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Every Day Is Earth Day: Evidence on the Long-Term Impact of Environmental Activism†

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We use variation in weather to study the long-term effects of activism during the original Earth Day on attitudes, environmental outcomes, and children's health. Unusually bad weather on April 22, 1970 is associated with weaker support for the environment 10 to 20 years later, particularly among those who were school aged in 1970. Bad weather on Earth Day is also associated with higher levels of carbon monoxide in the air and greater risk of congenital abnormalities in infants born in the following decades. These results identify benefits to volunteer activity that would be impossible to identify until years after the volunteering occurs. (*JEL* D64, D91, Q51, Q53, Q54)

In recent decades ordinary people have frequently taken action to address social problems, but it is not always clear what is gained by their doing so. For example, in September 2019 millions of students across the world participated in strikes intended to draw attention to the environmental problem of climate change (Sengupta 2019). This was lauded by many observers but also criticized by both policy makers (Watts 2019; Australian Associated Press 2018) and observers in the popular press (e.g., Freeman 2020; Caldwell 2019; see also Heglar 2018; Lukacs 2018; Geiling 2018; Matthews 2017). Many critiques questioned whether the actions of individuals matter. In the words of prominent activist Greta Thunberg, "the favorite argument here in Sweden, and everywhere else, is that it doesn't matter what we do because we are all too small to make a difference" (Carrington 2019).

This climate strike response reflects a broader uncertainty about the benefits of volunteer actions. A body of research has found that low levels of activism often stem not from individuals doubting the importance of social problems but from doubting that their actions can make a difference (Akpan 2019; Salomon, Preston, and Tannenbaum 2017; Semenza et al. 2008; Huebner and Lipsey 1981; Xu, Chi, and Zhu 2017; Rankin 1969). If this type of doubt is justified, then a low level of activism could

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be useful, as it would direct individuals away from taking costly actions of no benefit. But if this doubt is misplaced, the cost of directing efforts away from beneficial actions could be extremely high. Prior research offers little evidence for either possibility, as scholars have struggled with numerous challenges in evaluating volunteerism (e.g., Andreoni 2006). Brown (1999), in discussing these challenges, notes that "environmental activism [is a] form of volunteering in which it is much harder to quantify benefits" than other types of volunteerism since there is no designated recipient.

The goal of this paper is to provide new evidence on the impact of activism—in particular, environmental activism—by considering the original Earth Day, April 22, 1970. On this day, tens of millions of people came together to participate in gatherings ranging from teach-ins and cleanups to protests and marches in an effort to alter the values, environmental quality, and health of their communities. We explore whether the circumstances in a community on the original Earth Day relate to outcomes in that community over the next 20 years. We thus circumvent and embrace the challenge noted by Brown in that we adopt communities rather than individuals or nonprofits as the unit of observation.

We first investigate whether Earth Day had long-term impacts on environmental attitudes in communities. Such a study runs the danger of reverse causation: places that had successful Earth Day celebrations might be places with strong pro-environmental attitudes, and it is the enduring attitudes that lead to a successful Earth Day rather than the other way around. We address this concern by exploiting variation in the weather on Earth Day, comparing places that had unusually good or unusually bad weather on the exact date in question. Our key assumption is that unexpectedly good or bad weather on this date should not be related to confounders like underlying community attitudes about the environment. If this assumption is correct, we can interpret a strong relation between weather shocks on April 22, 1970 and outcomes many years later as evidence for the importance of Earth Day.

Using data from the 1977–1993 waves of the General Social Survey, we find that weather on Earth Day has a statistically significant effect on attitudes: individuals in places with bad weather on Earth Day express less support for environmental spending 10 to 20 years afterward. This result is observed in particular for those who were under age 20 at the time of the original Earth Day. For this group, a 1–standard-deviation increase in precipitation corresponds to a 0.08–standard-deviation increase in opposition to environmental spending. We discuss magnitude in Sections III and IV, but we view this effect and others as reasonably large in size. Weather shocks on other days from that April generally have no effect.

We next see if weather on Earth Day is subsequently related to the quality of the environment. To measure local environmental quality, we use data on air pollution. We find that bad weather on Earth Day is associated with higher levels of air pollution—specifically, carbon monoxide—years later. A 1–standard-deviation increase in precipitation leads to a 0.086–standard-deviation increase in average carbon monoxide over the next 20 years. When we look at other nonlocalized types of air pollution, such as ozone, we find no effect.

Finally, following a large empirical literature that relates environmental quality to infant health (e.g., Graff Zivin and Neidell 2013; Ritz et al. 2002), we find evidence connecting the original Earth Day to the health of newborns. A 1–standard-deviation increase in precipitation on Earth Day is associated with a 0.13–standard-deviation increase in the fraction of births with a congenital abnormality 10 to 20 years later. The evidence is suggestive that this result is stronger for children born to low-SES women.

Prior work—notably Madestam, Shoag, Veuger, and Yanagizawa-Drott (2013)—has studied large-scale instances of social activism and shown that conditions during gatherings such as political rallies can affect outcomes such as voting in subsequent elections.[1] Our work is distinct in several important ways. First, instead of political activism we focus on environmental activism, which, as noted above, is a type of volunteerism whose efficacy has been questioned and which has unique societal implications. Second, we consider social outcomes concerning pollution and infant health and provide direct evidence of Earth Day's influence on these outcomes. We do not know of prior work that attempts to relate the effects of a social gathering on measures of social well-being such as these. Third, our time horizon is much longer, as we focus on the decades following our event. This is especially noteworthy as the long-term effects for many environmental issues are potentially the ones of greatest consequence.

These novel features yield several implications. First, our results provide evidence that ordinary people's volunteer environmental actions do matter and that environmental activism warrants study as a mediator of environmental outcomes. An existing literature has considered the causes and importance of environmental activism; Price (2014) gives an overview. But this area of work is relatively small compared to work on government programs and policies to improve the environment. To our knowledge, work in this literature has not considered Earth Day or even the types of activities featured on Earth Day (gatherings, demonstrations, and community events) despite the fact that many millions of individuals have participated in such events. We do not know of any work on any type of environmental activism that presents large-scale and long-term evidence of benefits as we do here.

Second, our findings have implications for research on activism and evaluating the benefits of volunteer activity more generally. Work here has noted that the estimated value of volunteer time is often surprisingly small (e.g., Brown, Meer, and Williams 2019; Lilley and Slonim 2014). While several factors may drive this result, our work provides evidence on the potential importance of dynamic effects (cf. Scharf, Smith, and Wilhelm 2017), as all of the outcomes we consider happen years after Earth Day. Moreover, over time, we find that our results on carbon monoxide, which is the most consistently available outcome during the period of our study, only become significant in the mid-1970s, several years after Earth Day. Contemporaneous estimates of volunteerism here would underestimate the value of actions on Earth Day by a large amount. Our results show that there can be benefits

[1] See also Becker, Fetzer, and Novy (2017); Fujiwara, Meng, and Vogl (2020); and Madestam and Yanagizawa-Drott (2012). There is also work relating social gatherings and events to economic development (Montero and Yang 2020) and riots and mob violence (e.g., Iyer and Shrivastava 2018; Anderson, Johnson, and Koyama 2017). Our work is less related to the latter, as there are potentially important differences between violent and nonviolent protests (see, e.g., Chenoweth and Cunningham 2013). This paper is about nonviolent methods of activism.

to volunteer activity that would be impossible to identify until years after volunteering occurs. This conclusion is made feasible by our study's focus on community outcomes over decades rather than over months or a few years.

Third, prior work has explored how environmental quality can affect health in the long run (e.g., Isen, Rossin-Slater, and Walker 2017). Work of this kind generally relies on a fetal-origins–style argument (cf. Almond and Currie 2011). Rather than following that approach and connecting the well-being of adults to the policy circumstances of their births, we focus instead on a short-term event and observe how this event affects infants born after the event ends. These two mechanisms (not mutually exclusive) for dynamic effects would differ, for example, in predicting which cohorts are affected by temporary environmental events or retrenched environmental policies. Our work indicates that the long-run effects of environmental events may be driven by other channels in addition to fetal-origin–based effects.

Next, our work changes the interpretation of Earth Day itself. The importance of Earth Day in the history of the environmental movement is widely acknowledged, with Earth Day having played a role in the adoption of important laws such as the Clean Air Act, the Clean Water Act, and the Endangered Species Act. But accounts of Earth Day typically do not consider effects beyond changes in federal policy and further conclude that the effects of Earth Day on environmental attitudes were short lived (cf. Fried 1998; Shabecoff 1993; Dunlap 1991). O'Riordan et al. (1995) write that Earth Day "rapidly faded from public view" and in an influential article Downs (1972) uses concern about the environment in the early 1970s as a canonical example of an issue that "gradually fades from public attention." Our results indicate the opposite and emphasize, more generally, the highly local and long-lasting benefits of Earth Day. We know of no work in any discipline that documents benefits of this nature for this day.

This, however, raises a final and more pessimistic implication of our study. The year 2020 was marked by large protests and gatherings prompted by the death of George Floyd (Taylor 2020) and the campaign of Donald Trump (Bender and DeBarros 2020). Our work suggests that events of this kind could have long-term impacts on opinions and outcomes—but perhaps the largest impact will be from gatherings that never happened. April 2020 was the fiftieth anniversary of Earth Day, which had the potential to be widely observed and celebrated the world over. The salience of this day was, out of necessity, greatly diminished in the face of the coronavirus pandemic. The results of this paper do not gainsay the wisdom of social distancing in the face of a pandemic, but they suggest that in addition to the short-term damage created by the pandemic, the absence of social gatherings on April 22, 2020 could potentially lead to worse social outcomes decades from now.

The rest of the paper is organized as follows: We briefly overview Earth Day next. We then discuss data and methodology, present results, and conclude.

I. A Brief Overview of the Original Earth Day

Here we provide background on the first Earth Day. Rome (2013) is a good starting point for those wanting to learn more. Earth Day was conceived by US Senator Gaylord Nelson in 1969. Its purpose was, according to Nelson, to "force the issue [of the environment] into the political dialogue of the country" (Lewis 1990). Nelson originally planned for a national day of teach-ins, but his team helped to develop the notion into a much broader day. Between 20 and 25 million individuals—roughly one out of every ten Americans—participated. At the time, Earth Day was the largest organized demonstration in human history (Hayes 1988).

April 22, 1970, which was a Wednesday, was selected as Earth Day because it was a day without other major competing events. It was also late enough in the spring that the weather would likely be good. The organizers also felt that students would be especially important for Earth Day, and for most students April 22 would fall after spring break but before the end of the school year.

In an important sense, the organization of Earth Day was decentralized. Major environmental groups did not play a large role in the promotion of Earth Day (Shabecoff 1993). The central organizing committee provided information and materials when asked, but ultimately, many communities took an ad hoc approach, offering a variety of events for individuals of different ages and interests. Schools and students played an important part in Earth Day. Some schools closed for the day so that students and teachers could pick up litter and clean their communities, while other schools and universities had events such as teach-ins, tree plantings, and demonstrations (Swearingen 1970). According to some reports at the time, about four out of five high school and college students reported that their schools held an event (Youth Service 1970); roughly 2,000 colleges and 10,000 high schools participated (Associated Press 1970).

To illustrate different Earth Day events and their potential for lasting effects, consider the community of Albion, Michigan. On Earth Day, a group of Albion citizens gathered to clean up a section of the Kalamazoo River. They were led by an Albion College geology major named Walt Pomeroy. Next, students came together at Albion College and engaged in a mass can-smashing event. Aluminum cans were sold to a scrap facility (curbside recycling was unknown at this time), and nonaluminum cans were returned to their manufacturers to encourage them to change to a reusable material. Students in nearby schools also picked up litter.

The city of Albion had asked students to clean up a section of the river so that it could be turned into a park, and that park is still in operation today. The city also established a recycling center after Earth Day. For the student organizer Walt Pomeroy, participation in Earth Day was "the beginning of a lifelong dedication to environmental causes" (Albion College 2016). Pomeroy created the Michigan Student Environmental Confederation, a group that came to represent over 100 local student environmental organizations, while working with local and federal government officials to improve environmental policy (House Committee on Merchant Marine and Fisheries 1972, 305). He subsequently became a regional vice president of the National Audobon Society (Dempsey 2019). He credits Earth Day with helping to promote important local outcomes such as the greater availability of returnable cans and bottles and lower phosphate levels in detergents (Smith 2012).

These anecdotes indicate how Earth Day could have lasting effects by changing the infrastructure, leadership, and regulatory environments of communities. However, many communities made steps to improve the environment in the early 1970s, and the case of Albion could conflate Earth Day's effects with broader trends. Albion

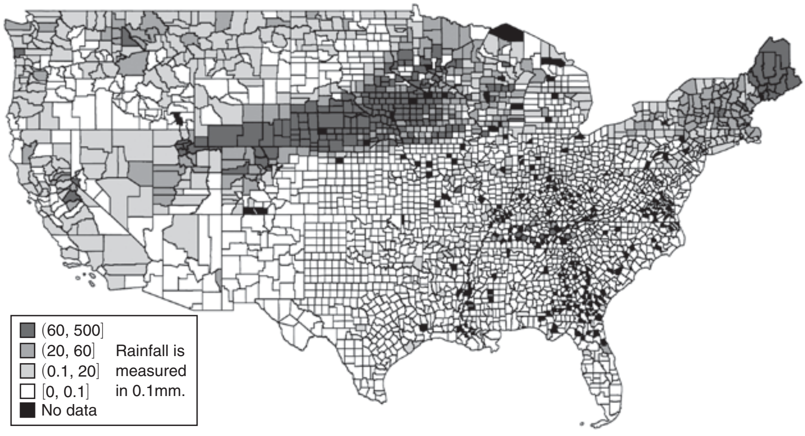

FIGURE 1. PRECIPITATION ON APRIL 22, 1970

could be a case of reverse causation: community engagement was high because community leaders were perceived to be receptive to volunteerism. Similarly, for individuals like Walt Pomeroy, actions on Earth Day could reflect an underlying taste for environmental volunteerism; he might have pursued a similar career even without Earth Day. The story of one community also says little about the overall effect of Earth Day. We turn to a broader analysis that addresses these concerns next.

II. Empirical Approach

Our approach will exploit variation in the weather on Earth Day. The original Earth Day was conceived as a one-time event; there was not a widespread recognition of Earth Day again until 1990. We thus focus on the interim period of the 1970s and 1980s and relate outcomes from this period to weather conditions on the original Earth Day. Our weather data come from the US Historical Climatology Network (USHCN).[2] Our unit of analysis from this data is the county and our measure of weather will be precipitation (cf. Madestam et al. 2013). For simplicity we will refer to this as "rainfall," as almost all precipitation observed on the original Earth Day was rain. However, precipitation could include snow. Precipitation is measured in 0.1-millimeter increments.

Figure 1 shows precipitation on Earth Day. Counties shaded black do not have available data, but the vast majority of counties are included. The scale in the picture is in tenths of a millimeter, indicating that the darkest gray areas received over 60 tenths of a millimeter (roughly 0.236 inches) of rain. April 22, 1970 was a day with good weather in much of the country, but there was widespread variation, with virtually every state having at least some precipitation. The Northeast

[2] The USHCN is a designated subset of weather observations from the National Oceanic and Atmospheric Administration Cooperative Observer Program (COOP) Network with sites selected according to their spatial coverage, record length, data completeness, and historical stability.

and the northern plains states received relatively more rain, and there were scattered instances of precipitation across the West Coast.[3]

It is intuitive that weather on Earth Day would affect participation, and many contemporaneous accounts of Earth Day mention the benefits of good weather (e.g., *Titusville Herald* 1970; *Danville Bee* 1970). Beyond affecting the number of participants, good weather could have improved the length and quality of participation and could have improved local media coverage of events. There is also anecdotal evidence from communities with activities marred by inclement weather (e.g., *Brainerd Daily Dispatch* 1970; *Oelwein Daily Register* 1970; *Ogden Standard-Examiner* 1970). For a more quantitative estimate of weather's effect on participation, one would need information on participation that included a high level of geographic detail and covered a wide range of areas. With this in mind, we can provide evidence on rain and Earth Day participation from two different data sources: the 1973 Youth Socialization Survey and the Current Population Survey. We discuss rainfall and participation on Earth Day more below.

When comparing places with precipitation on Earth Day to other places, we will include a number of control variables, many taken from the 1970 US decennial census. This census's timing, information on communities, and geographic detail are fortuitous for our study. A list of the variables is given in Table 1, panel A along with means and standard deviations. The panel also shows a coefficient regressing each variable individually on precipitation and a set of fixed effects. The text under Table 1 reports several conventional joint tests that indicate that precipitation on Earth Day does not appear to be significantly related to these community observables. When looking at a particular outcome y in community c in year t, our specification will be

$$y_{ct} = \alpha + r_c\phi + X_{ct}\beta + \Gamma_c\delta + \Phi_t\lambda + e_{ct}, \tag{1}$$

where r_c, which is not indexed by t, is precipitation on April 22, 1970; X_{ct} is a set of controls; Γ_c is a set of geographic fixed effects, which necessarily must subsume the measure of community c; and Φ_t is a set of year fixed effects. The scalar ϕ and vectors β, δ, and λ are to be estimated, and e_{ct} is noise. We use census regions for geographic fixed effects Γ_c, although for results using Vital Statistics data, which have many observed communities c per state, we will also consider state fixed effects. Some results use individual survey data; in these cases the unit of analysis is an individual i while the key regressor continues to be r_c. Our specification then becomes

$$y_{ict} = \alpha + r_c\phi + X_{ict}\zeta + X_{ct}\beta + \Gamma_c\delta + \Phi_y\lambda + e_{ict}, \tag{2}$$

where y_{ict} is the individual-level outcome variable, X_{ict} are a set of individual regressors, ζ is a set of coefficients to be estimated, and the other terms are as in (1). For

[3] One might wonder whether the actual weather patterns on Earth Day were close to the forecast patterns, as the weather forecast may have mattered, as well. We consulted national weather forecasts from April 21 and confirmed that, in general, the weather on Earth Day was close to what was forecast.

Table 1—Variables

Panel A. Control variables	Variable mean, [SD]	Regression on rainfall β, (SE)
Per capita income, 1969	20,957 [4,958]	24 (412)
Per capita state unemployment insurance transfers, 1970	82 [58]	2.596 (5.657)
Fraction population employed, 1970	0.409 [0.100]	0.00260 (0.00666)
Fraction population in poverty, 1970	0.164 [0.095]	−0.00473 (0.00695)
Average number of air quality monitors	2.89 [2.97]	−0.18602 (0.16893)
Fraction under age 18, 1970	0.350 [0.040]	0.00036 (0.00345)
Fraction with HS education, 1970	0.263 [0.053]	0.00052 (0.00284)
Fraction married, 1970	0.637 [0.044]	0.005138 (0.00216)
Fraction female, 1970	0.508 [0.017]	0.00081 (0.00116)
Fraction in manufacturing, 1970	0.068 [0.057]	0.00058 (0.00250)
Fraction in mining, 1970	0.008 [0.021]	−0.00109 (0.00083)
Fraction Black, 1970	0.082 [0.139]	−0.00197 (0.00129)
Fraction other race, 1970	0.011 [0.043]	−0.007327 (0.00393)
First population quantile	0.21 [0.41]	−0.02519 (0.03280)
Second population quantile	0.25 [0.43]	0.00919 (0.02406)
Third population quantile	0.26 [0.44]	−0.00032 (0.02286)
Fourth population quantile	0.28 [0.45]	0.01633 (0.02143)

Panel B. Precipitation and dependent variables	Variable mean, [SD]
GSS Anti-environmental spending index	1.47 [0.64]
GSS "spend too little" dummy	0.62 [0.49]
Carbon monoxide	1.76 [1.34]
Congenital abnormalities	0.01 [0.01]
Abnormalities (high SES)	0.01 [0.01]
Abnormalities (low SES)	0.01 [0.01]
Precipitation	13.4 [39]

Notes: 2,523 observations. For each variable in panel A, the left column shows the mean and standard deviation and the right column shows the coefficient and standard error of a regression of the variable on county-level precipitation on April 22, 1970 in tenths of a millimeter per day and a set of state fixed effects. Each coefficient is from a separate regression. A joint test of the significance of the association of all the above variables with precipitation on Earth Day yields $F(16,47) = 1.42$, $p = 0.16$. Using census division or region fixed effects in the joint test produces $p = 0.329$ and $p = 0.121$, respectively. A permutation test that randomly assigned Earth Day rain to counties and tested for joint significance 1,000 times obtained a mean p-value of 0.13; we thus take the results of the joint test as conservative. (In contrast, the t-statistics for individual regressors over-rejected only slightly.) The mean quantiles for population do not all equal 0.25 since some counties with missing variables are omitted from the sample and smaller counties are more likely to be omitted.

all outcomes in both (1) and (2), we will vary the set of controls to explore whether they affect estimates of ϕ.

Further, we can explore a stronger specification where we control for rain on other days in April 1970. If Earth Day stands out in its relation to later outcomes, this is strong evidence that it is Earth Day, rather than other unobserved elements that vary with weather, that drives our results. We can also consider results that use deviations from standard weather in our estimates. That is, we calculate the average precipitation on April 22 from 1968 to 1990 and call this $\bar{r}_c$. Then in equation (1) we can replace r_c with $(r_c - \bar{r}_c)$. This then identifies the deviation from standard weather on Earth Day, capturing the extent to which the weather was unusually good or bad. We can further combine both of these extensions, running regressions on the deviation from normal precipitation for various days in April 1970 and relating them to outcomes years later.[4] Several other comments are in order for the specifications used for each dataset and we discuss them next.

A. *GSS*

As Dunlap (1991) observes, there is little data that allows study of opinions about environmental issues over time during the period of our study. We need such data to be large in size, to cover much of the nation, and to provide reasonably precise information on one's local community. We know of one dataset fulfilling these criteria: the General Social Survey, or GSS. The GSS is a long running, roughly biennial survey that is nationally representative. In every survey from 1977 to 1993, respondents were asked whether the amount of money that we are spending "improving and protecting the environment" was too little, about right, or too much. We take these responses and use them to estimate equation (2). First, we simply construct an index where three corresponds with too much being spent, two corresponds with spending that is about right, and one corresponds with too little spending. The mean of the index is 1.5 (SE $=$ 0.64). We also construct a dummy that equals unity if a respondent says we spend "too little" on the environment. The overall mean of this dummy is 0.62 (0.49). These means and means for our other dependent variables are given in Table 1, panel B. We also include a set of individual controls in our GSS specification.[5] GSS data from this period use Primary Sampling Units (PSUs) as the geographic identifier, which are often similar to metropolitan statistical areas. We discuss our use of the PSU identifier and our construction of the GSS data more in online Appendix Section II.

B. *Carbon Monoxide*

Following many studies (e.g., Currie, Neidell, and Schmieder 2009; Currie and Neidel 2005), we consider air pollution as a key measure of environmental quality in the 1970s and 1980s. This choice reflects data availability rather than a belief that Earth Day particularly affected this type of pollution. We focus on carbon monoxide, as it is a pollutant proven to be related to both health outcomes and the local activity of individuals.[6]

[4] Rather than comparing days in April 1970, one could also compare April 22 in different years; as discussed below, we will do so. We find that the only year in the sample in which rainfall consistently predicts outcomes is 1970, which accords with the fact that Earth Day was not widely celebrated during most of the 1970s and 1980s.

[5] These are controls for age and dummies for high school and more than high school education, gender, race, year of survey, and which survey form was used to conduct the survey.

[6] Carbon monoxide is a colorless, odorless gas that enters the atmosphere when something is burned. Key sources of carbon monoxide in outdoor air include cars, trucks, and machines that burn fossil fuels (cf. Knittel, Miller, and Sanders 2016).

Following Chay and Greenstone (2003), we obtain annual monitor-level carbon monoxide data from the EPA Air Quality System (AQS).[7] Our data go from 1970 to 1988 and measurements are defined as average parts per million measured over a calendar year. The unit of analysis is the county. In most years we have between 200 and a little over 300 counties with carbon monoxide readings, but these counties cover over half of the US population in most of these years. We limit our sample to measurements from monitors that produce at least 15 observations in a year, although this does not substantively affect our results.

We also estimated the results of Earth Day on other pollutants, including nitrogen dioxide (NO2), sulfur dioxide (SO2), TSP, and ozone.[8] Importantly, these sources of air pollution can be driven by nonlocal sources or by activities that would likely not be affected by changes in individuals' volunteer behavior. For instance, the EPA reports that NO2 and ozone are capable of traveling several hundreds of miles due to wind and other factors (EPA 1999). Likewise, SO2 emissions form compounds and fine-particle pollutants (TSPs) that can travel hundreds of miles, making it difficult for downwind states to meet air quality standards (EPA 2019b, c).[9] Given this, we expect (and find) that Earth Day should be less related or unrelated to the presence of these pollutants in the atmosphere.

C. *Infant Health*

Our data here come from the Natality Detail Files prepared by the Division of Health Statistics of the National Center for Health Statistics. These data include essentially all births in the United States, about four million births per year.[10] Our key measure of infant health is congenital abnormalities, information about which is only consistently available starting in 1980.[11] Coding of this variable changed in 1989; for this reason (and noting, as discussed earlier, the resumption of Earth Day celebrations in 1990) we use the years 1980 to 1988. We also discuss results using fetal deaths as compiled by the Centers for Disease Control. Our geographic identifier for both the CDC mortality data and the vital statistics data is the county.

In both datasets, we separate out our samples by socioeconomic status (SES) using information on birth certificates. We define births and fetal deaths to low-SES mothers as occurring to women who are teenaged, unmarried, or non-White. High-SES women are all others. The (weighted) fractions of congenital abnormalities for all women, high-SES women, and low-SES women are each 0.01; the means and standard deviations are in Table 1.

[7] Specifically, we query the AQS API where pollutants and other substances are labeled as parameters. The associated parameter for carbon monoxide is 42101.

[8] These are AQS API parameter codes 42602, 42401, 11101, and 44201, respectively. These pollutants, along with carbon monoxide, comprise the five major air pollutants for which the EPA creates an Air Quality Index (AQI) as per the Clean Air Act.

[9] Additionally, see https://www.epa.gov/sips/basic-information-air-quality-sips for information on how these pollutants enter the air.

[10] For several states and years a 50 percent sample is provided; in this case we weight these states so that their sample reflects all births.

[11] We are also able to obtain this outcome for a few earlier years, which we use for placebo estimates below.

D. *Youth Socialization Survey*

The 1973 Youth Socialization Survey is the only study we know of that directly asks a national sample of young adults (or other adults) about volunteerism in 1970. This survey asked a nationally representative sample of 1,300 young adults, "Have you ever taken part in a demonstration, protest, march, or sit-in?" If they answered "yes," they were asked to give examples. The dataset includes the time period of each of the first two examples named. While this is a retrospective question and based on a small sample, we can use this survey response to estimate a relationship between rainfall and participation on Earth Day.

We take as our dependent variable a dummy that equals unity if a respondent reports participating in a demonstration or protest in 1970 and zero otherwise. A total of 48 respondents report participating in an event in 1970. We might expect more to have participated in Earth Day as other estimates say that 10 percent of the population participated; that percentage was likely higher for the age group in this survey. The low number reported could be driven by people reporting events in other years instead. (A total of 159 respondents list participation in events in other years but not 1970.) If people participated in Earth Day but do not recall doing so for this question (e.g., they do not consider their participation to have been a demonstration or a protest, as many events consisted of cleanups and teach-ins) that will bias estimates toward zero if such nonrecall is unrelated to the weather. If people who participated in Earth Day events during bad weather are especially likely to recall this when answering this retrospective question, that bias will work against our results. Similarly, if volunteering on Earth Day led to volunteering in subsequent years, and these more recent volunteering episodes were mentioned on the survey, they could crowd out the mention of volunteering on Earth Day, which would also bias the estimates toward zero. For location, we use the Primary Sampling Unit of respondents in the 1965 wave of the survey. PSUs are coded as MSAs or counties. We discuss this survey and our use of these sampling units in more detail in online Appendix Sections I and II.

In addition to this survey we can use the much larger samples from the 2002–2014 waves of the Current Population Survey, which explicitly asks about environmental volunteerism while covering more recent Earth Days. We report CPS estimates on Earth Day rain and volunteerism in online Appendix Section II; both datasets give qualitatively similar results.

III. Earth Day and Long-Run Environmental Attitudes

Figure 2 shows the results of regressing our anti-environment index from the GSS on the deviation from historical precipitation $(r_c - \bar{r}_c)$ for each day in April 1970. Coefficients are multiplied by 100 for readability. The figures show coefficients and 95 percent confidence intervals for April 17 through April 28. The full set of coefficients for all days is given in online Appendix Figure A3. Panel A restricts the sample to those under age 20 on Earth Day and panel B includes all respondents.

Panel A shows a large and statistically significant effect for rainfall on one day, Earth Day. Precipitation on this day is related to greater opposition to environmental

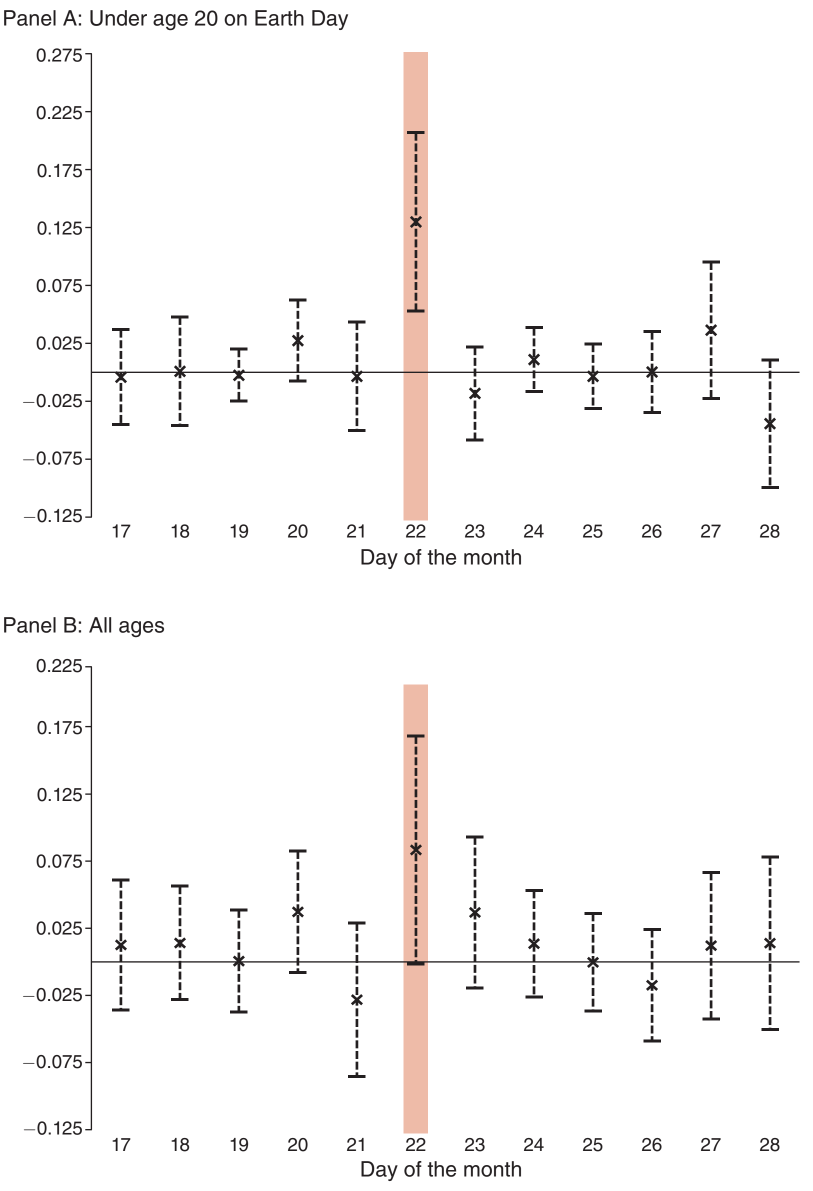

FIGURE 2. OPPOSITION TO ENVIRONMENTAL SPENDING IN THE 1970S AND 1980S AND APRIL 1970 RAINFALL

Notes: Each panel shows coefficients and 95 percent confidence intervals from a regression on agreement with the statement "We're spending too much money" on improving and protecting the environment on a set of covariates for rainfall on days in April 1970. Responses are taken from the 1977–1993 waves of the General Social Survey. Coefficients are multiplied by 100 for readability. The full set of results is given in the online Appendix.

spending by respondents 7 to 23 years later. The coefficient in panel B is smaller and marginally significant, showing that the effect of good weather on Earth Day is stronger for those under age 20. We take up the differential effects of Earth Day by age in more detail momentarily.

Table 2—Rainfall on April 22, 1970 and Environmental Support in the 1970s and 1980s

	Strongest support for environmental spending		Opposition to environment: Overall index	
	All ages (1)	"Under 20 on Earth Day" (2)	All ages (3)	"Under 20 on Earth Day" (4)
Rain on Earth Day	−0.046	−0.0854	0.0576	0.0976
	(0.0272)	(0.032)	(0.036)	(0.042)
Rain on Earth Day (levels)	−0.0572	−0.0839	0.0617	0.0932
	(0.032)	(0.038)	(0.043)	(0.047)
Rain on Earth Day (extra controls)	0.0119	−0.0713	−0.0164	0.0834
	(0.0217)	(0.0282)	(0.0294)	(0.0356)
Winzorized rainfall	0.00942	−0.0893	−0.0201	0.11
	(0.0297)	(0.0351)	(0.0407)	(0.0454)
Logistic/ordered logistic	0.0462	−0.366	−0.0259	0.368
	(0.0979)	(0.136)	(0.094)	(0.137)

Notes: Each coefficient is from a separate regression. Heteroskedasticity-robust standard errors, clustered by primary sampling unit, are reported in parentheses. The data come from the General Social Survey from 1977 to 1993. Coefficients and standard errors are multiplied by 100 for readability. In the first two columns the dependent variable is a dummy variable that equals one if a respondent says "we're spending too little money" on improving and protecting the environment. The last two columns index responses on the current level of environmental spending from one to three, where three means that spending is "too high," two means that it is "about right," and means "too little." For each dependent variable the first column shows all respondents and the second column shows results for those alive and under age 20 on the original Earth Day. There are 18,370 and 5,161 observations in the baseline regression in these columns, respectively. The mean of the index is 1.5 (SD = 0.65) for the full sample and 1.3 (0.53) for the under-20 sample. The mean of the strongest support dummy is 0.62 (0.49) for the full sample and 0.74 (0.44) for the under-20 sample. All regressions include a set of individual controls (age, education, race, survey form used, year of interview).

For all columns, the first row uses deviation from historical average precipitation on Earth Day, which, for brevity, we refer to as "rain on Earth Day." The second row redoes the baseline specification but uses simple precipitation rather than its deviation from the historical mean. The third row redoes the baseline estimation but adds extra control variables (listed in Table 1) and census region fixed effects. The fourth row uses winsorized deviation from historical average rain using the 5 percent and 95 percent values for winsorizing and also includes extra RHS controls and region fixed effects. The last row redoes the third row using a logistic regression for the GSS survey responses for the first two columns and an ordered-logit regression for the last two columns. The logistic regressions are reported in log odds (multiplied by 100 for readability). The corresponding odds ratio coefficients (not multiplied by 100) for the second and fourth columns are 0.99634 (SE = 0.0014) and 1.00369 (0.0014).

The coefficient in panel A (multiplied by 100) is about 0.13 and, as noted earlier, the mean of the index variable is 1.5 with standard deviation 0.64. For increased rainfall on Earth Day of 100 tenths of a millimeter, the average change in this index would be an increase of about 0.13, or one-tenth of the mean. Put differently, a 1–standard-deviation increase in precipitation ($\sim$ 40 tenths of a millimeter) corresponds to roughly a 0.08–standard-deviation increase in opposition to environmental spending. Alternately, in the online Appendix (Table A2) we show that being older at the time of the survey leads to more anti-environmental attitudes and that the effect of a one-millimeter increase in precipitation on Earth Day is similar to the effect of aging one year. These different interpretations suggest that the effect of Earth Day is modestly sized but nontrivial.

Table 2 shows results from estimating equation (2) under a number of alternate specifications, measures of environmental support, and samples. In the first two columns, the dependent variable is a dummy for whether people say that we are spending too little on the environment. The last two columns use the overall opposition index used in Figure 2. Coefficients are again multiplied by 100 for readability. The first row presents results using precipitation deviating from the historical norm, which, for brevity, the table simply calls "rain." Unlike the estimates in Figure 1, only weather on April 22 is included here. The second row redoes the baseline specification but uses simple precipitation r_c rather than its deviation from the historical mean. The third row redoes the baseline estimation but adds extra control variables (coefficients for controls are reported in online Appendix Table A2) and year and region fixed effects. Row 4 uses winsorized deviation from historical average rain using the 5 percent and 95 percent values for winsorizing and includes the extra RHS controls. By using winsorized rainfall, the results investigate whether the effect of Earth Day is driven by outliers that received far from normal weather or by more general patterns. The last row uses a logistic regression for the GSS survey responses for the first two columns and an ordered-logit regression in the last two columns. These coefficients are the changes in log odds (again, multiplied by 100). Log-odds ratios for the logistic estimations under age 20 are given under the table.

The table consistently shows a strong effect for those under age 20 on the original Earth Day, where higher precipitation leads to lower support for environmental spending later. Winsorizing the data makes the results stronger, suggesting our estimates are not driven by a small set of extreme values. But, clearly, the results are driven by those who were under age 20 on Earth Day. The implication is that Earth Day's power to generate variation in environmental opinion (or at least relative variation within a year of the survey) based on weather exposure seems strongest for those who were school aged at the time that Earth Day was observed. Moreover, if adults were likely to be impacted by Earth Day from watching television rather than participating in outdoor events, for example, the impact of Earth Day for them could be less responsive to the variation in local rainfall driving the results in Table 2.

Figure 3 explores the effects of age on Earth Day further. In this figure, we restrict the sample to those who were at least age five on Earth Day (results for those between ages zero and five on Earth Day are typically imprecise) and then adjust the maximum age at Earth Day in the sample one year at a time. The specification matches the one with extra controls used in row 3 of Table 1, and the dependent variable is the overall anti-environment index. 95 percent confidence intervals are shown around each coefficient. The picture shows that the effects are strongest for school-aged children and begin a gradual decline starting around age 15. Given our methodology, these results cannot rule out that Earth Day permanently affected attitudes for all cohorts; however, Earth Day's power to generate relative variation in environmental opinion within a cohort seems limited to those who were school aged at the time.

In the online Appendix we present further evidence on Earth Day and environmental opinion. First, online Appendix Figure A3 presents results from the first panel of Figure 2 showing all days in April 1970 as well as presenting results for our other outcome variables, which we discuss next. Second, online Appendix Figure A4 presents nonparametric estimations of rainfall and environmental support, relaxing

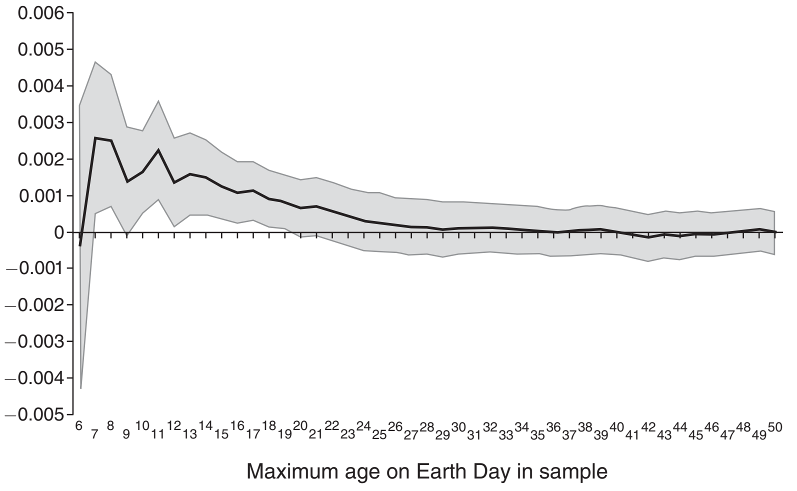

Figure 3. Environmental Attitudes and Rain on Earth Day: Adjusting the Sample by Age on April 20, 1970

Notes: The figure shows the results from 45 estimated regressions. Each regression regresses stated opposition to environmental spending on original Earth Day rainfall and a set of controls. The regressions limit the sample by age on Earth Day to individuals between age five and the given age on the *x*-axis. (Results including just those under age five are typically imprecise). The black line shows the coefficient estimate, and the gray area shows the 95 percent confidence interval as progressively older ages are included in the sample.

the assumption that this relationship is linear. The estimates are qualitatively similar to those shown here.

Last, online Appendix Section III describes alternate estimates of Earth Day and preferences using data on donations to the League of Conservation Voters. The data are limited to large donations reported to the government, and these results can be imprecise. But the point estimates suggest that good weather on Earth Day increases donations to the LCV in the following decades. Overall, Earth Day had long-lasting effects on individuals' opinions. We turn next to our estimates on air pollution and child health.

IV. Earth Day, Air Pollution, and Child Health

We first consider estimates that follow the estimates from Section III and then discuss several robustness tests and extensions.

A. *Main Estimates*

Figure 4 shows the day-by-day effect of Earth Day and other days from April 1970 on carbon monoxide levels.[12] The figure is constructed analogously to Figure 2, showing coefficients for deviation from historical average precipitation ("rain" for

[12] Online Appendix Table A3 shows results on other air pollution but as noted earlier, and as expected, we see no effect.

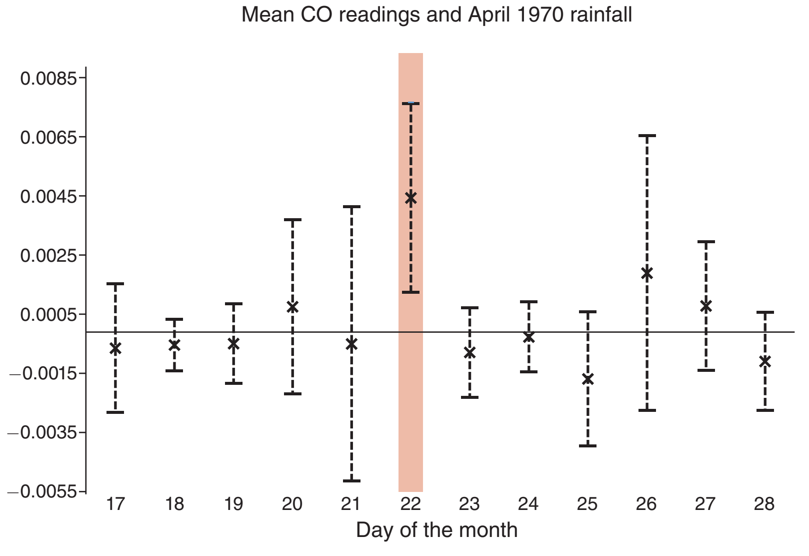

Figure 4. Earth Day and Air Pollution

Notes: This picture shows coefficients and 95 percent confidence intervals from a regression of annual CO levels (1970–1988) on a set of covariates for rainfall on days in April 1970.

short) for various days in April 1970 and parts per million of carbon monoxide in the atmosphere from 1970 to 1988.

As before, one days stands out: Earth Day. Communities that saw greater-than-average rainfall on Earth Day see more carbon monoxide in their air over the next 20 years. In this regression sample (limited to counties with carbon monoxide data) a 1–standard-deviation increase in precipitation is approximately equal to 25 tenths of a millimeter, suggesting a 1–standard-deviation increase in rain is associated with an increase in carbon monoxide in the atmosphere of $25 \times 0.0046 = 0.115$ parts per million, which is 0.086 standard deviations of carbon monoxide. During the period of the sample, average carbon monoxide in the atmosphere declined by about 2.8 parts per million; the standard deviation in rain effect is about one twenty-fifth of this general decline in carbon monoxide. As before, the effect is modest in size but not negligibly small.

We return to results on carbon monoxide momentarily but first consider Figure 5, with day-by-day results on congenital malformations. The results show that bad weather on Earth Day is associated with more congenital abnormalities 10 to 20 years later. The coefficients are multiplied by 100 so that an increase of 100 tenths of a millimeter in rain on Earth Day increases the probability that a child is born with a congenital abnormality by 0.3 percentage points. The effect of a one–standard-deviation increase in rain is roughly one-tenth the size of the effect from living near a landfill as estimated in Elliott et al. (2001).[13] Alternately, a one–standard-deviation

[13] Similarly, Currie, Greenstone, and Moretti (2011) look at the effect of the closing of a Superfund site on abnormalities from nearby births; depending on the specification, their results are about two to six times larger than these.

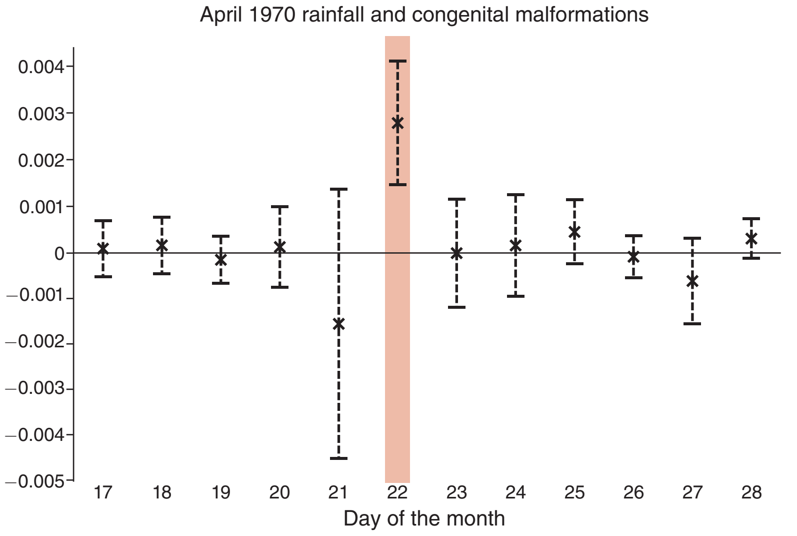

Figure 5. Earth Day and Infant Health

Notes: This picture shows coefficients and 95 percent confidence intervals from a regression of births with congenital malformations from 1980 to 1988 on a set of covariates for rainfall on days in April 1970. Coefficients are multiplied by 100 for readability.

increase in rain increases the fraction of children born with congenital abnormalities by about 0.1 standard deviations.

Table 3 presents regression estimates of (1) on carbon monoxide and congenital abnormalities. Residuals are clustered by state. The first column looks at carbon monoxide levels and finds consistent evidence that across our measures of precipitation there is a relationship between more rain on April 22, 1970 and more carbon monoxide in the air in the next 20 years. As with the GSS results, the magnitudes are similar but slightly smaller than in the day-by-day figure: controlling for other rainfall makes the coefficient slightly larger than the more conservative numbers here.

The last three columns report regressions with congenital abnormalities as the dependent variable and break the results out by the socioeconomic status of the mother. We find consistent effects of precipitation on the original Earth Day on the risk of congenital abnormalities 10 to 20 years later. This represents a novel example of how the neonatal health benefits of environmental action can endure absent a fetal-origins type of argument; the cohorts here were, of course, not even alive on the first Earth Day.[14] Looking at the last two columns, most of the estimates give larger point estimates to low-SES groups. One might wonder whether this

[14] While congenital malformations were collected on Certificates of Live Birth following the revision in 1968, they are not reported consistently on summary tape files until 1980, and there are no published local area statistics on congenital malformations in volumes of the *Vital Statistics of the United States* from 1968 to 1980. However, summary tape files do report tabulations on congenital malformations from 1969 to 1971 on a provisional basis. Estimating (1) using this data reassuringly yields small and statistically insignificant effects. Re-estimating row 4 for 1969 only, we obtain a multiplied-by-100 coefficient of 0.0008 (p-value $=$ 0.615), and including all years from 1969 to 1971, our multiplied-by-100 coefficient is 0.0018 (p-value $=$ 0.216).

Table 3—Rainfall on April 22, 1970 and Carbon Monoxide & Congenital Abnormalities in the 1970s and 1980s

		Congenital abnormalities†		
	Carbon monoxide (1)	All (2)	High-SES births (3)	Low-SES births (4)
Rain on Earth Day	0.00360	0.00514	0.00525	0.00515
	(0.00158)	(0.0011)	(0.0010)	(0.0012)
Rain on Earth Day (levels)	0.00295	0.00442	0.00422	0.00329
	(0.00198)	(0.0013)	(0.0012)	(0.0014)
Rain on Earth Day (extra controls)	0.00238	0.00364	0.0036	0.00474
	(0.00167)	(0.0012)	(0.0011)	(0.00118)
Rain on Earth Day (weighted, extra controls)	0.0031	0.00475	0.00482	0.00685
	(0.00161)	(0.0019)	(0.0016)	(0.00229)
Winzorized rainfall	0.00265	0.00542	0.00537	0.00743
	(0.00188)	(0.0023)	(0.0021)	(0.00242)
Winzorized rainfall (weighted)	0.00344	0.00628	0.00679	0.00934
	(0.00193)	(0.0027)	(0.0024)	(0.00308)

Notes: Each coefficient is from a separate regression. Heteroskedasticity-robust standard errors, clustered by state, are reported in parentheses. In column 1, the dependent variable is mean annual carbon monoxide readings (in parts per million) in a county from 1970 to 1988, and the sample includes a total of 3,823 observations. The mean of this variable is 1.757 (SD = 1.34). The specifications in each row follow Table 2.

In columns 2, 3, and 4 the dependent variable is the fraction of children born with a congenital abnormality; these data are available from 1980 to 1988 with a total sample size of 25,691. Column 3 restricts the sample to births from high-socioeconomic-status (SES) mothers and column 4 restricts the sample to low-SES mothers, where low-SES women are at least one of the following: teenaged, unmarried, or non-White. High-SES mothers are all others. The (weighted) fraction of congenital abnormalities for all women, high-SES women, and low-SES women is 0.01 (SD = 0.01), 0.01 (0.01), and 0.01 (0.01), respectively.

For all columns, the first row uses deviation from historical average precipitation on Earth Day, which, for brevity, we refer to as "rain on Earth Day." The second row redoes the baseline specification but uses simple precipitation rather than its deviation from the historical mean. The third row adds extra control variables (listed in Table 1) and census-region fixed effects. The first three rows use unweighted data. In the fourth row, we weight the estimates on carbon monoxide by the total population in a county, and we weight the congenital abnormality regressions by the number of births. The fifth row redoes the third row using winsorized deviation from historical average rain using the 5 percent and 95 percent values for winsorizing. The sixth row redoes the fifth row using weighted estimates where the weights are as in the fourth row.

†The coefficients and standard errors in columns 2, 3, and 4 are multiplied by 100 for readability.

indicates a proportional difference in abnormalities by SES, but as noted under the table, the incidence of abnormalities is similar for the two groups so that the proportional effects are similar or perhaps slightly higher for low-SES women. The results are similar using rain in levels instead of residualized deviation-from-mean rainfall in row 2, using extra controls and fixed effects in row 3, using weights (population weights for carbon monoxide and total births for congenital abnormalities) in rows 4 and 6, or when using winsorized rainfall in rows 5 and 6. One might also wonder whether the imposition of a linear relationship between weather and outcomes is appropriate. The winsorization results touch on this issue, but as mentioned earlier, online Appendix Figure A4 presents nonparametric estimates, and these estimates are qualitatively similar to the results here.

One could investigate whether rainfall on April 22 in other years matters for later outcomes. As noted before, recognition of Earth Day faded after 1970, and the day was not widely recognized again for most of the 1970s and 1980s. Figure A6 in the online Appendix shows such results from all three outcomes: environmental opinion, carbon monoxide readings, and congenital malformations. The only consistently observed effect is from rainfall in 1970, the year Earth Day occurred. Next, Figure A7 in the online Appendix presents results on congenital malformations with state fixed effects, thus identifying the effect of rainfall using variation within counties in the same state. Although the nature of the variation driving the figure is different, the results again find a strong effect for Earth Day.

In Table 3 we cluster our standard errors by state, allowing for errors within states and over time to be related arbitrarily while imposing an assumption of no between-state correlation. We report county-clustered standard errors in online Appendix Table A4. The carbon monoxide errors are similar from both approaches, but the county-clustered standard errors are somewhat smaller for the congenital abnormality results; thus, the results shown in Table 3 are more conservative relative to using county clusters.[15] In online Appendix Table A6, we report estimates on fetal deaths. These results are similar to Table 3 and suggest that bad weather on Earth Day is associated with more fetal deaths 10 to 20 years later, but these estimates are more sensitive to our choice of clustering method.[16]

Online Appendix Table A4 shows that county and state clustering are qualitatively similar, but both of these approaches impose assumptions about the spatial distribution of standard errors. The same was true of the GSS estimates in Table 2. Building on online Appendix Figure A6, we explore the implications of this with a series of placebo tests using rain from other days in April from 1968 to 1990. We take rainfall from each day in each of these Aprils, regress outcomes on rainfall, and compare the true coefficient to the distribution of coefficients from the placebo regressions. Similar to Madestam et al. (2013), we drop April 21, 22, and 23 of 1970 from the placebo distribution, and we avoid having the results on any given day driven by a small set of rainy counties by dropping days that received very little rainfall. (Madestam et al. use days where at least 10 percent of observations have 0.1 inches of rain; we use at least 10 percent having 3 millimeters.). We run placebo draws for the GSS separately from the other samples since these data are not at county level.

The results are shown in Figure 6. Each panel reports the cumulative distributions of the placebo estimates with a vertical line denoting the location of the true estimate. Below each panel the *p*-value based on the original inference method is reported alongside a *p*-value reporting the fraction of placebo coefficients that exceed, in absolute value, the original coefficient. The top two rows consider GSS results (using support for environmental spending and our opposition index) for all

[15] The GSS data use PSUs, which often—but not always—map into states; many states have few PSUs in the sample. Table A5 in the online Appendix provides results where we conduct a match of PSUs to states and calculate state-level standard errors. They are generally close to the PSU clusters shown earlier.

[16] We also consider low birth weight as an outcome, but these estimates are often insignificant, small, or "wrong-signed." For example, doing our main specification in Table 3 with all controls (as in row 4) on the fraction born weighing less than 1,500 grams produces coefficients (multiplied by 100) of −0.0001 (SE = 0.00023), 0.000048 (0.0002), and −0.0003 (0.0004) for all women, high-SES women, and low-SES women, respectively. This may be driven by a harvesting effect, since we have some evidence of an increase in fetal deaths. These null findings are similar to some of those in prior work on the environment and child health; e.g., Currie and Neidell (2005) find a significant relationship between carbon monoxide pollution and infant mortality but find no effect of carbon monoxide on birth weight, and Currie, Greenstone, and Moretti (2011) look at Superfund sites and infant health and find the strongest effects for abnormalities, less robust effects for mortality, and generally insignificant effects on birth weight. Overall, we do not have robust evidence relating Earth Day to birth weight.

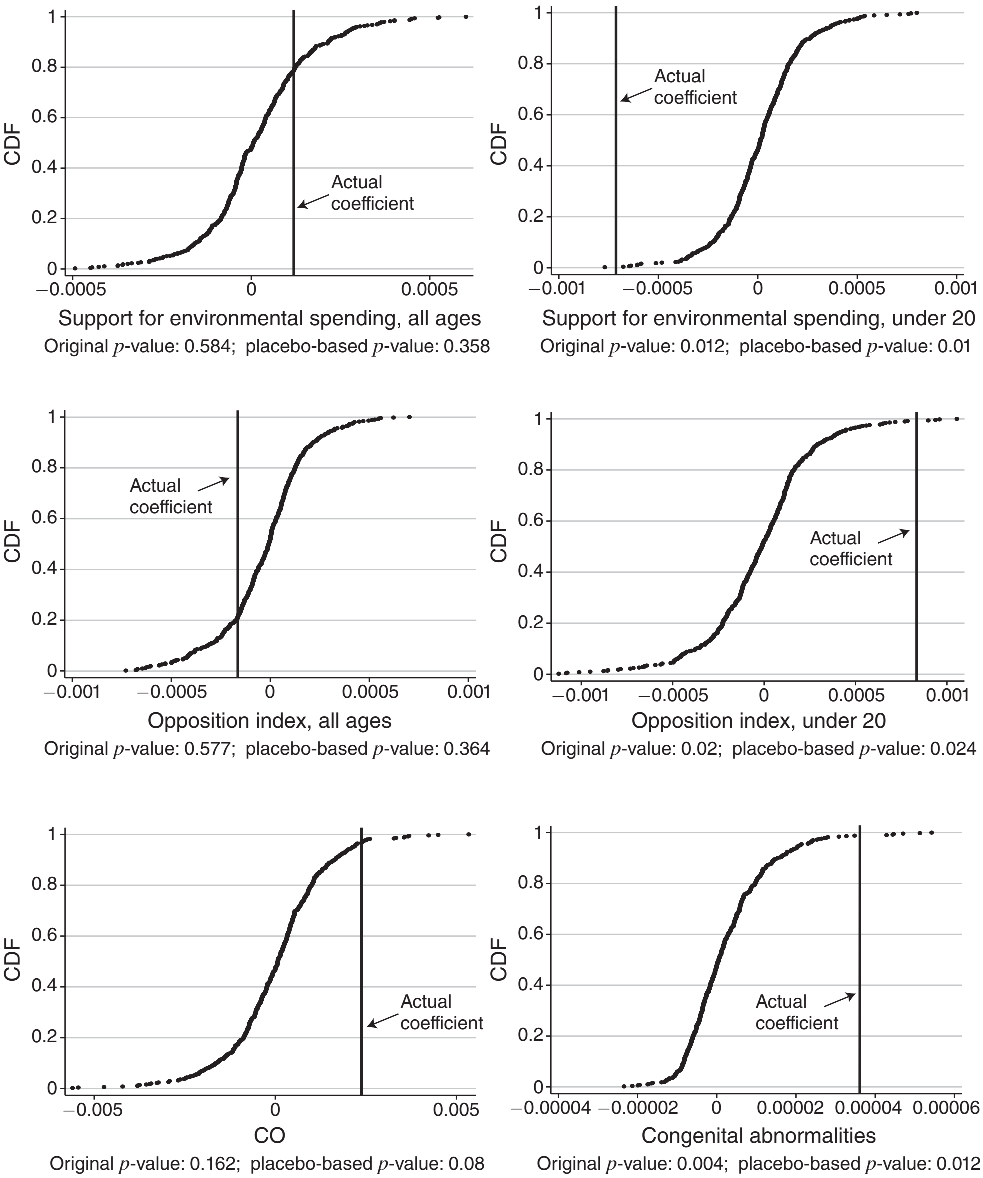

Figure 6. Effect of Rainfall

Notes: Each graph shows the true coefficient of the effect of rainfall on April 22, 1970 from regressions including extra controls against the cumulative distribution of coefficients from a series of regressions done on rainfall for each day in each April from 1968 to 1990. Similar to Madestam et al. (2013), we exclude from the placebo regressions weather from the original Earth Day and the days before and after it and use days where at least 10 percent of counties had 3 millimeters (about 0.1 inches) of rain. There are 500 placebo estimates in the first two rows and 503 for the figures in the bottom row. The original *p*-values from clustered standard errors in Tables 2 and 3 are given below each table along with a two-sided *p*-value based on the fraction of placebo regressions producing (in absolute value) a coefficient greater than the true coefficient.

ages on the left and for those under age 20 on the right. The bottom row shows our estimates for carbon monoxide and congenital abnormalities.

Table 4—Earth Day Weather and Voluntarism: Evidence from the 1973 Youth Socialization Study

		Participated in demonstration in 1970
(1)	Rain on Earth Day	0.00214
		(0.0168)
(2)	Rain on Earth Day (levels)	−0.0185
		(0.0109)
(3)	Rain on Earth Day (extra controls)	−0.0208
		(0.0108)
(4)	Rain on Earth Day (extra controls, region FEs)	−0.0208
		(0.0128)
(5)	Winzorized rainfall	−0.0207
		(0.0219)
(6)	Logistic	−0.974
		(0.4200)
(7)	Demonstrated in other years	0.0566
		(0.0289)

Notes: All coefficients are multiplied by 100 for readability; the logistic regression reports log-odds. Each coefficient is from a separate regression. Heteroskedasticity-robust standard errors, clustered by primary sampling unit, are reported in parentheses. The data come from the 1973 Youth Socialization Study. There are 1,308 respondents in the sample. In the first six rows the dependent variable is a dummy that equals one if a respondent reports having ever participated in a "demonstration, protest march, or sit-in" in 1970. (48 respondents report this, the mean is thus 0.0366.) The last row is a dummy for whether a respondent reports participating in a demonstration, protest march, or sit-in in other years. (159 respondents report this.)

The first row uses deviation from historical average precipitation on Earth Day (which, for brevity, we refer to as "rain on Earth Day") and individual controls for age, education, and race. The second row uses uses simple precipitation rather than its deviation from the historical mean. The third row redoes the baseline estimation but adds extra control variables (listed in Table 1). Row 4 further adds region fixed effects; some other specifications become imprecise when these are included. Row 5 uses winsorized deviation from historical average rain using the 5 percent and 95 percent values for winsorizing and also includes extra RHS controls from the third row. The sixth row redoes the third row using a logit regression rather than OLS. The last row uses the baseline specification from the first row.

The overall takeaway from the figure is that the precision of the estimates based on this placebo-estimate approach is similar to that from the main estimates. In one case an estimate goes from insignificant to marginally significant when the placebo inference technique is used (for carbon monoxide, in the bottom row), and otherwise the results are qualitatively similar with both techniques. The results frequently suggest, as with online Appendix Table A4, that our use of state clusters is, if anything, a more conservative approach to inference.

B. *Participation Dynamics and Further Discussion*

In this section we discuss several extensions to our main results. First, can we quantify the impact of rain on participation on the original Earth Day? Table 4 uses the 1973 Youth Socialization Survey to explore this issue. The table shows estimates from regressing self-reported participation in a 1970 demonstration or protest on original Earth Day rainfall. Coefficients are multiplied by 100 for readability; the logistic coefficient is a log-odds coefficient. The first row is the baseline estimate of participation on deviation-from-mean rainfall and individual controls. The second row uses simple precipitation rather than deviation-from-mean rainfall. The third row redoes the baseline estimation with extra control variables (those in Table 1); the fourth row further includes census-region fixed effects. The fifth row redoes the third row using winsorized precipitation. The sixth row redoes the third row with a logit regression. The last row redoes the baseline, but now the dependent variable is participation in years other than 1970.

Most coefficients are negative and significant, indicating that that rain on April 22, 1970 is negatively associated with individuals subsequently reporting participation in a demonstration or event that year. Noting that the coefficients are multiplied by 100, the magnitude suggests that an increase of 40 tenths of a millimeter lowers reported participation by a little under 1 percentage point. If one assumed that that participation in Earth Day for this group was twice that of the average member of the population, the implied effect would be 5 percent of the mean ($0.01/0.2 = 0.05$). The logit regression similarly suggests that such an increase in rain would lower the odds of participation by about $e^{(40\times -0.00974)} \approx 0.65$, an effect off of a base of about 0.03 to $0.03 \times 0.65 \approx 0.019$. In contrast, the results in the bottom row suggest that rain on Earth Day increases the likelihood that a person reports participating in an event some other year; this coefficient is large but less precise than some of the main results. We take these results as suggestive, since the estimates in the table are sensitive to specification (as are results using rain in many days in April, which are generally insignificant) and the data come from a small sample. In online Appendix Section 2, we find qualitatively similar effects from a much larger sample in the CPS (using later years). Overall, the results indicate that, as one would expect, bad weather on Earth Day is associated with lower participation, and Table 4 suggests that the effects of Earth Day on later attitudes and outcomes may be associated with moderately sized changes in participation in response to rain.

Next, our results show a long-term effect from Earth Day. Can we characterize the dynamics of this effect? Since carbon monoxide levels are the outcome most consistently available over the entire period, we investigate whether and how our carbon monoxide estimates change over time. Figure 7 shows the results from regressing carbon monoxide levels on deviation from the historical norm for precipitation on the original Earth Day. Each coefficient is from a separate regression analogous to the regression in column 1, row 1, of Table 3 except that in each regression here we limit the sample to a single year. We omit the years before 1973 as their confidence intervals are extremely imprecise and affect the scale of the picture (but these intervals are given under the table).

Figure 7 shows point estimates that gradually decline in the late 1970s and then moderate in the 1980s. Notably, however, the effects only become statistically significant starting five years after Earth Day. This suggests that studies of the efficacy of volunteer action should consider carefully the potential for middle- or long-term effects even when there are no significant short-term effects. One explanation for this result is that those whose opinions changed the most from Earth Day (students) needed time to reach an age where their decisions (e.g., driving) are consequential

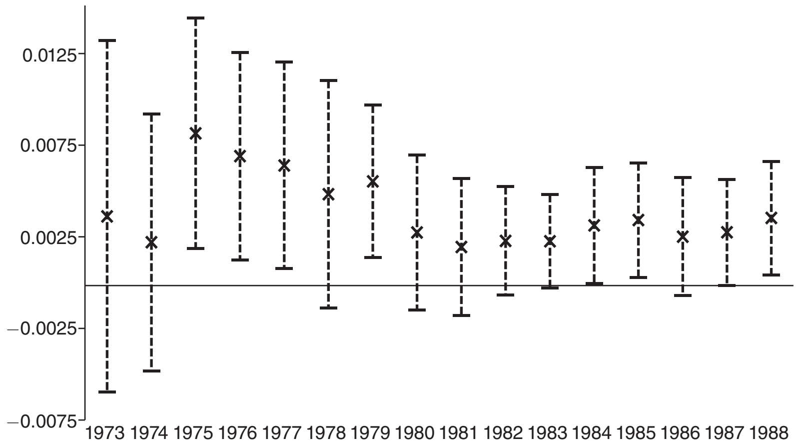

Figure 7. The Effect of Earth Day on CO Over Time

Notes: The figure shows coefficients and 95 percent confidence intervals from regressing carbon monoxide (CO) levels on deviation from historical norm precipitation on the original Earth Day. Each coefficient is from a separate regression analagous to the regression in column 1, row 1, of Table 3 except that in each regression here we limit the sample to a single year. The years before 1973 are omitted as their confidence intervals are large and distort the axis (the 1970 CI is {−0.067, 0.013}, for 1971 it is {−0.012, 0.021}, and for 1972 it is {−0.0046, 0.016}).

for carbon monoxide. Also, for individuals of any age there are likely frictions that could introduce some time lag in making decisions that matter for air pollution.

One noteworthy decision of this kind could be migration: places that celebrate Earth Day could subsequently become more attractive to like-minded individuals who relocate. This is a possible way by which weather on Earth Day could affect community characteristics years later. Even if Earth Day does not alter migration decisions, places that were "treated" by Earth Day could change the environmental stances of migrants after they move. For example, Earth Day could alter the values of the media or elites, who then subsequently influence the views of those who move into a community. Relatedly, Perez-Truglia and Cruces (2017) show that the salience of social engagement from one's neighbors can affect one's own social engagement; if Earth Day makes environmentalism more salient in a community, this could encourage pro-environmental migrants to be more engaged or outspoken. On the other hand, if Earth Day neither affects migration decisions nor the values nor engagement of migrants after they relocate, then we would expect our results to be driven by nonmigrants.

The GSS asks whether respondents live in the same city as they did at age 16 so that one can explore whether the effect of rain on environmental opinion in the GSS differs for migrants versus nonmigrants. In Table 5, we redo the main estimates of support for environmental spending in row 3 of Table 2, where rainfall is now interacted with a set of dummies for whether a respondent reports living in the same city as at age 16; living in a different city, but in the same state, as at age 16; or living in a different state than at age 16. (Noninteracted moving dummies are also included.) The last row in each column reports the p-value of a Wald test of the null hypothesis that the three "rain on Earth Day" coefficients are equal.

Table 5—Environmental Support among Movers and Non-movers

	Strongest support for environmental spending		Opposition to environment: overall index	
	All ages (1)	Under 20 on Earth Day (2)	All ages (3)	Under 20 on Earth Day (4)
Rain on Earth Day × nonmover	−0.0128	−0.0611	0.0084	0.0631
	(0.0306)	(0.0365)	(0.0417)	(0.0428)
Rain on Earth Day × in-state mover	0.0483	−0.0899	−0.06	0.108
	(0.0293)	(0.0507)	(0.0382)	(0.0654)
Rain on Earth Day × out-of-state mover	0.0118	−0.0573	−0.0149	0.0759
	(0.0312)	(0.0680)	(0.0429)	(0.0816)
Test of equality of coefficents (p-value)	0.147	0.829	0.260	0.760

Notes: Coefficients and standard errors are multiplied by 100 for readability. Each column is from a separate regression. Heteroskedasticity-robust standard errors, clustered by primary sampling unit, are reported in parentheses. Specifications match those in row 3 of Table 2, where here rainfall is interacted with a set of dummies for whether a respondent reports living in the same city as at age 16, living in a different city in the same state as at age 16, or living in a different state than at age 16. (Noninteracted moving dummies are also included.) There are 7,612 stayers, 4,776 in-state movers, and 5,791 out-of-state movers in the main sample. In the first two columns the dependent variable is a dummy variable that equals one if a respondent says "we're spending too little money" on improving and protecting the environment. The last two columns index responses on the current level of environmental spending from one to three where three indicates that spending is "too high," two indicates that it is "about right," and one indicates that it is "too little." That last row in each column reports the p-value of a Wald test of the null hypothesis that the three rain-on-Earth-Day coefficients are equal.

We make several observations. First, for the under-20 sample, the coefficients are all similarly sized, and across all specifications, the Wald tests cannot reject the hypothesis that the coefficients are equal. This is evidence against a story where migrants play no role in Earth Day: our results indicate that the conditions on Earth Day in one's current community matter, even if one is a migrant. Second, across all specifications, the out-of-state-mover coefficients are statistically insignificant while the in-state-mover results are larger in absolute value and (for the under-20 sample) more precise. The fact that in-state movers have stronger results than out-of-state movers could be explained several ways. For example, rainfall in the community of residence could be a better proxy for Earth Day conditions for nearby movers; alternately, nearby movers could have different information or different abilities to sort than out-of-state movers when choosing a destination within a state (e.g., within a metropolitan area). However, we take this result as suggestive, as the coefficients are not precise enough to confirm any potential difference between the two groups.

Next, the results also suggests that mobility is not the only channel by which Earth Day affects outcomes; if it were, then we would then expect the stayers' coefficient to be zero. We also explored whether rain on Earth Day was related to the change in total county population between 1970 and 1975, 1980, or 1985; in all cases county population growth was unrelated to rain on Earth Day. We thus do not observe a direct mobility affect while we do observe opinion effects and county-wide pollution and child health effects from Earth Day. Together, these results do not support simple stories where migration plays no role in Earth Day or is the driving factor behind Earth Day. Rather, the results are potentially more consistent with a story of values adoption or selective migration among movers as well as enduring effects among nonmovers. We leave further investigation of these alternatives to future work.

Individuals' differential responses to technological change could also influence dynamics. For instance, the introduction of the catalytic converter reduced carbon monoxide emissions from automobiles starting with model year 1975 vehicles in the United States; there were other changes that also increased the availability of lower-emission vehicles at this time.[17] Overall, there was a 40 percent reduction in carbon monoxide emissions from the average car in operation, both new and old, between 1970 and 1975 (MVMA 1976). In comparison, the average individual in our sample saw mean carbon monoxide of 2.4 in 1975, so Figure 7 suggests that a one–standard-deviation change in rainfall leads to about an 8 percent of the mean difference in carbon monoxide that year.[18] Other factors could also matter for Figure 7, such as the possibility that the effects of Earth Day decayed over time (and potentially did so differently for those who were older on Earth Day versus those who were younger). Overall, the main takeaways from Figure 7 are that the effects of volunteer activity may be very long lasting, that these effects may at first appear negligible and then become visible only several years after the activity takes place, and that several plausible stories are consistent with these results.

V. Conclusion

In this paper we show that ordinary people, taking volunteer action, can come together on a single day to alter the the values, cleanliness, and health of their communities for years to come. We show that this happened on April 22, 1970. The effects of this activism were long lasting and in some cases only became statistically significant after several years.

Prior work has shown long-term effects of environmental policy on health and well-being, but as noted earlier, this is typically done through a fetal-origins argument. Our focus, showing a hysteresis-style effect wherein a temporary event affects cohorts born later, is different. If such effects apply to other temporary events (e.g., retrenched environmental policies), an implication would be that pre–post comparisons of cohorts born before and after an event or policy ends could produce biased estimates (likely biased toward zero, as "control groups" in the post period would still reflect the treatment), although we do not test for that possibility here.

[17] For example, new EPA regulations and external forces such as the 1970s oil embargo both led to more fuel-efficient vehicles in production (Kahn 1976).

[18] How relevant might those under age 20 on Earth Day be for the result in Figure 7? Suppose there are two types of drivers—old and young—and that both pollute at rate z, but that if treated by Earth Day the young pollute at rate $z \times e$. Drivers who had been under the age of 20 on Earth Day made up about one-fourth of all drivers by 1975 (MVMA 1976). Thus, an 8 percent effect means $(0.75z + 0.25z) \times 0.92 = 0.75z + 0.25z \times e$, or $e = 0.68$. If young drivers respond to Earth Day with a ~ 30 percent change in emissions, this could drive Figure 7. As noted above, this would actually be smaller than the overall change in emissions observed for the average car during this period (and assumes no change in other behavior or from other individuals). This suggests young drivers could plausibly have played an important role in changing pollution in 1975.

These results also change the story of Earth Day itself, showing that Earth Day had previously unnoticed, highly local, and enduring impacts. These results, however, do not refute the importance of Earth Day in promoting national change through the adoption of federal policies such as the passage of the Endangered Species Act. Accounting for these national benefits, which are likely independent of local rainfall and which our estimates thus do not include, would make the social benefits of Earth Day greater still. Whether these results will hold for other mass demonstrations, we cannot say. Applying the approach here to other large-scale volunteer events represents an excellent idea for future research.

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