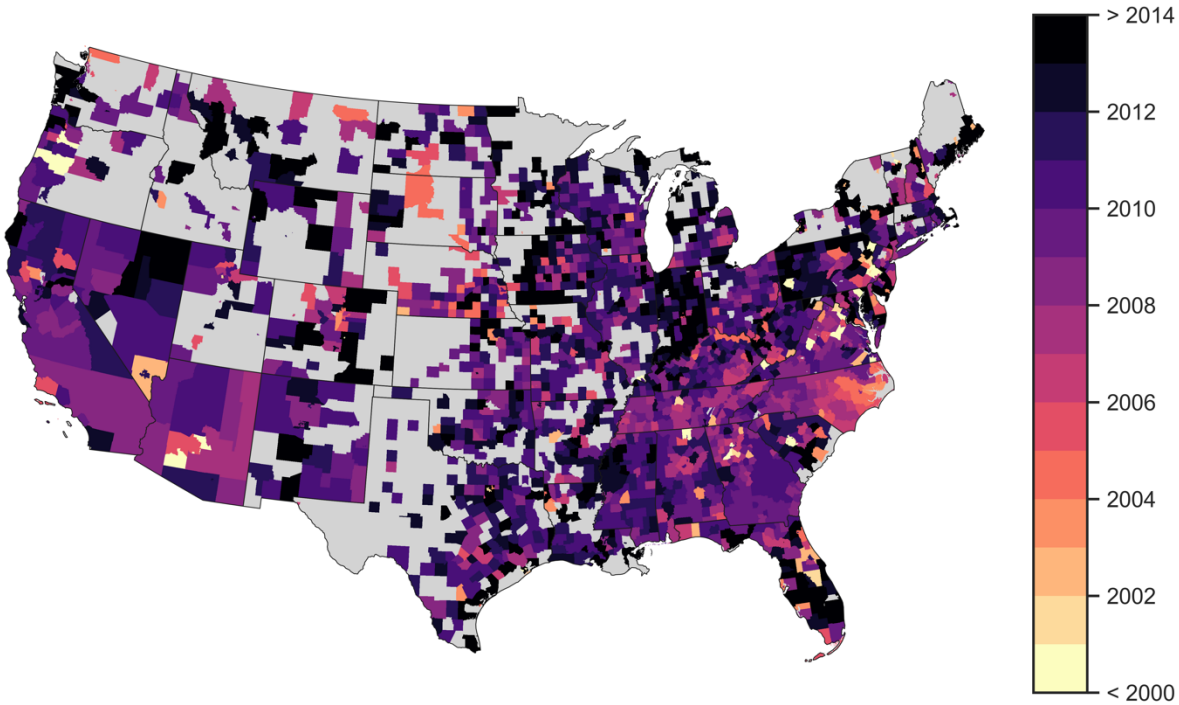

Fig. S4 | Year of flood insurance rate map (FIRM) updates.

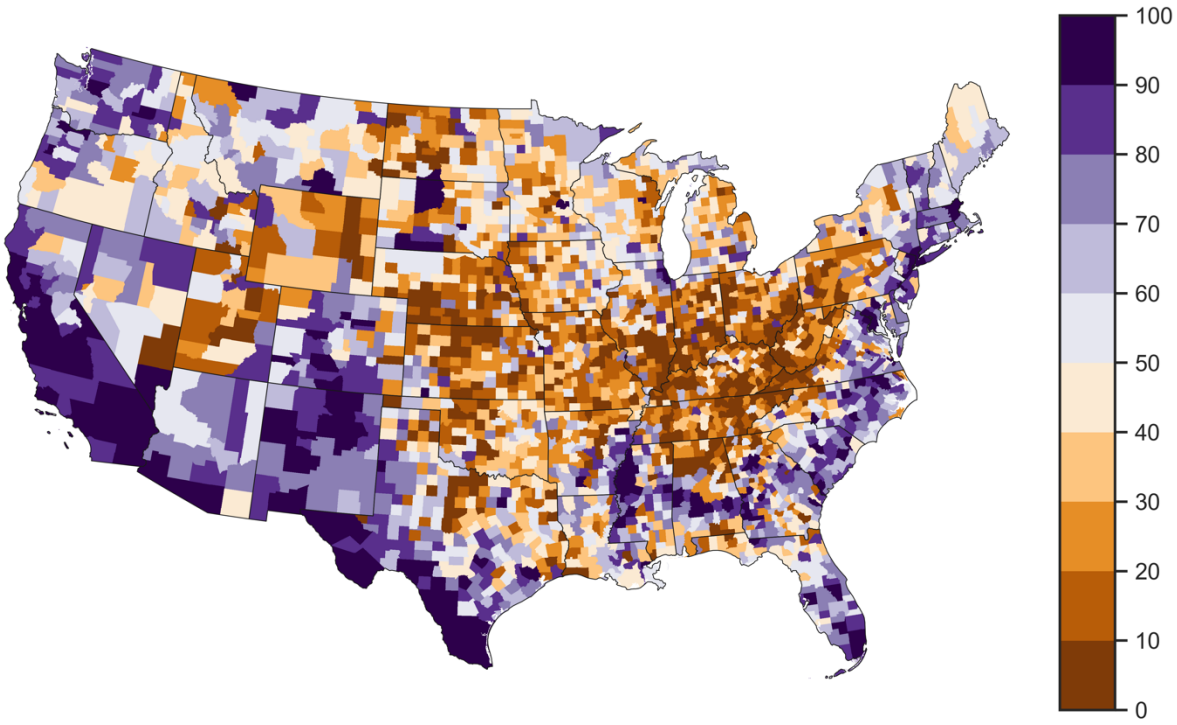

Fig. S5 | Yale Climate Survey responses to the question, "Do you think global warming will harm you personally?"Counties are colored based on their percentile rank.

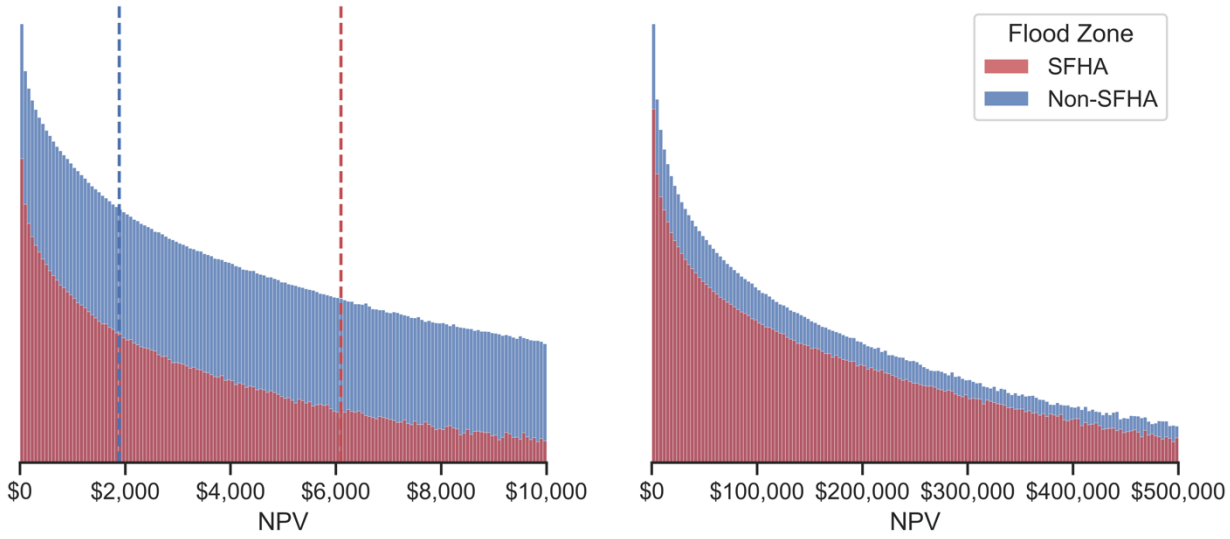

Fig. S6 | Histogram of net present value of flood losses by SFHA and non-SFHA properties. Both plots use the same data, but have different x-axis limits. Vertical dashed lines indicate median values.

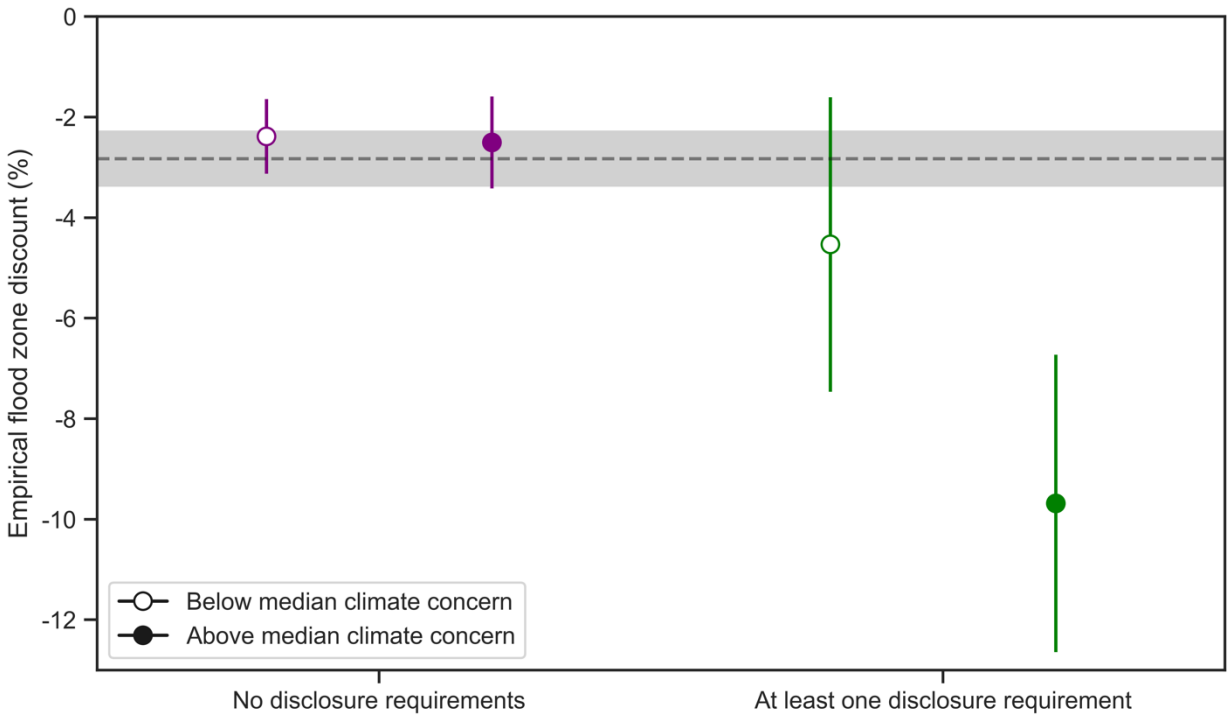

Fig. S7 | Estimated flood zone discounts from the panel model (our preferred specification), by county-level flood risk disclosure requirements and concerns about climate risk (n = 35,866,115). Points indicate mean estimates and error bars indicate the 95% confidence interval. The dashed line indicates the national average.

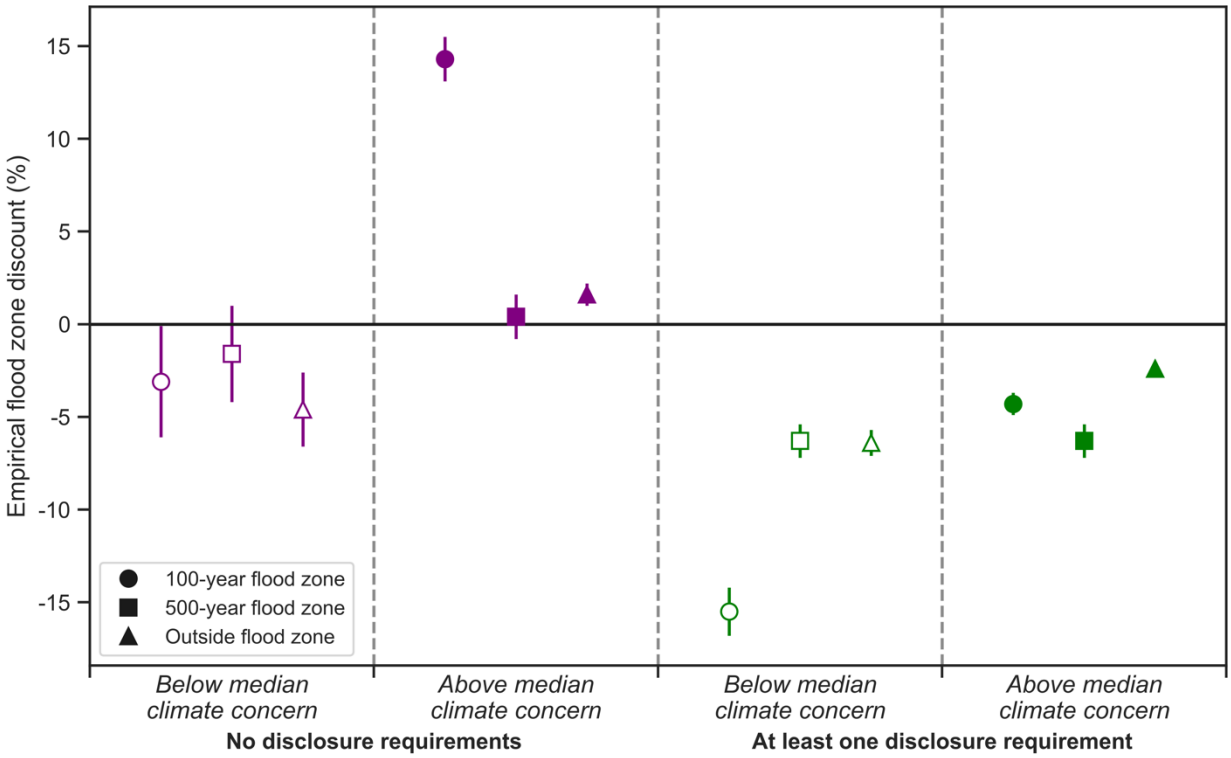

Fig. S8 | Estimated flood zone discounts from the cross-sectional model (the less preferred specification), by county-level flood risk disclosure requirements and concerns about climate risk (n = 35,866,115). Points indicate mean estimates and error bars indicate the 95% confidence interval.

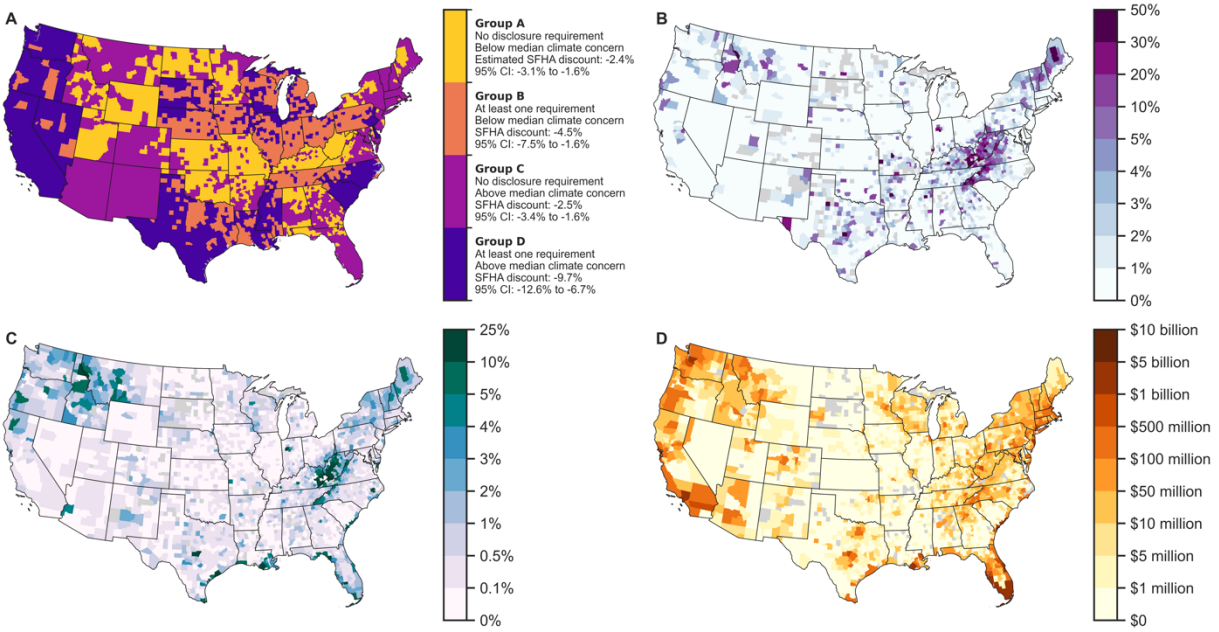

Fig. S9 | Flood risk capitalization and property overvaluation by county, similar to Fig. 1. Instead of using a 3% discount rate and the 'mid' hazard scenario, these results are based on a 7% discount rate and the 'low' hazard scenario to provide lower-bound estimates on overvaluation.

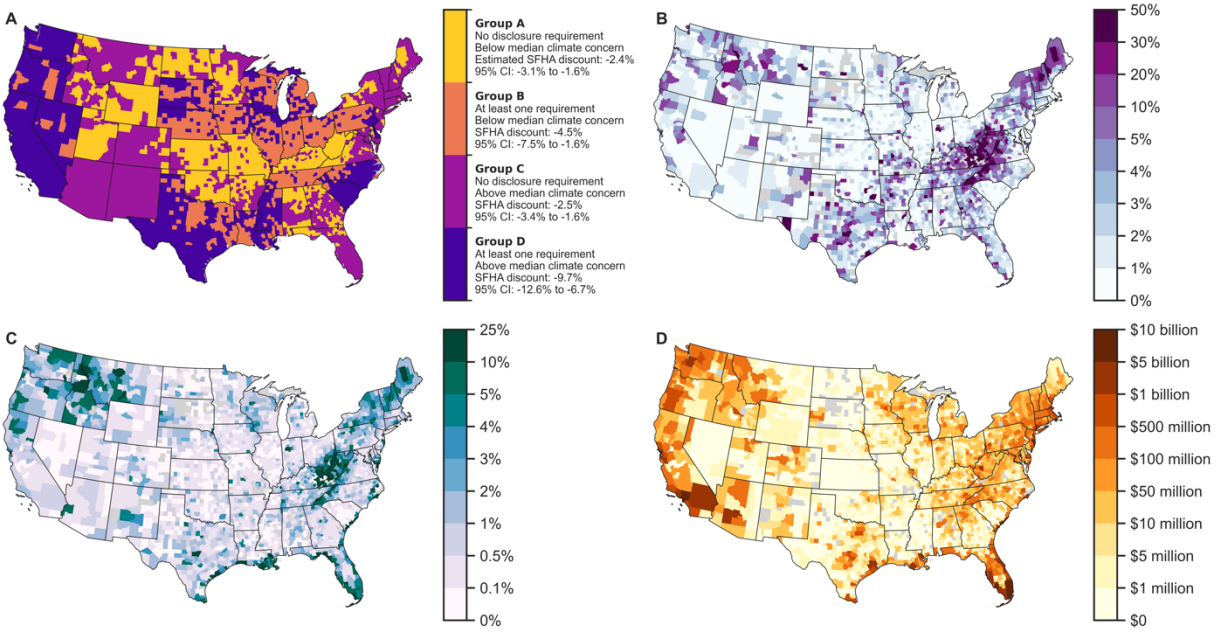

Fig. S10 | Flood risk capitalization and property overvaluation by county, similar to Fig. 1. Instead of using a 3% discount rate and the 'mid' hazard scenario, these results are based on a 1% discount rate and the 'high' hazard scenario to provide upper-bound estimates on overvaluation.

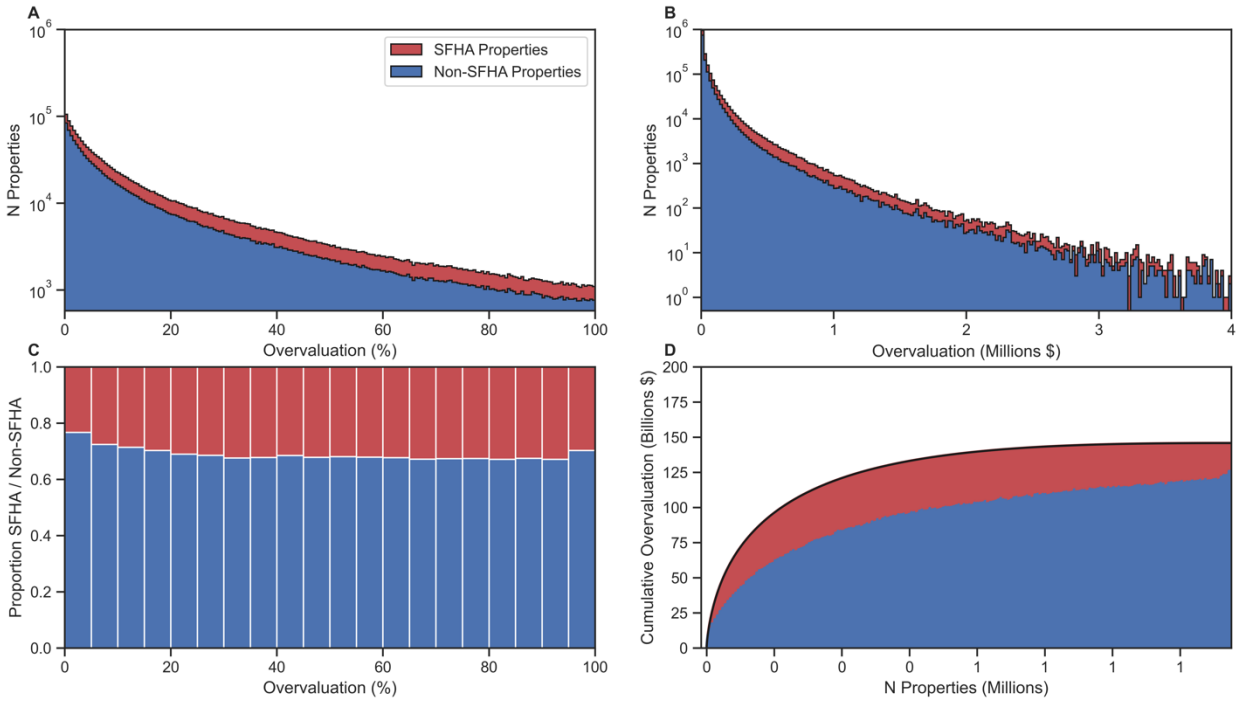

Fig. S11 | Distributions of overvaluation by property location, similar to Fig. 2. The difference being that all properties are assumed to discount flood risk as was estimated for SFHA properties. Under this alternative assumption, total overvaluation is $146 billion, a 22% decrease from our central estimate.

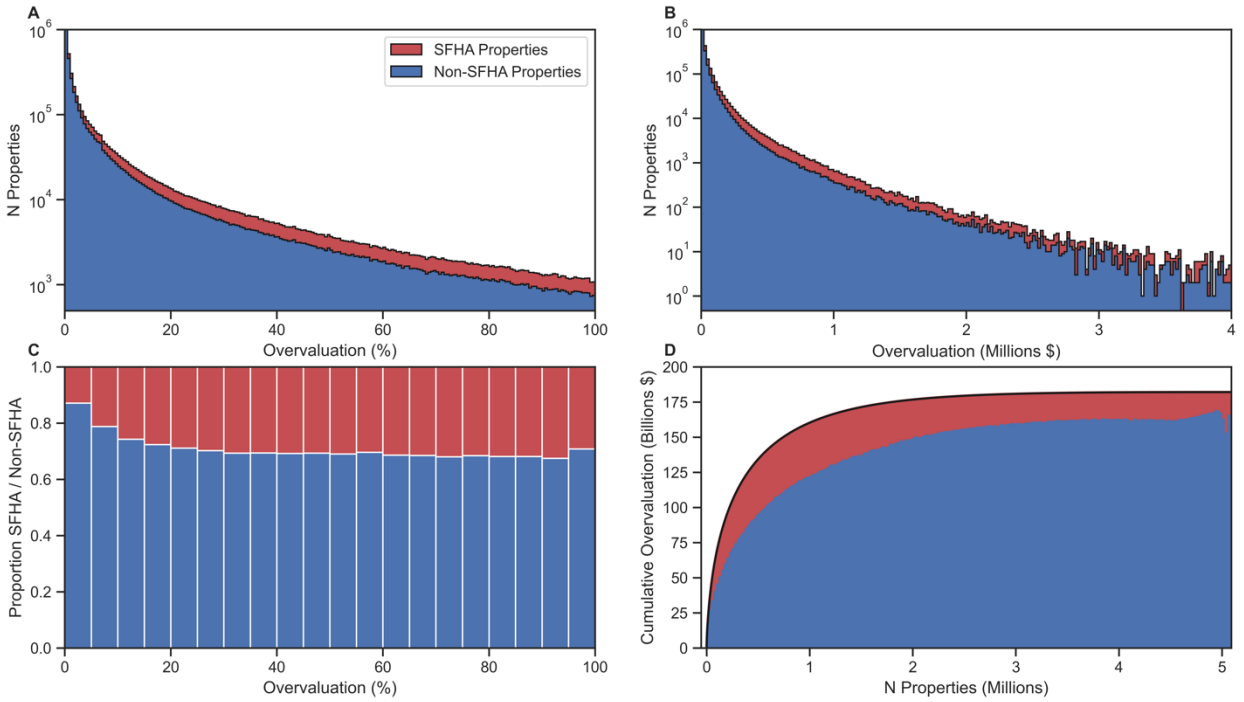

Fig. S12 | Distributions of overvaluation by property location, similar to Fig. 2. The difference being that flood risk discounts were estimated by the cross-sectional model instead of the panel model. Under this alternative assumption, total overvaluation is $182 billion, a 2% decrease from our central estimate.

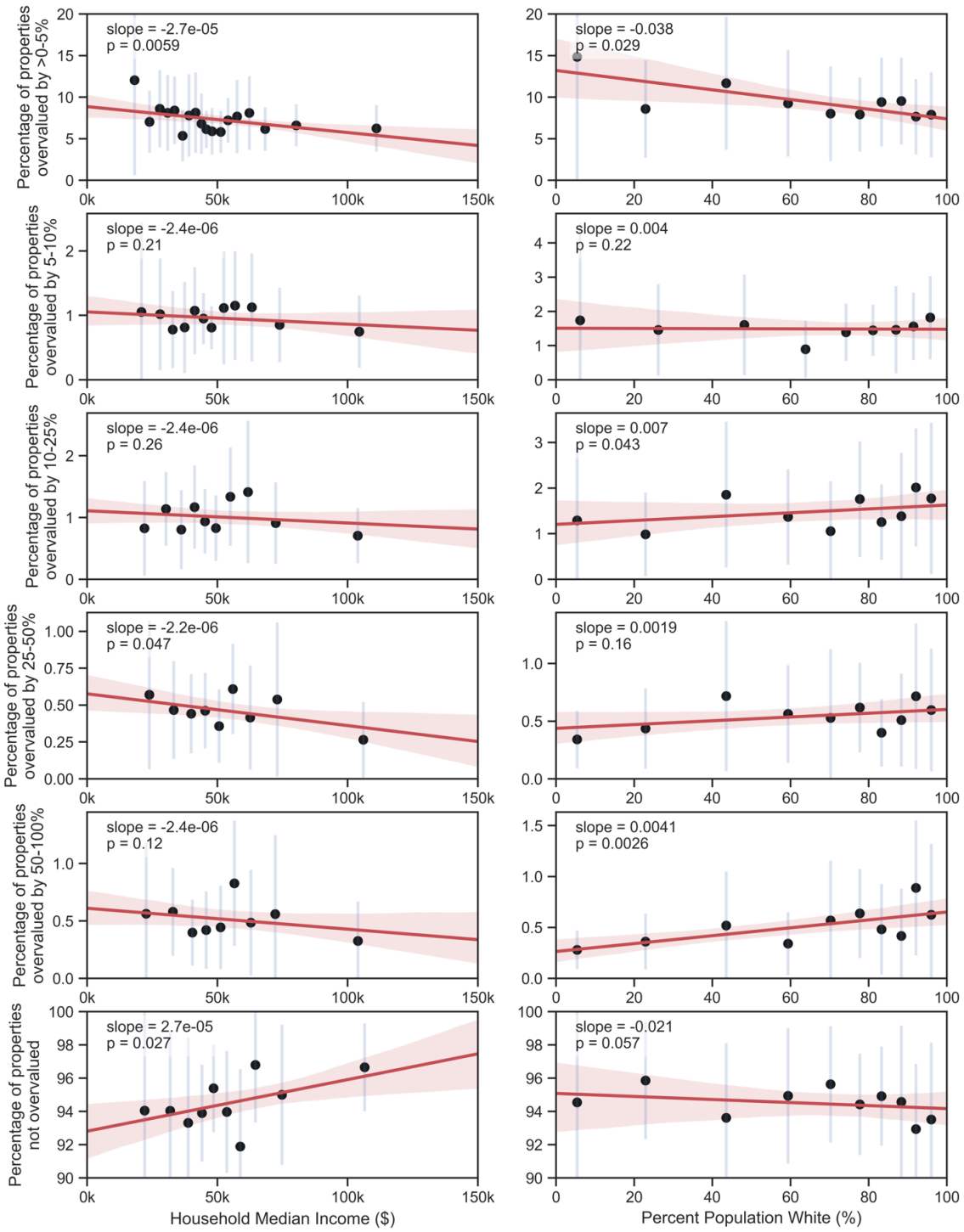

Fig. S13 | Estimated relationships between percentage of overvalued properties and population characteristics at the census tract-level (n = 61,476). Census tracts were binned using the 'binsreg' package in Python v3.9. The slope and significance of the trendlines were estimated using an OLS model, with observations weighted by census tract population size. Points indicate mean estimates and error bars/bands indicate the 95% confidence interval. Statistical significance was estimated using a two-tailed t-test.

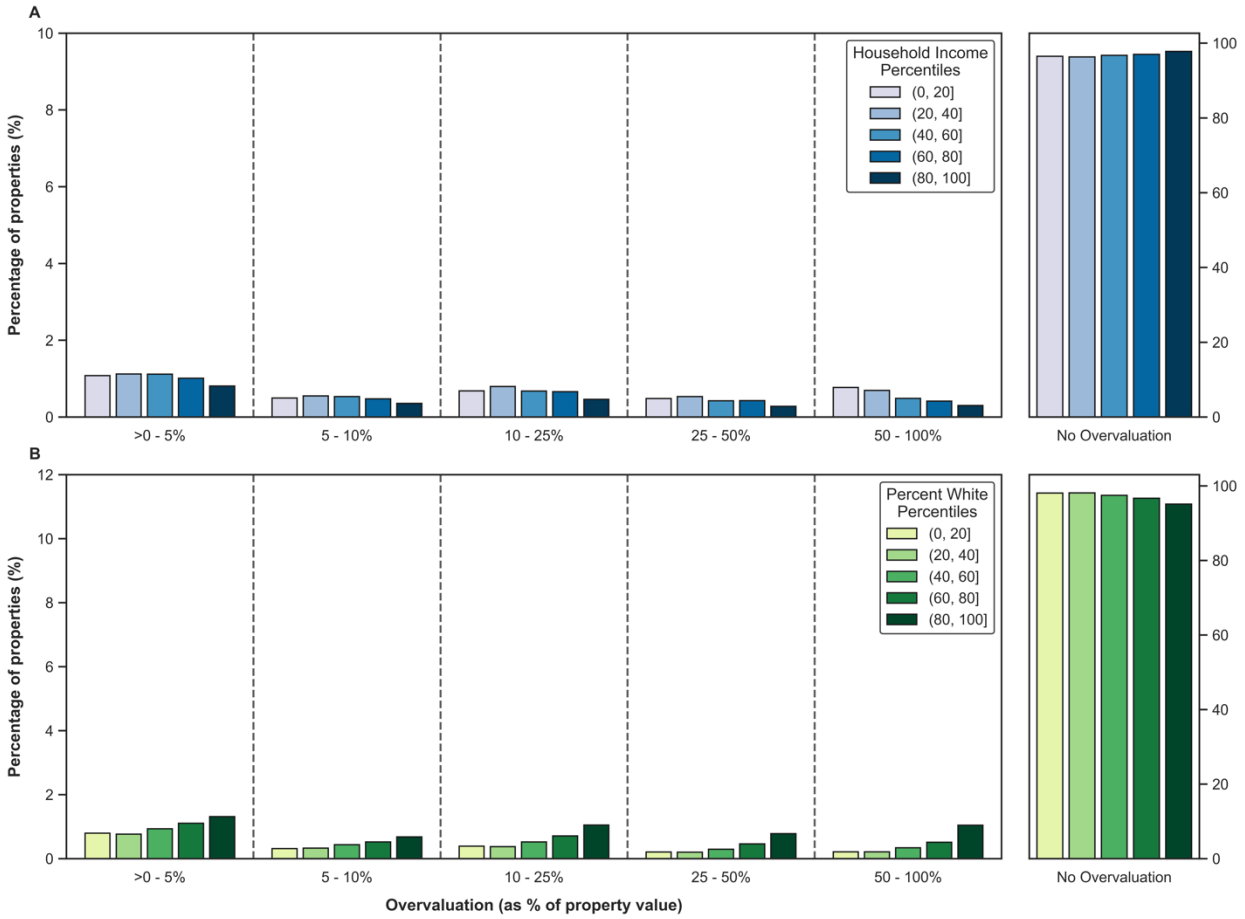

Fig. S14 | Distribution of property overvaluation among demographic groups, similar to Fig. 3. The difference being that all properties are assumed to discount flood risk as was estimated for SFHA properties.

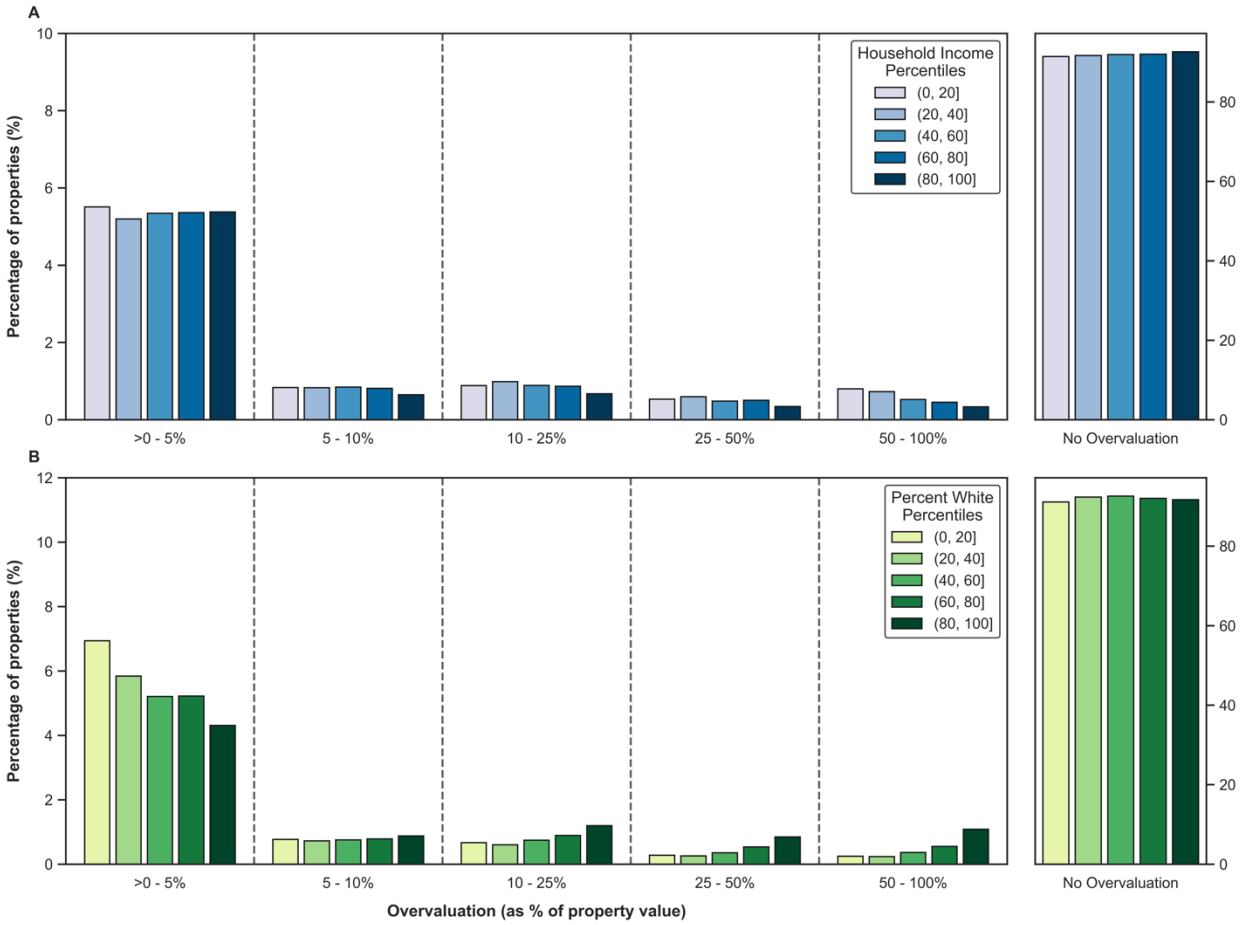

Fig. S15 | Distribution of property overvaluation among demographic groups, similar to Fig. 3. The difference being that flood risk discounts were estimated by the cross-sectional model instead of the panel model.

Table S1 | Counties where local governments are vulnerable to budgetary shortfalls as the result of property price deflation. The counties in this list are in the top quintile of both property tax revenue, as a percentage of total revenue, and property overvaluation, as a percentage of total property value. The table is listed alphabetically by state then county.

County	Property Tax Revenue (as % of total revenue)	Property overvaluation (as % of total property value)	Median property overvaluation (as % of individual property value)	Total overvaluation
Marin County, CA	29.5%	3.5%	3.9%	$ 2,257,165,696
Mineral County, CO	44.3%	3.4%	3.3%	$ 643,097
Middlesex County, CT	50.7%	2.1%	0.3%	$ 213,537,962
New Haven County, CT	47.2%	1.4%	0.9%	$ 501,895,388
Manatee County, FL	27.8%	5.7%	0.9%	$ 2,003,588,396
Miami-Dade County, FL	30.1%	2.8%	0.1%	$ 3,873,492,541
Palm Beach County, FL	30.7%	2.9%	0.6%	$ 3,969,325,179
Blaine County, ID	27.6%	1.8%	0.8%	$ 521,477,156
Camas County, ID	33.6%	3.3%	0.8%	$ 3,052,857
Custer County, ID	30.1%	6.4%	3.4%	$ 28,367,576
Kootenai County, ID	28.8%	1.7%	1.4%	$ 327,081,578
Lemhi County, ID	30.2%	5.3%	3.0%	$ 35,936,101
Nez Perce County, ID	35.5%	1.4%	10.0%	$ 26,695,764
Oneida County, ID	36.4%	1.4%	0.5%	$ 2,552,347
Owyhee County, ID	25.7%	5.9%	6.5%	$ 28,312,756
Valley County, ID	40.1%	1.4%	1.4%	$ 66,458,389
Elkhart County, IN	44.6%	1.5%	1.0%	$ 103,816,030
White County, IN	28.4%	13.7%	43.5%	$ 187,957,417
Winneshiek County, IA	35.5%	1.6%	4.7%	$ 14,982,202
Wichita County, KS	27.2%	1.4%	0.5%	$ 100,002
Martin County, KY	28.4%	35.9%	59.3%	$ 38,101,700
Knox County, ME	54.0%	1.8%	3.4%	$ 20,652,937
Penobscot County, ME	42.5%	3.8%	9.6%	$ 42,452,962
Sagadahoc County, ME	85.2%	1.5%	1.0%	$ 34,983,511
York County, ME	54.6%	2.7%	1.9%	$ 409,920,431
Dorchester County, MD	34.1%	2.0%	0.7%	$ 43,962,529
Somerset County, MD	43.2%	2.8%	0.8%	$ 22,367,071
Worcester County, MD	32.5%	2.7%	0.3%	$ 165,968,497
Berkshire County, MA	43.5%	1.4%	2.4%	$ 176,797,478
Franklin County, MA	46.6%	1.7%	2.5%	$ 82,240,761
Gladwin County, MI	32.6%	3.0%	2.8%	$ 47,087,392
Leelanau County, MI	26.3%	2.2%	4.7%	$ 115,639,143

Midland County, MI	36.6%	1.8%	0.7%	$	117,256,631
Newaygo County, MI	34.8%	2.5%	2.9%	$	57,782,545
Crow Wing County, MN	34.3%	1.7%	6.3%	$	21,945
Goodhue County, MN	38.9%	1.4%	3.4%	$	37,893,689
Cascade County, MT	26.1%	2.8%	3.6%	$	84,839,580
Deer Lodge County, MT	47.2%	3.0%	0.9%	$	12,864,176
Fergus County, MT	30.5%	2.1%	2.1%	$	11,837,380
Flathead County, MT	26.3%	1.9%	0.9%	$	144,319,735
Judith Basin County, MT	26.5%	6.7%	9.3%	$	2,692,595
Mineral County, MT	27.7%	26.2%	76.6%	$	48,282,912
Missoula County, MT	32.0%	2.6%	1.8%	$	191,450,421
Stillwater County, MT	42.0%	8.7%	8.1%	$	52,770,831
Belknap County, NH	66.6%	1.8%	3.8%	$	139,216,612
Cheshire County, NH	48.7%	1.7%	4.5%	$	48,040,250
Coos County, NH	30.3%	3.7%	5.0%	$	24,163,820
Grafton County, NH	54.0%	5.1%	31.7%	$	55,774,842
Merrimack County, NH	54.7%	1.6%	3.9%	$	89,542,180
Sullivan County, NH	56.0%	2.6%	4.8%	$	44,026,495
Cape May County, NJ	59.8%	1.5%	0.0%	$	535,930,880
Ocean County, NJ	44.2%	4.8%	2.6%	$	5,014,317,558
Warren County, NJ	70.8%	1.7%	4.1%	$	148,827,638
Chemung County, NY	33.8%	3.1%	1.1%	$	41,876,233
Columbia County, NY	35.5%	1.7%	2.9%	$	45,331,453
Cortland County, NY	30.6%	3.5%	2.5%	$	50,372,257
Delaware County, NY	33.7%	4.6%	12.0%	$	103,357,815
Franklin County, NY	35.9%	1.9%	4.4%	$	22,856,859
Greene County, NY	43.2%	1.6%	4.4%	$	74,053,629
Hamilton County, NY	47.3%	5.8%	9.1%	$	36,585,067
Herkimer County, NY	35.1%	2.7%	4.0%	$	55,793,935
Lewis County, NY	32.6%	2.4%	4.0%	$	14,359,914
Livingston County, NY	35.2%	2.1%	2.3%	$	50,353,164
Orange County, NY	38.7%	1.4%	8.2%	$	24,975,286
Rensselaer County, NY	26.0%	1.4%	3.4%	$	85,395,093
St. Lawrence County, NY	30.8%	3.3%	5.8%	$	73,600,960
Steuben County, NY	26.4%	4.2%	3.4%	$	127,368,296
Sullivan County, NY	32.1%	2.8%	10.3%	$	85,148,017
Tioga County, NY	34.0%	2.7%	2.1%	$	45,915,690
Tompkins County, NY	28.4%	2.2%	7.1%	$	73,960,085
Warren County, NY	29.9%	2.4%	2.8%	$	137,425,019
Washington County, NY	55.5%	2.4%	7.0%	$	57,169,553

Wyoming County, NY	26.6%	2.0%	2.9%	$	21,245,910
Ashe County, NC	26.6%	11.3%	48.4%	$	272,546,410
Avery County, NC	29.7%	4.0%	36.2%	$	79,944,814
Buncombe County, NC	27.3%	1.4%	5.4%	$	299,118,328
Carteret County, NC	34.2%	6.9%	2.3%	$	732,300,937
Clay County, NC	47.7%	6.0%	27.4%	$	73,820,555
Craven County, NC	28.6%	2.5%	1.0%	$	146,959,310
Henderson County, NC	29.6%	1.7%	8.5%	$	159,801,458
Jackson County, NC	48.2%	6.7%	56.2%	$	393,515,170
Macon County, NC	42.5%	6.7%	40.8%	$	384,483,909
Montgomery County, NC	29.2%	1.5%	2.5%	$	22,596,130
Onslow County, NC	26.3%	3.2%	2.3%	$	248,032,155
Transylvania County, NC	28.0%	3.7%	17.7%	$	108,216,509
Watauga County, NC	29.6%	5.5%	42.2%	$	378,512,622
Vinton County, OH	33.9%	1.6%	8.1%	$	8,603,037
Coos County, OR	30.0%	1.5%	2.1%	$	79,409,875
Curry County, OR	28.9%	2.5%	12.0%	$	71,888,921
Douglas County, OR	34.8%	7.3%	8.0%	$	476,465,129
Josephine County, OR	35.6%	5.6%	5.7%	$	430,485,281
Union County, OR	27.8%	1.9%	0.9%	$	14,760,203
Bedford County, PA	31.1%	5.3%	15.4%	$	105,023,046
Cameron County, PA	31.6%	5.1%	1.6%	$	1,785,706
Potter County, PA	30.8%	4.6%	4.8%	$	21,311,647
Sullivan County, PA	30.5%	1.5%	10.0%	$	8,647,309
Washington County, PA	28.1%	2.3%	24.3%	$	290,402,040
Wayne County, PA	52.6%	2.0%	9.0%	$	86,488,114
Wyoming County, PA	35.2%	1.7%	0.6%	$	25,284,872
Beaufort County, SC	33.0%	11.9%	0.6%	$	2,900,422,069
Jones County, SD	60.1%	1.5%	8.4%	$	292,827
Hardin County, TN	46.9%	2.4%	5.7%	$	30,724,513
Unicoi County, TN	37.0%	2.8%	4.0%	$	21,265,755
Blanco County, TX	41.5%	2.3%	11.6%	$	16,901,316
Bosque County, TX	30.4%	1.5%	9.5%	$	3,925,633
Brazoria County, TX	28.2%	2.5%	2.4%	$	380,648,508
Calhoun County, TX	32.2%	16.6%	4.9%	$	88,485,958
Galveston County, TX	25.8%	4.6%	2.5%	$	994,992,690
Jones County, TX	32.6%	1.6%	2.1%	$	1,012,603
Knox County, TX	48.7%	4.7%	15.7%	$	1,533,371
Live Oak County, TX	39.8%	2.1%	1.4%	$	4,929,442
Llano County, TX	52.3%	40.6%	100.0%	$	227,195,139

Palo Pinto County, TX	30.9%	3.5%	8.3%	$	20,339,255
Real County, TX	50.3%	6.0%	10.4%	$	6,053,184
Runnels County, TX	36.9%	1.5%	0.4%	$	342,734
San Patricio County, TX	25.9%	2.0%	0.9%	$	18,492,118
Shackelford County, TX	55.8%	1.5%	8.2%	$	1,670,326
Sutton County, TX	55.8%	1.8%	3.1%	$	2,253,440
Willacy County, TX	30.2%	1.4%	0.3%	$	3,735,860
Addison County, VT	58.4%	2.1%	9.7%	$	29,046,110
Bennington County, VT	78.3%	3.2%	3.9%	$	48,357,810
Lamoille County, VT	44.6%	1.6%	8.7%	$	38,418,164
Orange County, VT	82.3%	4.4%	20.4%	$	69,708,965
Orleans County, VT	35.2%	2.5%	10.2%	$	21,337,593
Rutland County, VT	56.4%	2.1%	2.9%	$	76,522,066
Washington County, VT	48.2%	3.7%	9.6%	$	80,180,612
Windham County, VT	46.6%	3.3%	12.8%	$	126,429,223
Buchanan County, VA	30.6%	35.1%	95.6%	$	72,071,672
Covington city, VA	28.2%	3.3%	3.6%	$	3,994,623
Poquoson city, VA	42.5%	2.1%	0.1%	$	27,329,122
Crawford County, WI	33.6%	4.0%	2.6%	$	12,635,895
Dunn County, WI	32.1%	2.4%	3.5%	$	48,528,062
Iowa County, WI	39.3%	1.5%	2.0%	$	22,095,201
La Crosse County, WI	39.0%	1.4%	0.8%	$	83,551,594
Marinette County, WI	27.1%	2.1%	1.6%	$	54,491,886
Price County, WI	29.8%	1.4%	2.7%	$	10,392,522
Rusk County, WI	26.5%	6.4%	11.5%	$	47,723,746

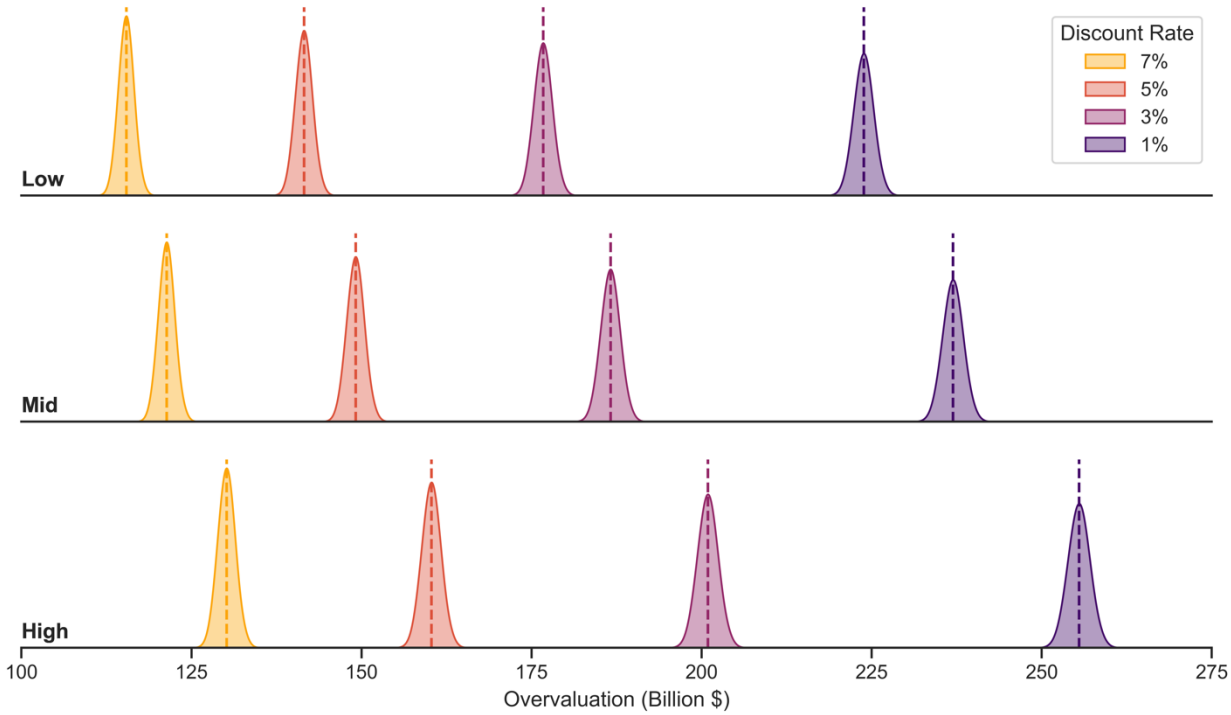

Fig. S16 | Uncertainty in estimates of total overvaluation. Each probability distribution function was generated using a Monte Carlo simulation that randomly sampled fitted distributions for the estimated flood zone discount coefficients. Rows indicate low, mid, and high flood hazard scenarios under RCP 4.5; colors indicate the applied discount rate. The mean value of the mid hazard scenario under a 3% discount rate is used as our central estimate of total overvaluation.

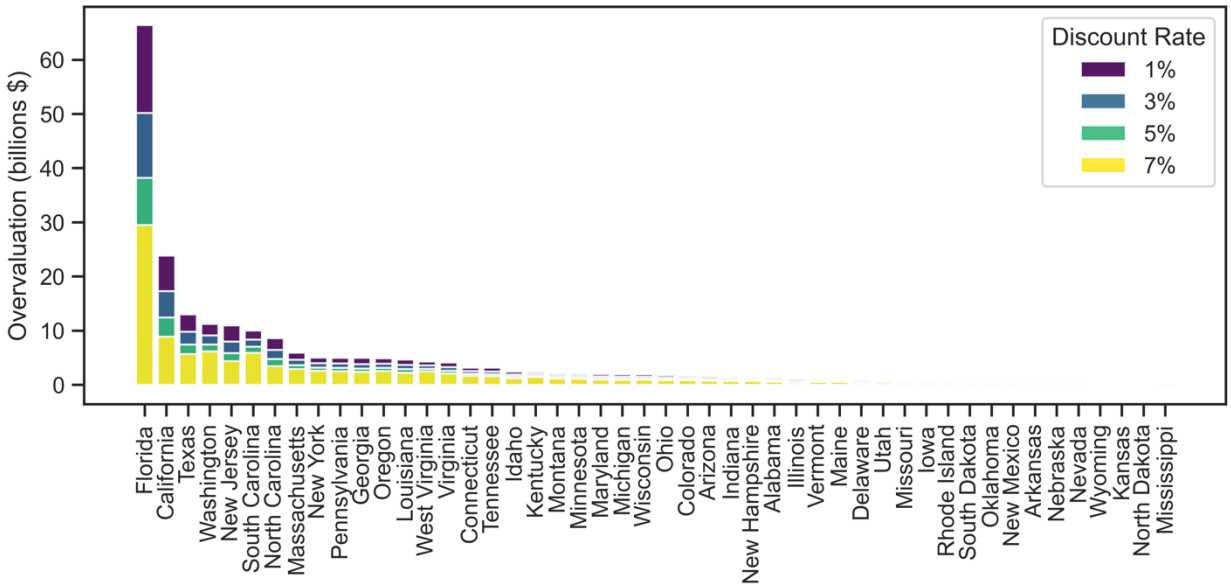

Fig. S17 | Property overvaluation in dollar terms ranked by state. The color of the bars indicates the discount rate applied in the net present value calculation.