Appendix

A Example Programs for Each Funding Mechanism

A.1 State Formula: PROTECT

Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) is a program under the Fixing America's Surface Transportation (FAST) Act, implemented under the Obama administration (Federal Highway Administration, 2021).[38] The act funded highway repairs in 2016–2020. The act was renewed in October 2020 for one year, and then renewed again under the BIL, both with the same apportionment rule as the original act. The PROTECT Formula Program under the BIL is charged with improving the climate resilience of transportation infrastructure through the distribution of funding to state authorities. Examples of the type of resilience improvements include construction of tide gates to protect against sea level rise, and development of natural infrastructure that protects transportation infrastructure, among others.

Funding under PROTECT totals $7.3 billion from 2022–2026. Funds are allocated to states based on their share of total funding received from the Highway Trust Fund in 2021 with three caveats: (1) a state must get at least 95% of what it contributes to the Highway Trust Fund, (2) funding is over 2% more than what was allocated in 2021, and (3) funding allocations increase by at least 1% per year. The share of funding allocated to states in 2021 is determined by a federal highway funding formula that has not been changed since those implemented under the Safe, Accountable, Flexible, Efficient Transportation Equity Act of 2005. Factors in the formula include the state's share of lane-miles, vehicle miles traveled, and fatalities on federal aid highways, as well as population.

The FAST act distributes the set formula of transportation funding to each state, split among several programs. PROTECT gets 2.91% of the remaining highway funding after states allocate about 8.5% of funding to the Congestion Mitigation and Air Quality Improvement Program, National Highway Freight Program, and the Metropolitan Planning Program. This leaves approximately $1.4 billion per year to the PROTECT program (Federal Highway Administration, 2021).

States have substantial discretion in how they spend federal highway dollars. State governments decide which projects to undertake, and get reimbursed by the federal government for projects that meet federal eligibility requirements under the various programs. Usually, the federal government is allowed to reimburse up to 80% of the project. About 95% of federal highway dollars are used on capital projects, whereas state funds tend to be for operations and maintenance (Congressional Budget Office, 2023).

[38] See U.S. Code Title 23, Chapter 1, Section 104 for additional details.

A.2 Competitive: National Coastal Resilience Fund

The National Coastal Resilience Fund (NCRF) is a competitive grant funding mechanism aimed at restoring or improving natural infrastructure to protect coastal communities and ecosystems from coastal hazards like flooding and storms (National Fish and Wildlife Foundation, 2023a). The NCRF is primarily funded by the National Oceanic and Atmospheric Administration and jointly operated with the National Fish and Wildlife Foundation. In 2023 the NCRF allocated nearly $150 million in awards.

The goal of the NCRF is to fund natural infrastructure investments in projects like coastal marsh restoration, dune rebuilding, and living reef development. It prioritizes projects that are able to be completed quickly and start generating benefits as well as projects that benefit underserved communities. Projects are evaluated using the Regional Coastal Resilience Assessments which identifies lands that have the greatest benefits from natural coastal infrastructure investments (National Fish and Wildlife Foundation, 2023b).

A.3 Federal Discretionary: Hazardous Fuels Management

The Hazardous Fuels Management program allocates funds to the US Forest Service for wildfire mitigation and the development of resilient forests through the reduction of flammable vegetation (USDA Office of the Inspector General, 2023). Total funding is approximately $100 million per year from 2022–2026.

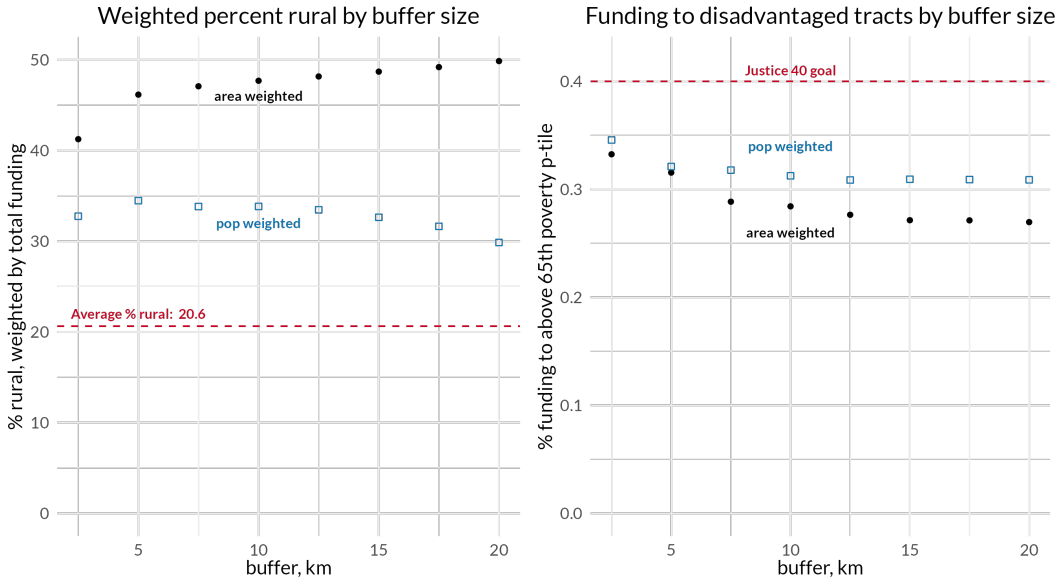
The program funds several different activities hazardous fuels activities to reduce wildfire risk such as forest thinning and timber harvesting, prescribed fires, and installation of fuel breaks in the natural habitat. In addition, grants are also awarded to incentivize the use of flammable biomass through, for example, increasing wood manufacturing capacity and further developing wood energy markets. Funds are also allocated for projects under the Tribal Forest Protection Act of 2004, which is responsible for funding projects to protect tribal lands and communities from wildfire, insects, and disease. Approximately 45% of program funds have been used on hazardous fuels activities and 8% has been used for Tribal Forest Protection Act purposes.

B Sensitivity Checks

B.1 Sensitivity to assumed buffer size

In our main analysis, we use a 10km buffer around the approximately 900 projects with only point locations because 10km is roughly the size of a town. We now assess sensitivity of our results to buffer size.

Figure B1: Change in descriptive statistics with buffer size



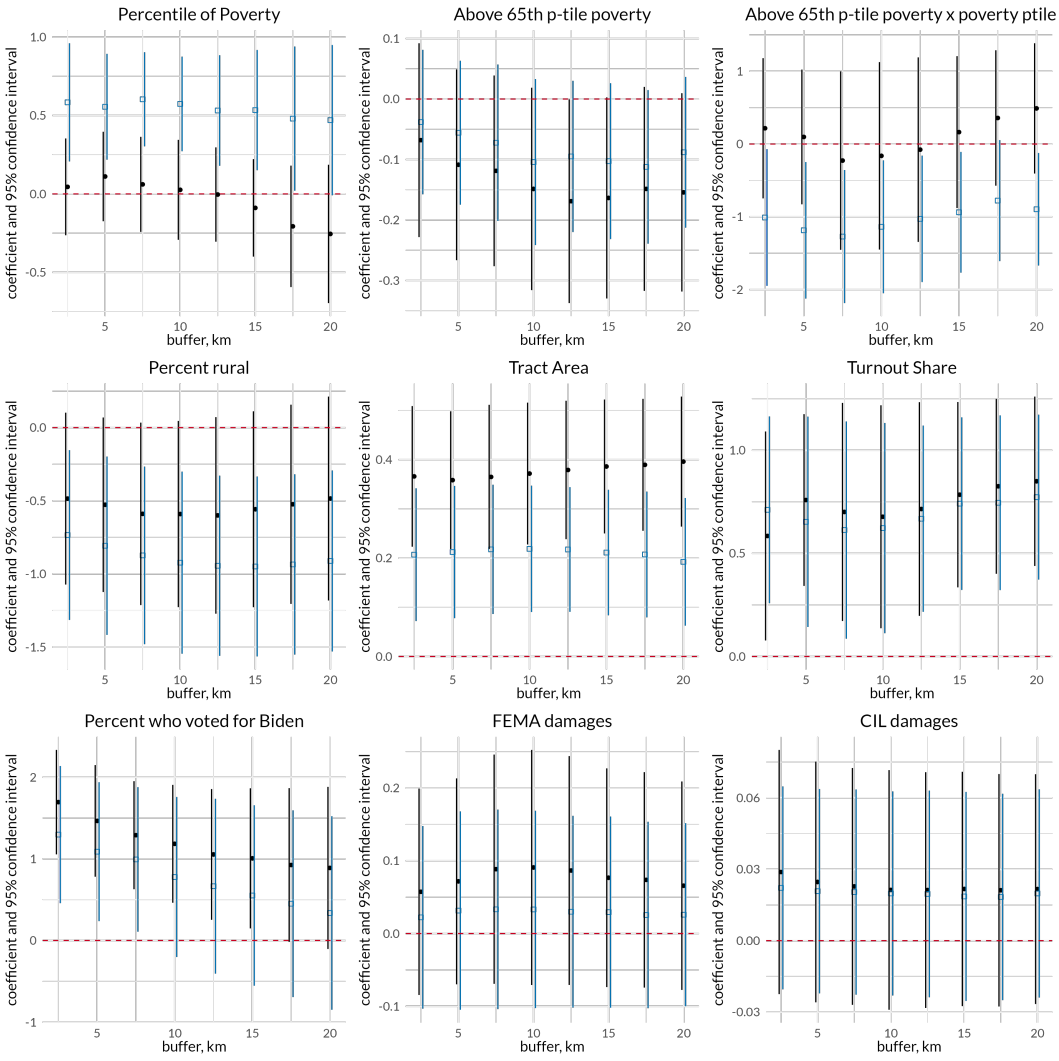
Note: In the left panel, we calculate the average of tracts' percent rural, weighted by dollars of funding to each tract, as assumed to be distributed with each funding weighting scheme (equal across area, weighted by population) and each buffer size around the $\sim$ 900 awards with only point locations. The horizontal line shows the average percent rural across all tracts in the 50 United States. The right panel shows the percent of funding to disadvantaged tracts that each buffer size around point locations implies.

One might be concerned that a given buffer size makes more rural tracts appear to receive more funding because they completely contain the buffer around some point and so absorb all of the funding assigned to that point. The left panel of Figure B1 plots the rural share for the average dollar of funding. This value is sensitive to buffer size but is always well above the national average rural share, reflecting a consistent rural bias in funding.

The right panel assesses whether the value of funding flowing to disadvantaged tracts is sensitive to the assumed buffer size. Funding to disadvantaged tracts does fall sharply as the buffer size increases. In fact, the Justice40 target can be met if we use both a very small buffer and a rule that assigns funding to tracts based on population shares in the buffer. The Justice40 targets is not attained under other assumptions.

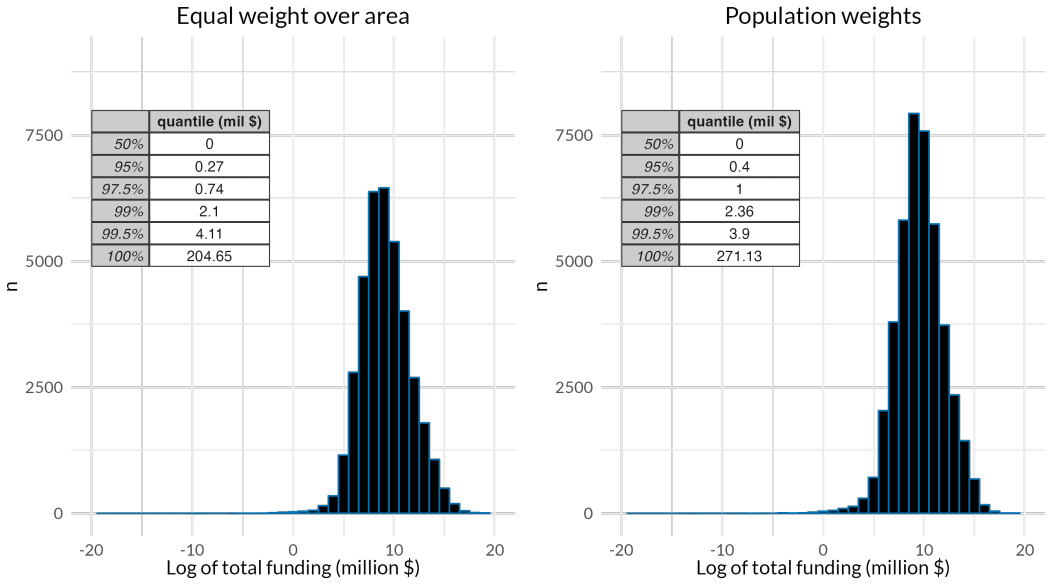
For Figure B2, we run our main regression specification for various buffer sizes and plot the coefficients. Coefficients are insensitive to buffer size: we can always reject that they are statistically different.

Figure B2: Coefficients by buffer size, funding weights



Note: We show coefficient estimates and 95% confidence intervals for total funding on each of the variables listed at the tops of plots, in our main specification with all controls. Blue squares show the central estimate for the assumption of population-weighted funding, while black dots show the central estimate for funding allocated equally over space. A horizontal dashed line is plotted at zero for reference.

Figure B3: Un-winsorized Census tract funding distribution

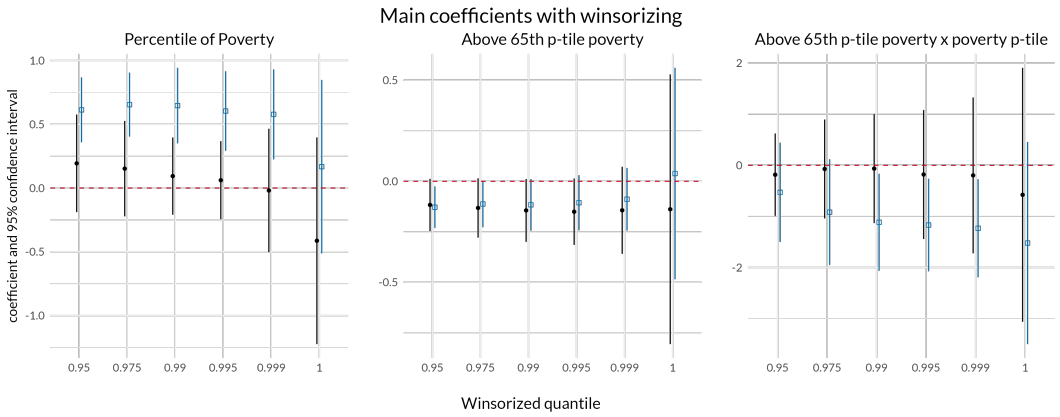


B.2 Sensitivity to winsorizing

Figure B3 shows the distribution of funding levels across census tracts along with the values at particular percentiles. The distributions appear to be lognormal, however there are a handful of Census tracts receiving orders of magnitude more funding than the others. Because of this, we winsorize our data at the 99.5th percentile.

In Figure B4, we show how our main coefficients change as we winsorize funding data. The values of the coefficients with no winsorizing (at winsorized quantile = 1) are slightly different from the trend of coefficients with winsorizing, which are comparatively stable. The plot suggests that outliers may drive our results in the absence of winsorizing. We choose to winsorize our data conservatively, at the 99.5th percentile. We can see that choosing a lower or higher percentile would not drastically change our main coefficients.

Figure B4: Main coefficients under different winsorization of funding



Note: We show coefficient estimates and 95% confidence intervals for total funding on each of the variables listed at the tops of plots, in our main specification with all controls. Blue squares show the central estimate for the assumption of population-weighted funding, while black dots show the central estimate for area-weighted funding. A horizontal dashed line is plotted at zero for reference. The x-axis shows the quantile of funding where the data is winsorized at. A winsorized quantile of 1 is equivalent to no winsorizing.

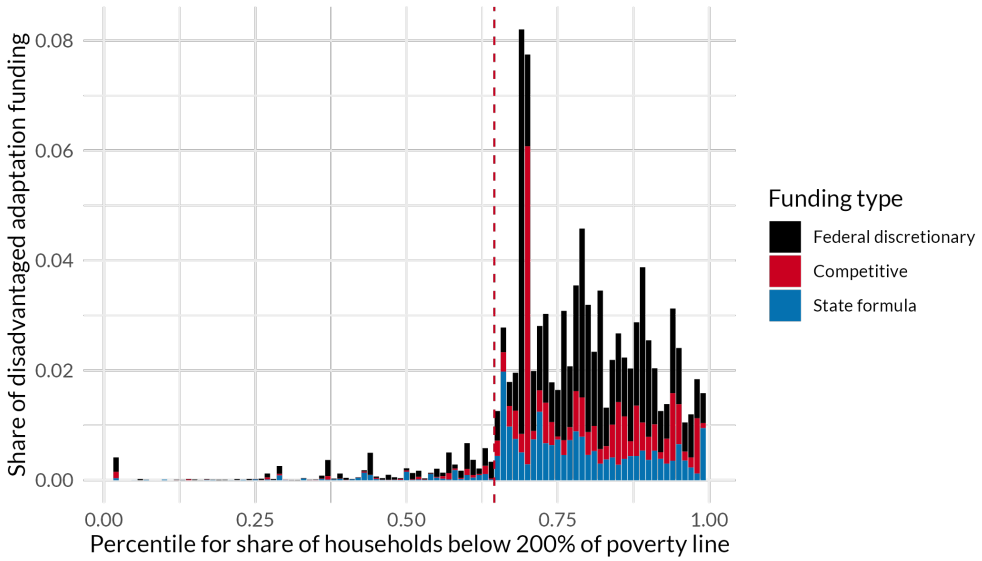
C Supporting Results

C.1 Most funding to disadvantaged tracts goes to lower-poverty tracts

94% of tracts above the 65th percentile of poverty qualify as disadvantaged according to the full Justice40 disadvantaged definition. Therefore, Justice40 applies equally to a broad group of tracts of various levels of burden and poverty. We assess whether funding is targeted to certain characteristics within disadvantaged tracts, first by poverty rate percentile.

Figure C5 shows what percentage of adaptation funding to disadvantaged tracts goes to each poverty rate percentile. 38.3% of tracts are either disadvantaged by the Justice40 definition or are above the 65th percentile of the poverty rate. Of these tracts, 84.3% fall into both categories; 10.6% are disadvantaged but below the 65th percentile of the poverty rate, and 5% are above the 65th percentile and not considered disadvantaged. Of the funding that goes to disadvantaged tracts and tracts above the 65th percentile, 92.6% goes to tracts in both categories. Only 5.3% goes to disadvantaged tracts below the 65th percentile of the poverty rate, and 2% goes to non-disadvantaged tracts above the 65th percentile of the poverty rate. More funding goes to the lower-poverty half of qualifying tracts, even if this pattern partly reflects outliers in the dataset. In fact, of the 22 tracts that received more than 50 million dollars, only 6 were considered disadvantaged, all were below the 85th percentile of the poverty rate, and 2 were at the 65% cutoff. We do not remove outliers in the dataset because they may reflect intentional targeting of tracts to meet Justice40.

Figure C5: Histogram of funding to disadvantaged tracts, by poverty rate



C.2 Can, and does Justice40 funding target race?

The Biden Administration has deliberately omitted race from being a determinant of disadvantaged status, in order to protect Justice40 from a court challenge (Friedman, 2022). However, failing to include race could limit Justice40's ability to address environmental justice; some studies have found race to be a more important determinant of the incidence of environmental injustice than income and poverty (see, for example, Bullard et al. (2008), Cushing et al. (2015) and Mohai and Bryant (2019)).

Here we explore if and how funding has been distributed with regard to race. The top left panel of figure C6 shows that Justice40's poverty measure is highly correlated with race, with the average percent non-white or black increasing steeply after the disadvantaged cutoff. Without targeting race explicitly, targeting poverty may result in a correlation between race and funding. Moreover, even without explicit targeting of race, we may see a positive correlation because percent black and percentile non-white population correlates with the other factors determining the Justice40 disadvantaged status as reported by the Climate and Economic Justice Screening Tool, especially legacy pollution exposure.

The next three figures explore whether adaptation funding goes disproportionately to Census tracts with larger non-white or black populations, conditional on poverty. We do so by binscattering

funding against percent non-white and percent black, residualizing by the poverty rate measure. The plots show little evidence of funding going to tracts with a higher proportion of non-white residents, after controlling for poverty rate. We do see a higher proportion of funding going to tracts with a higher black population after controlling for poverty, which is driven exclusively by federal discretionary funding.

C.3 Results split by states with environmental justice boards

State formula funding presents special obstacles to a federal equity goal because states have discretion about how to allocate funds within their borders but may not share either the broader equity goal or the definition of the equity goal. 14 states, covering 46.2% of Census tracts, have either a task force, commission, or office that advises the state government on environmental justice concerns. To test whether funding patterns are different in states with these boards, we estimate the following equation:

$$y_{is}^j = \alpha_1^j P_{is} + \alpha_2^j D_{is} + \alpha_3^j (P_{is} - 0.65) D_{is} + \alpha_4^j D_{is} EJ_s + \alpha_5^j (P_{is} - 0.65) D_{is} EJ_s + \beta^j X_{is} + \eta_s^j + \epsilon_{is}^j.$$

EJ_s is an indicator for whether state s has an environmental justice board. The coefficients α_4^j and α_5^j tell us whether the jump in funding at the 65th percentile poverty rate threshold and whether the correlation between poverty rate and funding beyond the threshold differ in states with environmental justice boards.

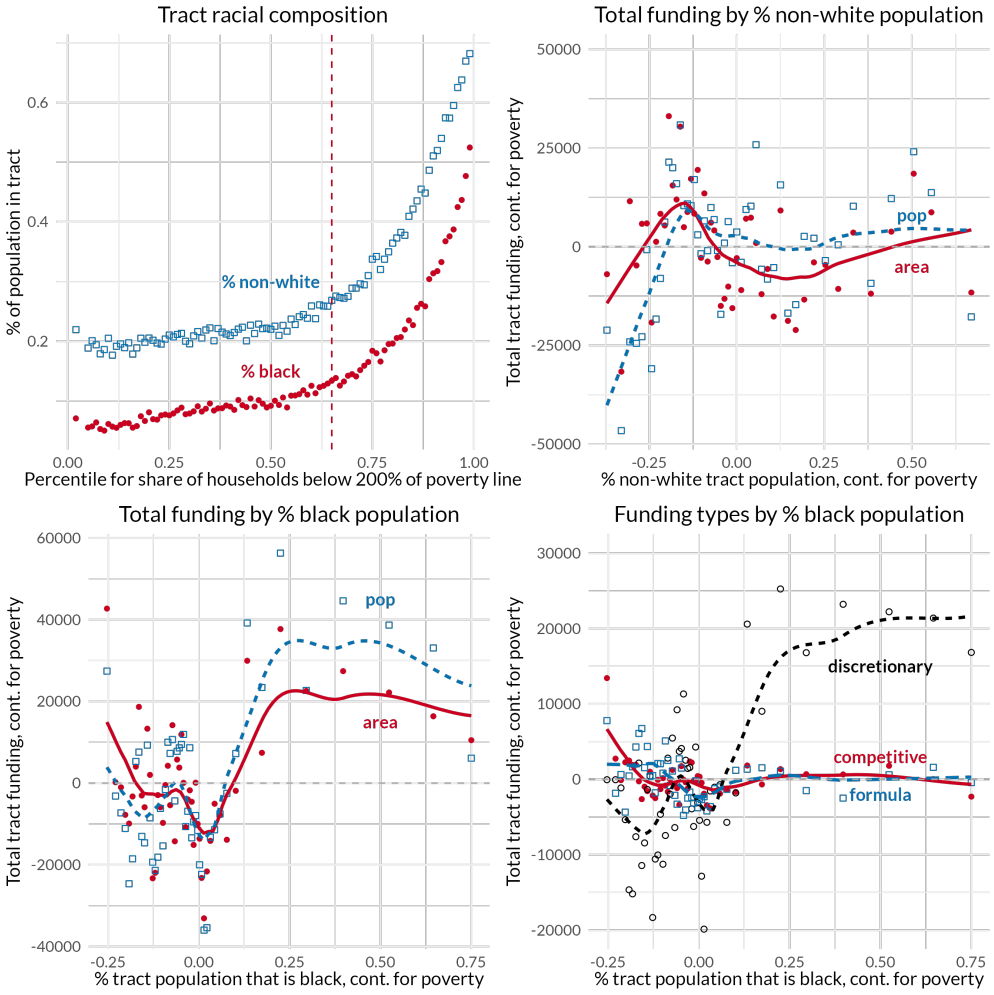
Table C1 reports the results. States with environmental justice boards do not appear to direct more formula funding to Census tracts near the threshold and direct *less* formula and competitive funding to the disadvantaged tracts with the highest poverty rates. This is surprising, since one might expect environmental justice boards to be most important for directing state formula funding. Of course, states choose whether to form such boards. As a result, states with such boards could have particular preferences and/or characteristics that affect how each mechanism allocates funding to disadvantaged tracts.

Table C1: Determinants of adaptation funding, split by states that have environmental justice boards

		Mechanisms		
	Total	Competitive	Formula	Discretionary
No controls, area-weighted				
Percentile of poverty rate	0.173	−0.622	0.773**	−0.251
	(0.239)	(0.527)	(0.313)	(0.344)
P-tile ≥ 0.65	−0.072	0.161	−0.002	−0.227
	(0.111)	(0.171)	(0.098)	(0.188)
(P-tile - 0.65) × (P-tile ≥ 0.65)	−0.729	1.863**	−3.232***	0.971
	(0.765)	(0.757)	(0.895)	(1.187)
(P-tile ≥ 0.65) × EJ board = 1	−0.090	0.014	−0.170	−0.082
	(0.227)	(0.236)	(0.273)	(0.258)
(P-tile ≥ 0.65) × (P-tile - 0.65) × (EJ board = 1)	−0.001	−2.975***	−1.149	−0.195
	(1.018)	(0.940)	(1.524)	(1.328)
All controls, area-weighted				
Percentile of poverty rate	−0.222	−1.072	−0.301	0.084
	(0.288)	(0.658)	(0.268)	(0.368)
P-tile ≥ 0.65	−0.121	0.074	−0.043	−0.216
	(0.108)	(0.190)	(0.102)	(0.175)
(P-tile - 0.65) × (P-tile ≥ 0.65)	−0.185	2.378**	−0.905	0.182
	(0.905)	(1.002)	(0.749)	(1.213)
(P-tile ≥ 0.65) × EJ board = 1	−0.058	0.042	−0.167	−0.093
	(0.225)	(0.233)	(0.226)	(0.268)
(P-tile ≥ 0.65) × (P-tile - 0.65) × (EJ board = 1)	0.491	−1.598*	−1.203	−0.339
	(0.984)	(0.896)	(1.324)	(1.480)
All controls, population-weighted				
Percentile of poverty rate	0.378	−0.550	0.499**	0.613*
	(0.279)	(0.699)	(0.238)	(0.368)
P-tile ≥ 0.65	−0.052	0.077	−0.010	−0.215
	(0.081)	(0.184)	(0.076)	(0.139)
(P-tile - 0.65) × (P-tile ≥ 0.65)	−1.368**	2.467***	−2.133***	−1.372*
	(0.563)	(0.894)	(0.524)	(0.832)
(P-tile ≥ 0.65) × EJ board = 1	−0.120	−0.065	0.081	−0.073
	(0.160)	(0.199)	(0.189)	(0.217)
(P-tile ≥ 0.65) × (P-tile - 0.65) × (EJ board = 1)	0.819	−1.270	−1.358	0.829
	(0.681)	(0.964)	(1.656)	(0.986)
State FEs	yes	yes	yes	yes
Num. obs.	72010	70858	72010	72010
Pseudo R^2 no controls, area-weighted	0.140	0.187	0.163	0.182
Pseudo R^2 all controls, area-weighted	0.242	0.315	0.315	0.231
Pseudo R^2 all controls, population-weighted	0.227	0.301	0.298	0.262

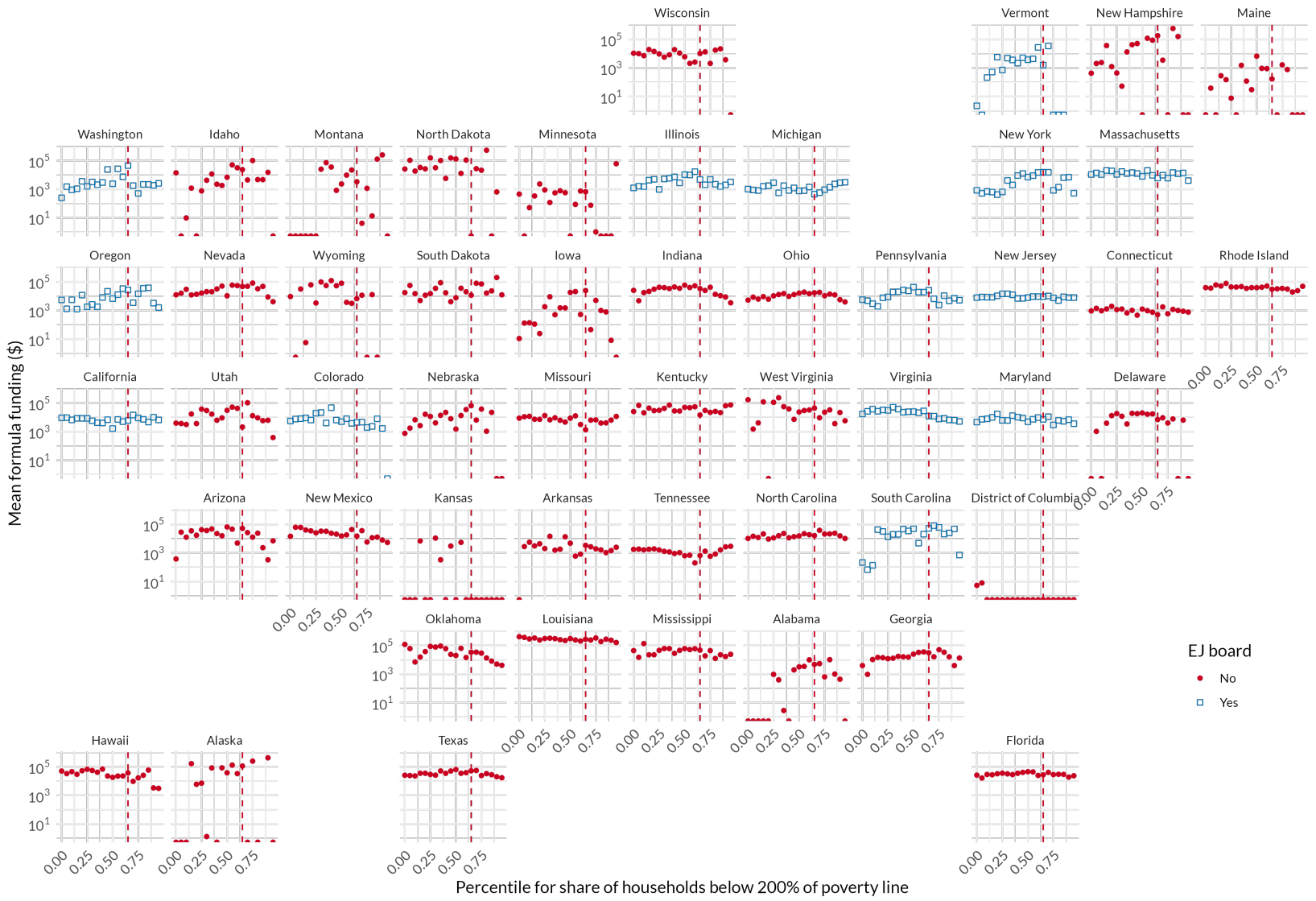
$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$

Figure C6: Funding to tracts by racial composition, controlling for poverty



Note: The top left plot shows a binscatter for the average percent of people in a tract who identify as either black or non-white, for each percentile for the share of households below 200% of the poverty line. The top right plot shows a binscatter for how total funding varies by the percent of the population that is non-white in each tract, for both our area and population-weighted funding measure. We residualize the total funding and percent non-white by the poverty rate percentile measure used throughout the paper. The bottom two plots show similar residualized binscatters, where tracts are binned by the percent of the population that is black. The bottom right plot splits total funding into the three mechanisms. We winsorize total funding to the .995 percentile before binning. The lines are locally estimated best-fit lines.

Figure C7: Formula funding for tracts in each poverty bin, population-weighted



Note: Each point is the average population-weighted funding for each percentile of the Census tract distribution of the share of households below 200% of the poverty line, for each state. The vertical dashed line corresponds to the 65th percentile which is the threshold for meeting the poverty rate criterion for being considered disadvantaged. Blue squares denote states that have environmental justice boards and red dots denote states that do not. Binscatter percentiles are calculated using the national poverty rate distribution. Zero values indicate either no funding was allocated to Census tracts with that poverty rate percentile or that the state does not have any Census tracts falling into that poverty rate percentile.

D Per Capita Funding Results

In this section we show results for funding per capita by tract, instead of total funding by tract.

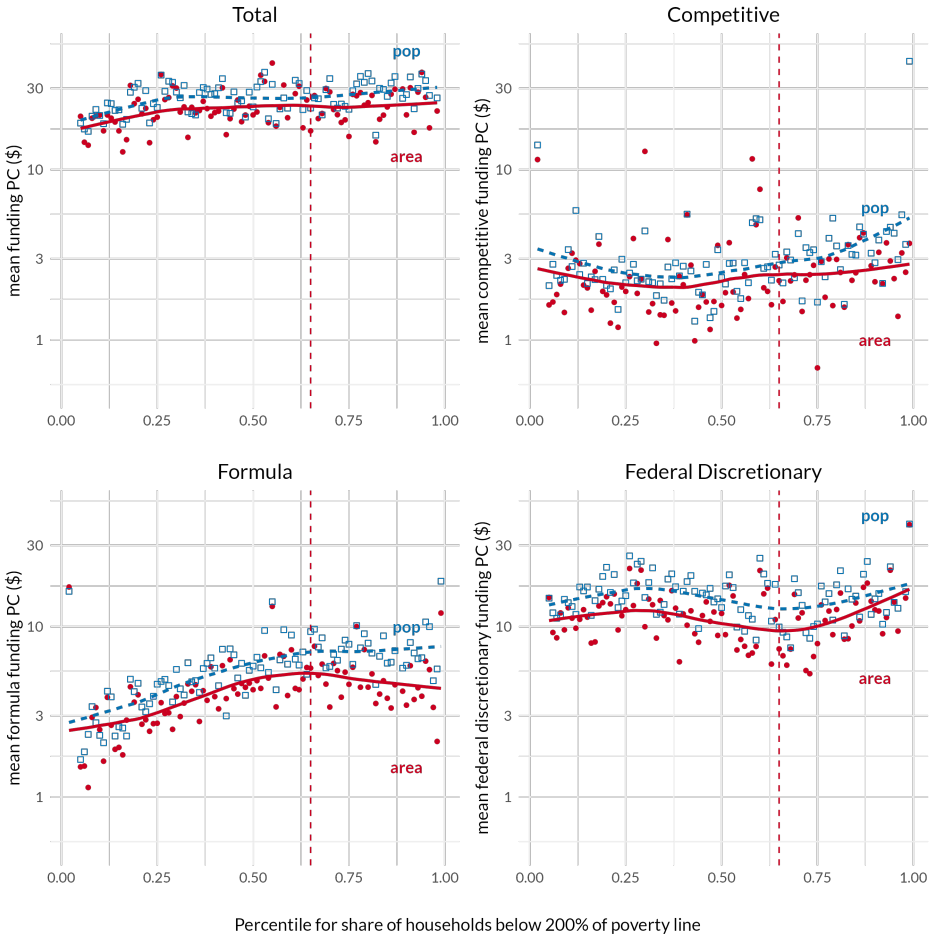
Figure D8 binscatters funding per capita against the poverty rate. Compared to Figure 4, per capita funding may be allocated slightly more progressively than total funding. The decline of formula funding above the poverty rate threshold also attenuates or vanishes when funding is in per capita terms.

Figure D9 shows that state formula funding per capita follows similar patterns to total funding.

Figure D10 shows that putting funding into per capita terms changes the direction of the association between funding and damages for the forward-looking CIL damage measure but not the backward-looking FEMA damage measure.

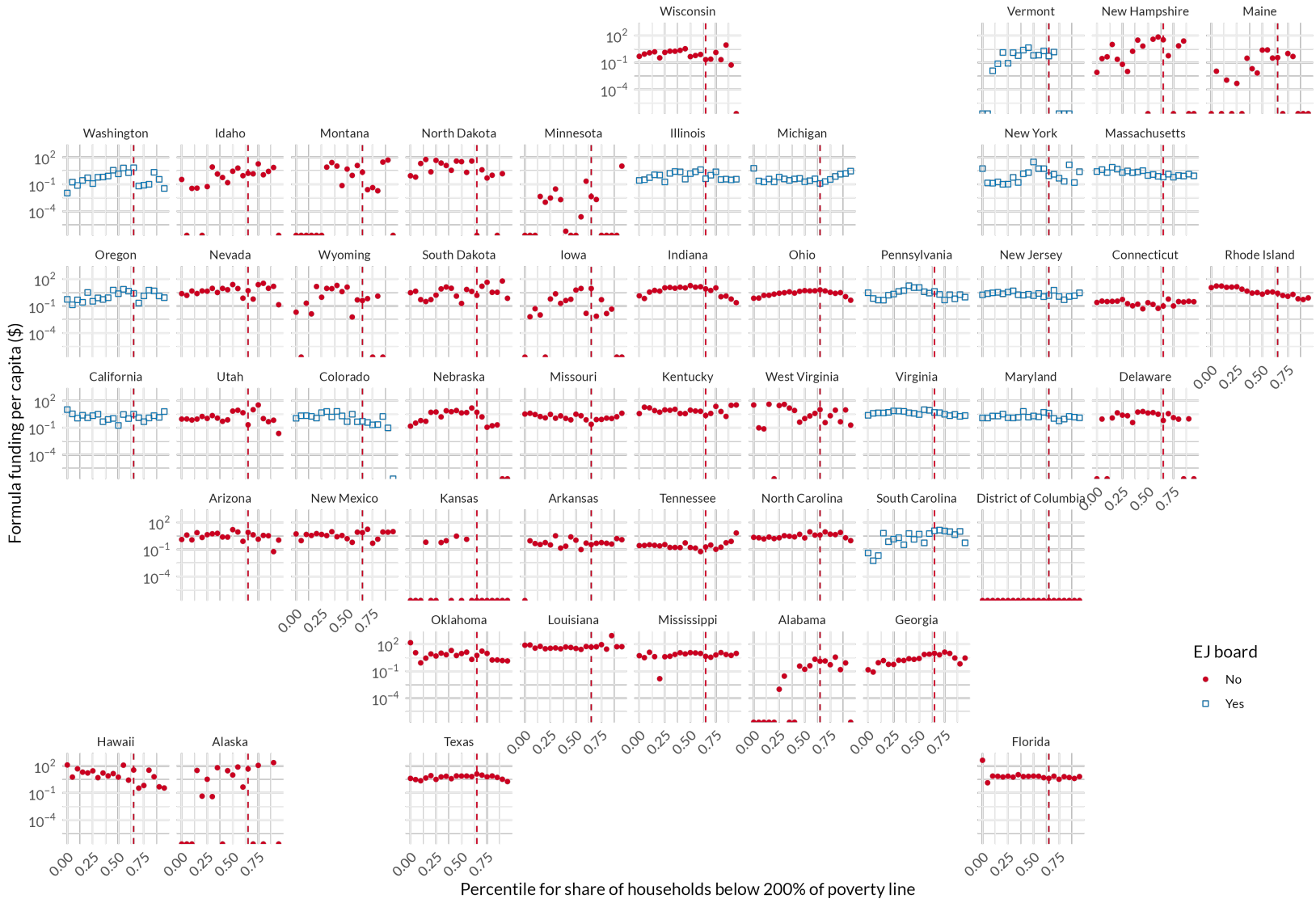
Table D2 replicates Table 3 but for per capita funding. Without controls but conditional on state fixed effects, total funding per capita has a v-shaped relationship with the poverty rate. All three funding mechanisms have the same pattern with varying statistical significance. The inclusion of controls attenuates the estimates, however the v-shaped relationship remains for total funding, although it is statistically insignificant. For the individual funding mechanisms, the inclusion of controls may qualitatively change the relationship. For example, population-weighted discretionary funding is monotonically declining in the poverty rate while population-weighted formula funding is hump-shaped.

Figure D8: Per capita adaptation funding, by poverty rate percentile and funding mechanism



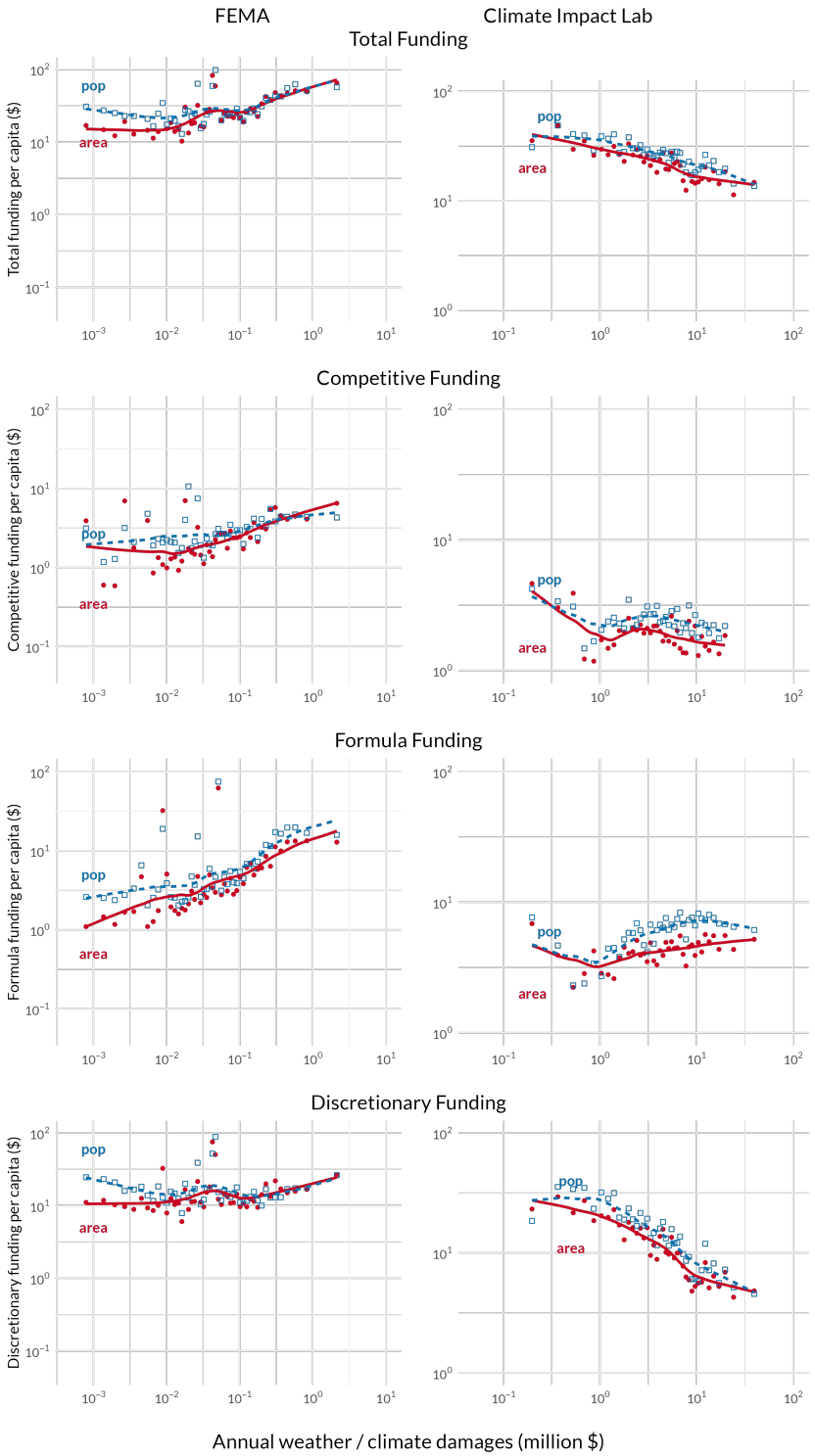
Note: Each point is the average per capita funding for each percentile of the Census tract distribution of the share of households below 200% of the poverty line. Before taking the average we winsorize Census tract funding levels to the 99.5th percentile. The solid lines are locally estimated best-fit lines for funding assumed to be distributed equally over area; the dashed lines are the analogous best-fit line for population-weighted funding. The vertical dashed line corresponds to the 65th percentile, which is the threshold for meeting the poverty rate criterion for being considered disadvantaged.

Figure D9: Per capita formula funding for tracts in each poverty bin, area weighted



Note: Each point is the average per capita area-weighted funding for each percentile of the Census tract distribution of the share of households below 200% of the poverty line, for each state. The vertical dashed line corresponds to the 65th percentile which is the threshold for meeting the poverty rate criterion for being considered disadvantaged. Blue squares denote states that have environmental justice boards and red dots denote states that do not. Binscatter percentiles are calculated using the national poverty rate distribution. Zero values indicate either no funding was allocated to Census tracts with that poverty rate percentile or that the state does not have any Census tracts falling into that poverty rate percentile.

Figure D10: Per capita funding mechanisms by damage components



Note: Each point is the the average per capita Census tract funding plotted against FEMA and CIL damages. Before taking the average we winsorize Census tract funding levels to the 99.5th percentile. The FEMA measures represents current expectations of weather-related hazards for six climate-related disasters. The CIL measure represents one version of expected future (2080–2090) damages in a high-emission scenario. For the lowest damage percentiles, the CIL measure estimates no damages (cold states are better off under climate change). We exclude these lowest bins from the plot. The solid lines are locally estimated best-fit lines for funding assumed to be distributed equally over area; the dashed lines are the analogous best-fit line for population-weighted funding.

Table D2: Determinants of Per Capita Adaptation Funding

		Mechanisms		
	Total	Competitive	Formula	Discretionary
No controls, area-weighted				
Percentile of poverty rate	−2.361*	−0.923	−1.694	−2.638**
	(1.270)	(1.681)	(1.616)	(1.216)
P-tile ≥ 0.65	0.460	0.791	0.455	0.061
	(0.383)	(0.978)	(0.369)	(0.400)
(P-tile - 0.65) × (P-tile ≥ 0.65)	6.076***	6.389***	3.202	7.089***
	(1.653)	(2.430)	(2.157)	(1.783)
No controls, population-weighted				
Percentile of poverty rate	−1.495**	−1.679	−1.069	−1.947**
	(0.595)	(1.481)	(0.889)	(0.882)
P-tile ≥ 0.65	0.247	1.157	0.382**	−0.444
	(0.374)	(1.074)	(0.185)	(0.341)
(P-tile - 0.65) × (P-tile ≥ 0.65)	6.879***	7.964***	2.543	9.200**
	(1.958)	(1.633)	(1.587)	(3.738)
All controls, area-weighted				
Percentile of poverty rate	−1.018	−0.038	0.557	−2.303***
	(0.762)	(1.077)	(0.507)	(0.893)
P-tile ≥ 0.65	−0.033	−0.198	−0.172	0.125
	(0.139)	(0.330)	(0.140)	(0.221)
(P-tile - 0.65) × (P-tile ≥ 0.65)	2.590**	0.315	0.016	2.586*
	(1.203)	(1.416)	(0.766)	(1.565)
All controls, population-weighted				
Percentile of poverty rate	−0.342	−0.442	0.874*	−1.594*
	(0.764)	(0.623)	(0.451)	(0.822)
P-tile ≥ 0.65	0.218	0.042	−0.057	0.203
	(0.185)	(0.278)	(0.090)	(0.229)
(P-tile - 0.65) × (P-tile ≥ 0.65)	1.414	1.796**	−1.020	0.653
	(0.949)	(0.843)	(0.642)	(0.812)
State FEs	yes	yes	yes	yes
Num. obs.	72010	70858	72010	72010
Pseudo R^2 no controls, area-weighted	0.136	0.229	0.198	0.166
Pseudo R^2 no controls, population-weighted	0.200	0.259	0.284	0.234
Pseudo R^2 all controls, area-weighted	0.511	0.422	0.627	0.369
Pseudo R^2 all controls, population-weighted	0.474	0.358	0.603	0.354

$^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$