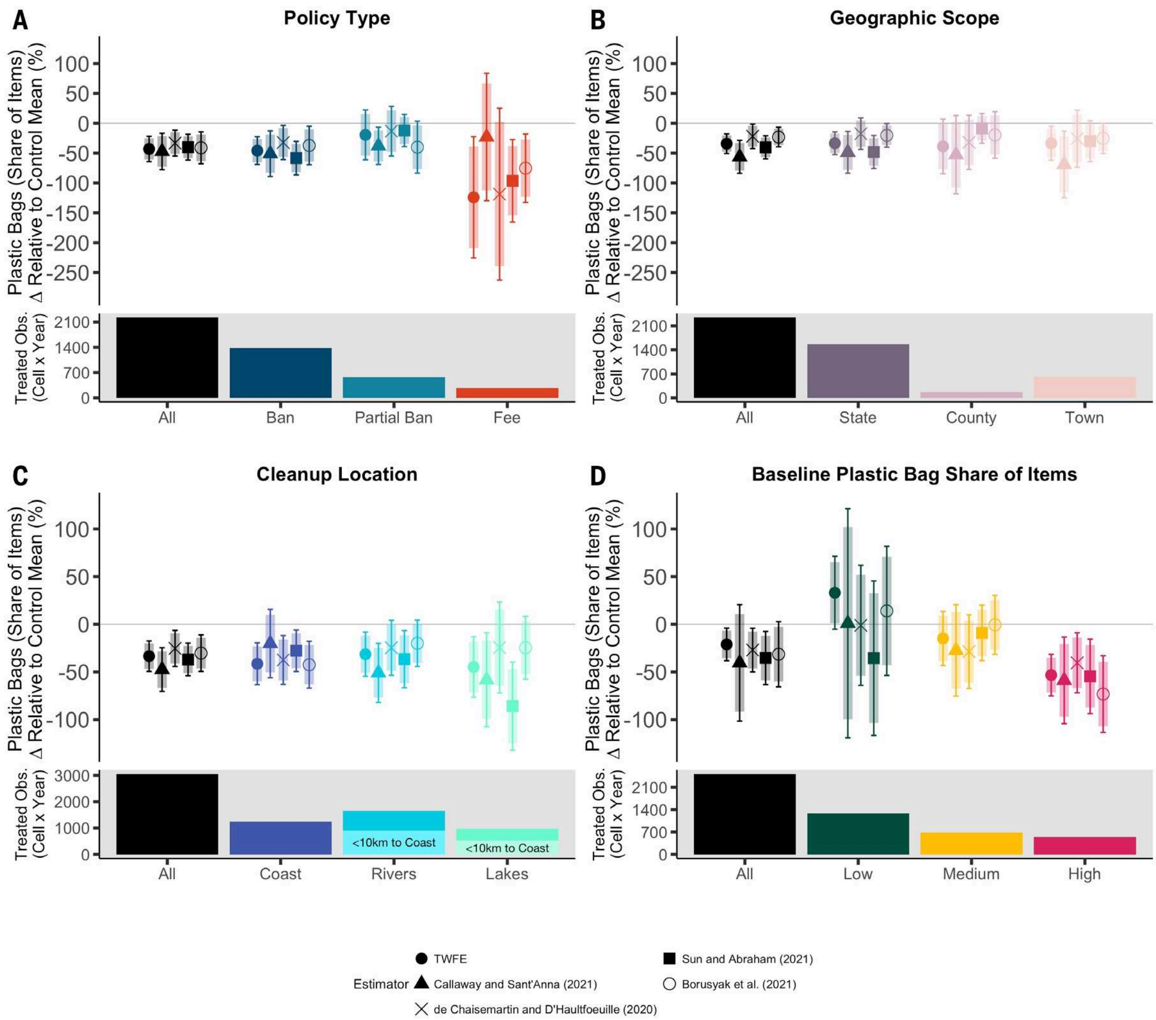

Fig. 4. Heterogeneity. Regression outcomes according to eq. S1 using five estimators [TWFE and (31–34)]. The outcome variables are plastic bags' share of total items collected, divided by the control means. (**A**) Heterogeneity by type of policy, including treated areas and control areas. Only treated grid cells with exactly one type of policy during 2017–2023 are included. (**B**) Heterogeneity by geographic scope of policy, including treated areas and control areas. Only treated grid cells with exactly one geographic scope of policy during 2017–2023 are included. (**C**) Heterogeneity by cleanup location type: coastal, river, and lake. All cleanups are within 1 km of each type of shoreline and include treated and control areas. Only 1.1% of analyzed cleanups are not within 1 km of a water body (not shown), otherwise all treated and control areas are included. Furthermore, 42.0% of river and 34.7% of lake cleanups analyzed are within 10 km of the coast. (**D**) Heterogeneity by the baseline (before policy) average of plastic bags as a share of all cleanup items collected. Only treated grid cells areas are included (not controls). Low baseline areas have pretreatment levels of plastic bags' shares below the median (<2.9%), medium areas are between the median and 75th percentile (2.9 to 5.6%), whereas high areas are above the 75th percentile (>5.6%). Control means are calculated as pretreatment averages (and are 2.7, 5.2, and 13.2%, for low, medium, and high baseline areas, respectively). In all panels, thick lines show 90% confidence interval, and thin lines show 95% confidence interval. Standard errors clustered by zip code.

of plastic bag policies could be even greater in many jurisdictions outside the US, although that impact could be blunted if the policies are not well enforced.

While plastic bags present distinctive problems for waste management and animal life, the data on US shoreline cleanups suggest that regulating other single-use plastic items, such as plastic water bottles and caps (the third- and fourth-largest categories of shoreline litter, respectively), might further reduce plastic litter in the environment. However, it is important to note that different categories of plastic may have different mechanisms of supply, consumption, and waste management, so policies regulating them may yield different results. This highlights the potential importance of policies on plastic production, such as the global treaty on plastics that countries aim to continue negotiating in August 2025 (37). As waste generation is projected to increase through the end of the century (38), the leakage of plastic debris into the world's oceans will remain an important problem in future decades in the absence of large-scale policy shifts.

Materials and methods summary

In this study, we combine two main sources of data. First, we collect all US state-, county-, and town-level plastic bag regulations from various sources (39–45). For each, we record the effective date and policy type and match to covered zip codes. We download data on US shoreline cleanups from TIDES [Trash Information and Data for Education and Solutions (36)]. The main variable of interest we derive is plastic bags as a percentage of the total items collected in a cleanup. We then match cleanups to zip codes and determine treatment status. For our main analysis, we aggregate cleanups to the 0.1° latitude/longitude (or ~11.1 km) grid cell by year level on the basis of the characteristics of the cleanup data. We consider a grid cell