Political influences on greenhouse gas emissions from US states

Thomas Dietz[a,1], Kenneth A. Frank[b], Cameron T. Whitley[c], Jennifer Kelly[c], and Rachel Kelly[c]

[a]Department of Sociology, Environmental Science and Policy Program, Center for Systems Integration and Sustainability, Michigan State University, East Lansing, MI 48823; [b]Department of Counseling, Educational Psychology and Special Education, Department of Fisheries and Wildlife, Center for Systems Integration and Sustainability, Michigan State University, East Lansing, MI 48823; and [c]Department of Sociology, Environmental Science and Policy Program, Michigan State University, East Lansing, MI 48823

Edited by William C. Clark, Harvard University, Cambridge, MA, and approved May 15, 2015 (received for review September 18, 2014)

Starting at least in the 1970s, empirical work suggested that demographic (population) and economic (affluence) forces are the key drivers of anthropogenic stress on the environment. We evaluate the extent to which politics attenuates the effects of economic and demographic factors on environmental outcomes by examining variation in CO_2 emissions across US states and within states over time. We find that demographic and economic forces can in part be offset by politics supportive of the environment—increases in emissions over time are lower in states that elect legislators with strong environmental records.

greenhouse gas emissions | human drivers | environmentalism | STIRPAT | multi-level models

What drives human impacts on the environment? Why do geopolitical units such as nation-states or the states and provinces within them differ in the stress they place on the environment? From the initial scientific debates on these questions to the most recent reviews, economic and demographic factors are identified as the dominant driving forces of environmental impact (1–4). Even as the emissions scenarios and representative emissions pathways that drive climate models have become more sophisticated, population and affluence are still at their core (5). However, a diverse set of theories and supporting empirical evidence suggest that the effects of economic activity and population size might be mitigated by other factors. These arguments, including ecological modernization, treadmill of production, environmental Kuznets curve, world systems, neo-structuralism, and commons management theories, are complex and subtle (6–11). However, the importance of politics is a common theme in each of them, as well as the focus of a substantial literature in its own right. Some approaches focus on how institutions, including laws and treaties, shape the actions of individuals, organizations and nations (9, 12–15). Others emphasize the dynamics of political power (6–8, 16–20). As Shwom argues, who has power influences what polices, programs, and institutions are in place to moderate or exacerbate how human actions influence the environment–political factors are part of what are commonly called the driving forces of environmental change (21).

We use greenhouse gas emissions of US states to examine the potential moderating role of politics on the more frequently examined drivers of environmental stress. We make this choice for several reasons. First, greenhouse gas emissions are a critical environmental stressor that influences the climate—a global commons. Explaining variation in emissions is thus an appropriate challenge for a theory of anthropogenic environmental change. Second, in the absence of strong US national policy on climate change, states have varied substantially in the actions they have taken to limit emissions, potentially reflecting differences in the distribution of political power and political ideology (22). Third, the concepts we wish to address can be operationalized with well measured variables available for all 50 states over a reasonable span of time.

What Drives Human Stress on the Environment?

The quantitative literature examining the human driving forces of environmental stress is consistent in the finding that, at least at the level of geopolitical units such as states, provinces, or nation-states, the size of the human population and its level of affluence, usually measured as gross domestic product per capita (GDPPC), are dominant influences (2, 4, 23, 24). Taken together, GDPPC and population compose the scale of the economy. Of course, the impacts of the scale of economic activity, and in particular of economic growth, could be ameliorated by changes in the composition of consumption and in the mix of technologies used.

Our hypothesis is that the extent to which scale is moderated by the composition of consumption and the technology of production will depend on politics. The importance of politics is one of the basic ideas that emerge from the debates about human drivers of environmental stress in the social science literature. In particular, Shwom argues that when the environmental movement is influential and its goals are widely accepted, environmental reforms are possible and thus we would expect some mitigation of the effects of scale. However, when the environmental movement is not influential and its goals are not widely accepted, little amelioration of environmental stress can be expected (21).

The US environmental movement is diverse and has evolved substantially over its long history. Different elements of the contemporary movement focus on different environmental issues (25, 26). However, nearly all environmentalists express deep concern about climate change and urge reduction in greenhouse gas emissions through shifts in policy, shifts in the composition of

Significance

Population and affluence have long been seen as major drivers of environmental stress. A substantial empirical literature now substantiates their role in anthropogenic environmental change. Using data on greenhouse gas emission from US states, we show that the effects of population and affluence can be substantially moderated by political factors and in particular support for environmentalism. Our results indicate the potential of politics to ameliorate the effects of the scale of economic activity on the environment and our methods provide a vehicle for testing the influence of diverse hypothesized human drivers of environmental change.

Author contributions: T.D., K.A.F., and C.T.W. designed research; T.D., K.A.F., C.T.W., J.K., and R.K. performed research; K.A.F. contributed new analytic tools; T.D., K.A.F., and C.T.W. analyzed data; and T.D., K.A.F., C.T.W., J.K., and R.K. wrote the paper.

The authors declare no conflict of interest.

This article is a PNAS Direct Submission.

Freely available online through the PNAS open access option.

[1]To whom correspondence should be addressed. Email: tdietz@msu.edu.

This article contains supporting information online at www.pnas.org/lookup/suppl/doi:10.1073/pnas.1417806112/-/DCSupplemental.

consumption, and shifts in the technologies of production. Thus, we would expect that environmentalism—the strength of the environmental movement and the acceptance of its goals on the part of the public and elites—to be the major counterbalance to the political forces opposed to considering environmental costs of greenhouse gas emissions.

It may seem obvious that a strong and well-accepted environmental movement will lead to a reduction in human impacts on the environment and in particular to a reduction in greenhouse gas emissions. However, some recent commentators have been skeptical of the effectiveness of the environmental movement especially with regard to climate change (27, 28). They point to the failure of a coalition of major environmental organizations in promoting a national "cap and trade" policy to reduce US greenhouse gas emissions. However, efforts to mitigate emissions take a variety of forms at the state and local level and may have substantial impact even in the absence of a unified national policy (22). The details of how these politics play out will vary over time and across contexts. New laws can be enacted that regulate or subsidize technologies, existing regulations can be applied strictly or less stringently, and programs can be pursued enthusiastically or given a low priority. Even without formal policy and programs, the importance of reducing emissions can be widely accepted by individuals and organizations and result in actions that have substantial impact (29). Our approach here is not to examine the details of the policies adopted and their implementation, nor to examine in detail the behavior of households and organizations. Rather we measure the "total" effects of power and ideology, acting both directly and indirectly through policies and behavioral change. If arguments of Shwom and others who emphasize politics are correct, we anticipate that the distribution of political power in a state will have an impact on greenhouse gas emissions net of the primary demographic and economic drivers of population and affluence. Thus, we are proposing that ideology and the distribution of power, and in particular the strength of the environmental movement and acceptance of its goals, will have an effect on the biophysical environment.

Driving Greenhouse Gas Emissions

We assess the drivers of environmental impact using the Stochastic Impacts by Regression on Population, Affluence, and Technology (STIRPAT) model, a widely used approach to examining the human drivers of environmental change (30, 31). Models of emissions and other environmental stresses commonly include both population size and per capita affluence in a multiplicative functional form along with variables that might moderate the effects of these two drivers as predictors of stress placed on the environment (30–32). Following this approach, we model state greenhouse gas emissions as a multiplicative (additive in logs) function of the state's population and affluence per capita. Thus, our fundamental model for state s at time t is

$$E_{st} = aP_{st}^{b}A_{st}^{c} \ldots e_{st}. \qquad [1]$$

That is, greenhouse gas emissions (E) for a particular state for a particular year are the product of the size of the human population (P), the per capita affluence (A), a constant term a that scales the relationship, a variety of other potentially moderating factors we will discuss below, and an error term that is state and time period specific. This functional form is the well-known IPAT (impacts = population × affluence × technology) or Kaya identity modified to allow for statistical estimation (30, 33–35). In the models estimated below, following standard practice we include a quadratic term in the log of affluence to capture the potential ameliorating effects of high levels of affluence, a pattern suggested by several theories of the dynamics of environmental stress, in particular ecological modernization and environmental Kuznets theories (6, 10, 11). The approach for considering both within and across state variation is discussed in *Materials and Methods*.

We added two variables to this well-established model. One is environmentalism as captured by the environmental voting record of the state's Congressional delegation. We use the term environmentalism to indicate the degree to which the environmental movement's goals are accepted by the public and by elites and thus are likely reflected in the politics of a state. Our use of legislative behavior is consistent with the most common approaches to assessing the political ideology of a state, described in *Materials and Methods*. This indicator captures Shwom's argument that when the environmental movement is strong, the effects of population and affluence on the environment will be moderated, but when the environmental movement is weak, there will be no moderation of the effects of overall economic activity ($P \times A$).

We also included the rate of employment in our model. Although GDPPC, and its state level analog, gross state product per capita (GSPPC), are the most commonly used measures of affluence in work assessing drivers, we explore the level of employment as an alternative. Because gross state product is defined in terms of financial transactions, it may capture many activities that have minimal direct environmental impact. To allow for this possibility, several cross-national studies have predicted emissions using the proportion of the economy in the service sector, although generally these effects have been small and not statistically significant (2). The proportion of the labor force actively working may be a better indicator than the size of the service industry for capturing economic activity that is environmentally consequential both because labor intensive industries may be more polluting and because employment leads to increased consumption, including commuting, and with it increased emissions net of affluence. We also note that for several decades, the argument that environmental reforms harm the economy and in particular cost jobs, has frequently been deployed in opposition to environmental, and in particular climate, policy. To the extent that this argument has political traction, then high employment might reduce barriers to environmental reforms, an effect opposite in sign to what we would expect if high employment leads to increased consumption and thus increased demand on the environment.

We consider two conceptualizations of the relationship between greenhouse gases and the independent variables (population, gross state product per capita, environmentalism, employment). First, it may be that states that have larger populations, higher GSPPC, weaker and less broadly accepted environmental movements, and higher employment have higher greenhouse gas emissions. Effects of state-level cross-sectional characteristics such as population would reflect an accumulation of the effects of the independent variables over time and would suggest comparison across states. Alternatively, one might argue that as a given state experiences short-term changes in population, GSPPC, environmentalism, and employment, its greenhouse gas emissions will also change. Effects of short-term changes within the state would suggest a comparison of conditions within each state over time.

The two approaches described above reflect different conceptions of the counterfactual—what would have happened under other circumstances—bases for making causal inferences. In the first case of comparison across states, a given state is compared with concurrent others that are similar on the characteristics in the model. In the second case, a given state is compared with itself in earlier or later years. Because both the inter- and intrastate comparisons are reasonable counterfactuals, we estimate a multilevel model consisting of time points t nested within states s. The within state model of time points (level 1) allows us to evaluate whether changes in a state's conditions increase or decrease emissions (we also include a time trend variable in this model), whereas the model between states (level 2) allows us to estimate the relationship between state level characteristics and emissions in a given year.

Other Influences on Environmental Protection

The key variable that we anticipate will moderate the effects of population and affluence is the strength and acceptance of the environmental movement. However, we will consider several other political factors that might mediate greenhouse gas emissions by including them in our state-level model. Because of the moderate number of degrees of freedom at the state level (50 df), we included potential influences one variable at a time as a robustness check on the effects of the variables that are our main focus: scale of the economy and environmentalism.

Political Ideology. The traditional split in US politics between liberals and conservatives might have a substantial effect on consumption patterns, production technologies, and environmental policies in a state. Over the last few decades, conservatives have been markedly opposed to regulation to protect the environment and indeed often challenge the seriousness of environmental problems and climate change in particular (36, 37). Thus, the balance of power between liberals and conservatives in a state might influence the degree to which steps are taken to mediate greenhouse gas emissions.

Women's Empowerment. It has long been noted that in the United States, white males express less concern with the environment than do women or minorities (38–41). We conjecture that the relative power in state government of women and minorities vs. white men may influence the degree that environmental issues are given attention. Data limitations force us to examine only the power of women, which we capture with the proportion of legislative seats held by women.

Unionization. The labor movement was instrumental in the founding of the new environmental movement of the late 20th century (42). The passage of some of the major legislation to reduce air and water pollution in the United States had strong labor support, with unions arguing that workers and their families were the most exposed to air and water toxins. However, as debate moved from problems that had substantial local impact to problems that addressed national and global commons, in the United States at least, labor has become less supportive of environmental protections. For example, some unions view policies to limit greenhouse gas emissions with suspicion because they may reduce employment. Some unions have opposed cap and trade for emission reduction, whereas others have been supportive (43, 44). Thus, we cannot anticipate the sign of the relationship between the strength of labor and action on climate change. We include the strength of labor, measured as the percent of workers unionized, in our analysis to see if these contradictory tendencies in the labor movement yield a net result that either increases or decreases greenhouse gas emissions.

Results

Table 1 displays the results of our model, which is a two-level regression with all variables except the time trend in log form. At level 1, population has a coefficient near 1. Because the model is in multiplicative form, it implies that a 1% increase in population will, ceteris paribus, lead to a 0.94% increase in greenhouse gas emissions. This effect is consistent with estimates of population elasticity in most cross-national analyses (2, 24). The combined effects of the linear and quadratic term in log affluence suggest an environmental Kuznets curve, in which greenhouse gas emissions increase with growing affluence but begin to decline at high levels of affluence, an inverted U pattern. Our method allows each state to have its own turning point for the effect of affluence, with the mean across states at $22,749 per person. By 2005, every state except Alaska (which has experienced a decrease in inflation-adjusted GSPPC) had passed its inflection point. Our other measure of affluence, employment rate, has a strong effect and is significant. Each 1% increase in employment leads to a 1.21% increase in emissions. The overall time trend is positive, indicating a tendency toward increased emissions, net of other factors. Environmentalism per se does not have an effect at this level. However, the interaction of environmentalism with time substantially counteracts the general time trend. A 1% increase in environmentalism more than neutralizes (–0.0069) the typical annual increase (0.0047) in emissions.

Table 1. Multilevel model of greenhouse gas emissions

Variable	Coefficient	Standard error
Level I (T =16 × 50 = 800)		
Population	0.9394***	(0.0858)
Gross state product per capita (linear)	0.1170	(0.0869)
Gross state product per capita (quadratic)	−2.6635***	(0.6761)
Employment rate	1.2066**	(0.3815)
Environmentalism	−0.0069	(0.0092)
Time	0.0047***	(0.0010)
Time × environmentalism (1990)	−0.0069***	(0.0014)
Level II (n = 50)		
Population	0.8880***	(0.0614)
Gross state product per capita (linear)	−0.0458	(0.2898)
Employment rate	−3.5177	(5.0569)
Environmentalism	−0.4539***	(0.1116)
Intercept	1.8357***	(0.0246)

**P < 0.01; ***P < 0.001.

The between-state results suggest that population differences between states may be as strong a driver of differences in greenhouse gas emissions as changes in population within a state overtime, with a 1% difference in population associated with a 0.89% difference in emissions. Neither GSPPC nor employment rate has a statistically significant effect on differences across states in emissions. In Table S1, we provide estimates for a model that includes a quadratic term in population for the between states model. It was not significant and did not change in any noteworthy way other estimates or inferences. Environmentalism has a relatively strong negative effect on differences in emissions between states. A 1% increase in environmentalism has more than half the effect of a 1% increase in population. Although increasing population size tends to increase stress placed on the environment, a strong and widely accepted environmental movement can substantially countervail against that pressure.

We used three approaches to check for the robustness of these findings. First, we added political ideology, women's political enfranchisement, and union strength to the state level model (level 2). These controls were added one at a time to preserve degrees of freedom. None of these potential moderators of the effects of growth had significant effects, net of the other variables at level 2. Moreover, including these controls did not change inferences for the effect of population or environmental movement strength. So the effects of environmental movement strength are not spurious as a result of correlation with these other possible explanations. Detailed results are presented in Tables S2–S4.

Second, any inference of an effect of population, GSPPC, or environmental orientation on greenhouse gas emissions depends on the basis of comparison. Inferences from the within state model are based on a comparison of a state with itself at different times. Inferences from the between state model are based on the comparison of a state with other states that are similar on the variables in the model. Either comparison could be flawed if

SUSTAINABILITY SCIENCE

there is some factor that is responsible for changes in the independent and dependent variables. For example, a given state might experience a change in the mix of industries in the economy that would be responsible both for a reduction in pro-environmental dispositions and an increase in greenhouse gas emissions. Similarly, between states, one state may have weaker environmental dispositions and greater greenhouse gas emissions than another precisely because of the historic presence of some industries rather than others.

In each of the examples above, an inference regarding the effect of an independent variable (e.g., environmentalism) on the outcome (greenhouse gas emissions) could be invalid because of a variable omitted from the analysis (e.g., industrial composition). One response is to identify all such possible variables and include them in the model, as we have attempted to do here. However, there may still be concerns about possible omitted variables. In response to the problem of omitted variables, we quantify the robustness of our inferences to the impact of an omitted variable. Frank defines the impact of a confounding variable on an estimated regression coefficient as impact = $r_{k\bullet y} \times r_{k\bullet x}$, where $r_{k\bullet y}$ is the correlation between a confounder, k, and the outcome, y, and $r_{k\bullet x}$ is the correlation between k and x, a predictor of interest–environmentalism (45). Then, for a given threshold for inference, $r^{\#}$ (such as statistical significance), it is possible to calculate how large the impact of an omitted variable must be to invalidate an inference (although extensions of this logic to multilevel models can be complicated, they are simplified in the case of balanced data, as we have here, with equal numbers of observations per state) (45–47). In our analysis, an omitted variable would have to have an impact of −0.334 to invalidate the inference of an effect of environmentalism on greenhouse gas emissions across states (the level 2 model). Correspondingly, the omitted variable would have to be correlated with environmentalism and with greenhouse gas emissions at a level of 0.578 or greater to invalidate our inference (and the correlations would have to take opposite signs). As a basis of comparison, of the control variables, women's political enfranchisement had the strongest impact on the estimated effect of environmentalism on emissions. Women's political enfranchisement was correlated 0.255 with environmental movement strength and −0.476 with emissions for an impact of 0.255 × (−0.476) = −0.121 (the negative impact would reduce the negative effect of environmentalism on emissions). Thus, to invalidate our inference of an effect of environmentalism on emissions, an omitted variable would have to have more than 2.5 times stronger impact than our strongest tested covariate, women's political enfranchisement.

Of course, our results are based on the features of states embedded in the US federal system of government and current US politics, so these processes may play out differently elsewhere. As a third check, we can quantify the robustness of our results with respect to populations or policies not represented in our data. Consider a population that is 50% American states and 50% from some other political entity such as European provinces or other administrative divisions, where different causal processes unfold. The correlation between environmentalism and CO_2 emissions would have to be −0.06 in the other entities to invalidate the inference that environmental orientation has an effect on CO_2 emissions in the hypothetical combined data (48). The hypothetical correlation of −0.06 in the other unobserved entities is compared with the estimated correlation of −0.53 between environmental orientation and CO_2 emissions, partialed for covariates, in our data. Given this formulation, the combined data would have a correlation of −0.3, which would be at the threshold for statistically significant ($P = 0.05$) given our sample size. Thus, the phenomenon would have to be markedly different between the two regions to invalidate a general inference of an effect across regions. Alternatively, one would have to replace 44% of our data with the null hypothesis cases (no effect of environmentalism on emissions) to invalidate our inference.

Discussion

Our findings replicate those of analyses running back four decades—that population and affluence are dominant drivers of greenhouse gas emissions. For US states, affluence in the form of higher levels of employment, net of GSPPC, also increases emissions. There is also evidence for an environmental Kuzents curve acting over time, with higher levels of affluence ameliorating emissions. Given the population growth that is anticipated over the next decades and the strong consensus in the United States for employment growth, the ameliorating effects of GSPPC alone are not likely to counterbalance the forces pushing for greater emissions. It is possible that the curvilinear relationship of emissions with affluence is the result of emissions being displaced from higher to lower income states so that there is no overall amelioration from economic growth. Population growth also has a between-state effect, suggesting that high levels of population lead to what might be considered "diseconomies of scale"—even worse impacts than the strictly multiplicative effect of population would predict.

All of this suggests that "business as usual" growth in population and affluence will substantially increase anthropogenic environmental stress. However, the effect of environmentalism is a potentially powerful mediating factor. By counteracting the time trend toward increased emissions and by moderating the overall effect of population and affluence, environmentalism seems to have been effective at reducing greenhouse gas emissions below levels that would otherwise have occurred. Thus, even as efforts to establish a national policy to limit emissions have yet to be implemented, at the state level, it appears that a strong and broadly accepted environmental movement does produce a mix of shifts in policy, consumption patterns, and production practices that slows emissions. Our analysis cannot unpack the details of how those effects play out, as they will vary from state to state. Across US states, there is an eclectic mix of policies that influence greenhouse gas emissions. For example, even ostensibly similar policies such as state renewable energy portfolio standards differ in their target levels, their deadlines, and their definitions of renewable. We consider detailed policies and regulations as intervening variables that lie causally between environmentalism and environmental outcomes. Because of the diversity of policy and regulatory details, we do not try to disentangle their effects, a problem best handled by case studies. However, our results do counter the assessment that the environmental movement has been ineffective in dealing with climate change. Of course, the political system and institutional arrangements of the US federal system are quite different from those in most other industrial nations, so our results might not generalize either to the dynamics within another nation or to cross-national differences. Further comparative research is certainly warranted, including research that examines the effect of institutional arrangements on environmental stress within and across nations.

A strong environmental movement can open space in policy systems for advocacy coalitions to influence decision making (19, 21). The result might be a mix of energy efficiency standards or subsidies, renewable portfolio standards, transportation policies, building codes, emissions prices, shifting norms about energy use and greenhouse gas emissions, or any of a variety of other changes. Existing approaches to understanding public and private environmental policy can help elucidate the processes that underpin the dynamics we identify.

Our results emphasize the importance of taking into account political factors in analyzing human stress placed on the environment. Although population and affluence remain strong drivers, factors that may mediate or exacerbate their effects should be examined. It appears that solutions to environmental problems do not emerge more or less automatically as growth occurs, quite the opposite, it takes a strong movement presence to counteract the effects of growth.

Materials and Methods

Units of Analysis. Using US states as the unit of analysis provides a useful context in which to examine the effects of political power on the environment. The federal system of the United States allows considerable variance in political economy across states, but always in the context of a national economy, national laws, and national political institutions that provides a common playing field for political action across states. For our purposes, this is a clear advantage over cross-national comparisons where very substantial differences in political context, economic structure, and institutions make comparisons more difficult.

Model Structure. Because we are interested in how environmentalism moderates the effects of the scale of the economy in driving environmental impacts, we estimated hierarchical models. At level 1, we model changes within a state from a base year (1990, the first year in our data series) in greenhouse gas emissions as a function of population, GSPPC (in linear and quadratic form), the employment rate, environmentalism, a linear time trend variable, and the interaction between time and environmentalism. At level 2 (the state level), we model the intercept in the level 1 model as a function of population, GSPPC, employment rate, and environmentalism. Including these variables at level 1 and level 2 allows us to estimate effects that differentiated the states at baseline (1990), as well as how each state evolved over time.

Because we have only 50 states, we have added political ideology, women's political power, and unionization one variable at a time to level 2 of the model. None of these variables proved statistically significant (and did not alter our interpretations) so we report the results of these models in Tables S2–S4 rather than in the main text. Although these aspects of the distribution of power in a state may have some effect, it must be indirect, given their lack of significance when environmentalism and scale of the economy are controlled.

Operationalizing the Variable.

Greenhouse gas emissions. The dependent variable, greenhouse gas emissions, was obtained from the Environmental Protection Agency (EPA) (49). They are estimates of the total CO_2 emissions from fossil fuel combustion, which includes commercial, industrial, residential, transportation, and electric power. Data have been prepared annually since 1990 as part of the national greenhouse gas inventory report. The greenhouse gas emissions data are measured in million metric tons of CO_2.

Population and affluence. Population and affluence together indicate the scale of economic activity in a state. Our data are from the US Bureau of Economic Analysis and are in constant 1990 dollars (50, 51). In 1997, there was a shift in how GDP was calculated, and we corrected for this shift (*SI Appendix*). The employment rate is the complement of the unemployment rate and was obtained from the US Bureau of Labor Statistics (52).

Environmentalism. In research on the influence of political ideology on state policy and politics, the best-established procedure is to use the ideology of the Congressional delegation as a measure of ideological power within the state (53, 54). [A parallel approach has used participation in environmental treaties to estimate the environmental disposition of nation states (55–57).] The logic is that members of Congress are elected by the population of the state, shape, and are shaped by the overall politics of the state and wield power directly in Congress and indirectly through the dynamics of state politics. Therefore, the ideology of members of Congress reflects the strength of ideological positions in multiple ways. Thus, standard measures of state political ideology are based on the ratings of Congressional voting made by advocacy groups. We followed this approach in using pro-environmental voting by the state's Congressional delegation to assess the strength and acceptance of the environmental movement in the state. The League of Conservation Voters compiles a score, ranging from 0 to 100, for each member of Congress in each Congress based on her or his votes on environmental issues as identified by the League (individual reports cited in *SI Appendix*) (58). The state averages for their Senate delegation and their House delegation are compiled by the League. Our measure is the average of the House and Senate scores.

Ideology. We construct a composite measure of the strength of conservative vs. liberal ideology using three measures well accepted in the literature on state politics: citizen ideology, legislative ideology, and state spending patterns (53, 54, 59). To enhance reliability, compensate for idiosyncrasies that might influence any single measure, and preserve degrees of freedom, we created an additive composite of these three measures. The resulting measure has $\alpha = 0.616$. Details on construction of the composite are in *SI Appendix*.

Unionization. Unionization is the percent of all workers who are union members and was obtained from Hirsch and Macpherson (60).

Women's political power. To measure the political power of women, we use the proportion of seats in the state legislature held by women. Data were obtained from the Center for American Women in Politics (61).

Dataset. We use balanced panel data on US states from 1990 to 2007 to estimate the model. We have 15 observations for each state resulting in 750 observations (15 × 50 states). Data availability precludes the inclusion of years before 1990.

Model and Estimation Methods. The model for the greenhouse gas emissions of state s at time t is as follows (all raw variables in log10):

$$\text{Green House Gas Emissions}_{st} = \beta_{0s} +$$

$$\beta_{1s}\,(\text{population} - \text{population at 1990})_{st} +$$

$$\beta_{2s}\,(\text{GSPPC} - \text{GSPPC at 1990})_{st} +$$

$$\beta_{3s}\,(\text{GSPPC} - \text{GSPPC at 1990})^2_{st} +$$

$$\beta_{4s}\,(\text{employment rate} - \text{employment rate at 1990})_{st} +$$

$$\beta_{5s}\,(\text{environmentalism} - \text{environmentalism at 1990})_{st} +$$

$$\beta_{6s}\,(\text{time})_{st} +$$

$$e_{st}$$

$$\beta_{0s} = \gamma_{00} + \gamma_{01}\,\text{population in 1990}_s + \gamma_{02}\,\text{GSPPC in 1990}_s + \gamma_{03}\,\text{employment rate in 1990}_s + \gamma_{04}\,\text{environmentalism in 1990}_s + u_{0s}$$

$$\beta_{1s} = \gamma_{10}$$

$$\beta_{2s} = \gamma_{20}$$

$$\beta_{3s} = \gamma_{30}$$

$$\beta_{4s} = \gamma_{40}$$

$$\beta_{5s} = \gamma_{50}$$

$$\beta_{6s} = \gamma_{60} + \gamma_{61}\,\text{environmentalism in 1990}_s.$$

For example, γ_{01} represents the effect of a state's population level in 1990, whereas γ_{10} represents the average value of β_{1s}, representing the effect of the deviation of a state's population level from its average value. The errors at level 1, e_{st}, are assumed normal (0, σ^2), and the u_{0s} are assumed normal (0, τ_{00}).

Note that the time level predictors are deviated from their 1990 values, defining the intercept, β_{0s}, as the emissions in 1990. The level 2 model then predicts emissions in 1990 as a function of attributes of the state in 1990. The model was estimated as a multilevel model using the HLM software (62).

1. Ehrlich PR, Holdren JP (1971) Impact of population growth. *Science* 171(3977): 1212–1217.
2. Rosa EA, Dietz T (2012) Human drivers of national greenhouse gas emissions. *Nature Climate Change* 2(8):581–586.
3. Dietz T, Rosa EA, York R (2010) Human driving forces of global change: Examining current theories. *Human Footprints on the Global Environment: Threats to Sustainability*, eds Rosa EA, Diekmann A, Dietz T, Jaeger C (MIT Press, Cambridge, MA), pp 83–132.
4. Levy MA, Morel AC (2012) Drivers. *Global Environmental Outlook 5*, ed United Nations Environment Programme (United Nations Environment Programme, Nairobi, Kenya), pp 3–30.
5. Van Vuuren DP, et al. (2011) The representative concentration pathways: An overview. *Clim Change* 109(1-2):5–31.
6. Mol AP, Spaargaren G, Sonnenfeld DA (2014) *Ecological Modernization Theory: Taking Stock, Moving Forward* (Routledge International Handbook of Social and Environmental Change, New York).
7. Schnaiberg A (1980) *The Environment: From Surplus to Scarcity* (Oxford Univ Press, New York).
8. Jorgenson AK, Givens J (2014) The emergence of New World-systems perspectives on global environmental change. *The Routledge International Handbook of Social and Environmental Change*, eds Lockie S, Sonnenfeld DA, Fisher D (Routledge, New York), pp 31–44.
9. Ostrom E (2010) Polycentric systems for coping with collective action and global environmental change. *Glob Environ Change* 20(4):550–557.
10. Kaika D, Zervas E (2013) The environmental Kuznets curve (EKC) theory—Part A: Concept, causes and the CO2 emissions case. *Energy Policy* 62(0):1392–1402.

11. Kaika D, Zervas E (2013) The environmental Kuznets curve (EKC) theory. Part B: Critical issues. *Energy Policy* 62(0):1403–1411.
12. Held D, Hervey A (2011) Democracy, climate change and global governance: Democratic agency and the policy menu ahead. *The Governance of Climate Change*, eds Held D, Fane-Hervey A, Theros M (Polity Press, Cambridge, UK), pp 89–110.
13. Dryzek JS, Stevenson H (2014) *Democratizing Global Climate Governance* (Cambridge Univ Press, Cambridge, UK).
14. Biermann F, et al. (2012) Science and government. Navigating the anthropocene: improving Earth system governance. *Science* 335(6074):1306–1307.
15. Young OR (2011) Effectiveness of international environmental regimes: Existing knowledge, cutting-edge themes, and research strategies. *Proc Natl Acad Sci USA* 108(50):19853–19860.
16. Carter NT (2013) Greening the mainstream: Party politics and the environment. *Env Polit* 22(1):73–94.
17. Carter NT (2014) The politics of climate change in the UK. *WIREs Climate Change* 5(3):423–433.
18. Hess DJ, Coley JS, Mai QD, Hilliard LR (2015) Party differences and energy reform: Fiscal conservatism in the California legislature. *Environ Politics* 24(2):228–248.
19. Henry A, Vollan B (2014) Networks and the challenge of sustainable development. *Annu Rev Environ Resour* 39:583–610.
20. Henry AD (2011) Ideology, power, and the structure of policy networks. *Policy Stud J* 39(3):361–383.
21. Shwom RL (2011) A middle range theorization of energy politics: The U.S. struggle for energy efficient appliances. *Env Polit* 20(5):705–726.
22. US National Research Council (2010) *Limiting the Magnitude of Climate Change* (National Academy Press, Washington, DC).
23. Jorgenson AK, Clark B (2012) Are the economy and the environment decoupling? A comparative international study, 1960-2005. *Am J Sociol* 118(1):1–44.
24. Jorgenson AK, Clark B (2010) Assessing the temporal stability of the population/environment relationship in comparative perspective: A cross-national panel study of carbon dioxide emissions, 1960–2005. *Popul Environ* 32(1):27–41.
25. Brulle R (2000) *Agency, Democracy and the Nature: The U.S. Environmental Movement from a Critical Theory Perspective* (MIT Press, Cambridge, MA).
26. Kline B (2011) *First Along the River: A Brief History of the U.S. Environmental Movement* (Rowman and Littlefield, Lanham, MD), 4th Ed.
27. Skocpol T (2013) Naming the problem: What it will take to counter extremism and engage Americans in the fight against global warming. *Paper prepared for the Symposium on the Politics of America's Fight against Global Warming, Harvard University, January 2013*. Available at www.scholarsstrategynetwork.org/sites/default/files/skocpol_captrade_report_january_2013y.pdf. Accessed May 26, 2015.
28. Luers A (2013) Rethinking US climate advocacy. *Clim Change* 120(1-2):13–19.
29. Dietz T, Gardner GT, Gilligan J, Stern PC, Vandenbergh MP (2009) Household actions can provide a behavioral wedge to rapidly reduce US carbon emissions. *Proc Natl Acad Sci USA* 106(44):18452–18456.
30. Dietz T, Rosa EA (1997) Effects of population and affluence on CO2 emissions. *Proc Natl Acad Sci USA* 94(1):175–179.
31. York R, Rosa EA, Dietz T (2003) Footprints on the earth: The environmental consequences of modernity. *Am Sociol Rev* 68(2):279–300.
32. York R, Rosa EA, Dietz T (2002) Bridging environmental science with environmental Policy: Plasticity of population, affluence and technology. *Soc Sci Q* 83(1):18–34.
33. Chertow M (2001) The IPAT equation and its variants: Changing views of technology and environmental impact. *J Ind Ecol* 4(4):13–29.
34. Waggoner PE, Ausubel JH (2002) A framework for sustainability science: A renovated IPAT identity. *Proc Natl Acad Sci USA* 99(12):7860–7865.
35. Kaya Y, Yokobori K (1997) *Environment, Energy, and Economy: Strategies for Sustainability* (United Nations Univ Press, New York).
36. McCright AM, Dunlap RE (2003) Defeating Kyoto: The conservative movement's impact on U.S. climate change policy. *Soc Probl* 50(3):348–373.
37. McCright AM, Dunlap RE (2010) Anti-reflexivity: The American conservative movement's success in undermining climate science and policy. *Theory Cult Soc* 27(2-3):100–133.
38. Stern PC, Dietz T, Kalof L (1993) Value orientations, gender and environmental concern. *Environ Behav* 25(3):322–348.
39. Kalof L, Dietz T, Guagnano GA, Stern PC (2002) Race, gender and environmentalism: The atypical values and beliefs of white men. *Race Gend Class* 9(2):1–19.
40. Davidson DJ, Freudenburg WR (1996) Gender and environmental risk concerns: A review and analysis of available research. *Environ Behav* 28(3):302–339.
41. Slovic P (1999) Trust, emotion, sex, politics, and science: Surveying the risk-assessment battlefield. *Risk Anal* 19(4):689–701.
42. Dewey S (1998) Working for the environment: Organized labor and the origins of environmentalism in the United States, 1948-1970. *Environ Hist* 3(1):45–63.
43. Markell B (2008) Cap and Trade Bill boosts jobs, helps environment: Rebuilding U.S. manufacturing. *Solidarity*. Available at www.uaw.org/story/cap-and-trade-bill-boosts-jobs-helps-environment. Accessed May 25, 2015.
44. Trisko EM (2009) Statement on behalf of the United Mine Workers of America, AFL-CIO Before the Committee on Energy and Commerce Energy and Environment Subcommittee U.S. House of Representatives April 23, 2009 "The American Clean Energy and Security Act of 2009." *Committee on Energy and Commerce, Energy and Environment Subcommittee U.S. House of Representatives* (Washington, DC).
45. Frank KA (2000) The impact of a confounding variable on a regression coefficient. *Sociol Methods Res* 29(2):147–194.
46. Seltzer M, Frank KA, Kim J (2006) Studying the sensitivity of inferences to possible unmeasured confounding variables in multisite evaluation studies. *CES Technical Report* (Center for Research on Evaluation, Standards and Student Testing, Los Angeles).
47. Frank KA, et al. (2008) Extended influence: National board certified teachers as help providers. *Educ Eval Policy Anal* 30(1):3–30.
48. Frank KA, Min K-S (2007) Indices of robustness for sample representation. *Sociol Methodol* 37(1):349–392.
49. US Environmental Protection Agency (2013) *State CO2 Emissions from Fossil Fuel Combustion, 1990-2011*. Available at epa.gov/statelocalclimate/resources/state_energyco2inv.html. Accessed June 5, 2014.
50. US Bureau of Economic Analysis (2009) *Gross Domestic Product by State: GDP & Personal Income All Industries: Regional Data, SIC 1963-1997*. Available at www.bea.gov/iTable/iTable.cfm?ReqID=70&step=1#reqid=70&step=1&isuri=1. Accessed February 24, 2014.
51. US Bureau of Economic Analysis (2009) *Gross Domestic Product by State: GDP & Personal ncome All Industries: Regional Data, NAICS 1997-2005*. Available at www.bea.gov/iTable/iTable.cfm?ReqID=70&step=1#reqid=70&step=1&isuri=1. Accessed February 24, 2014.
52. US Bureau of Labor Statistics (2013) *States and Selected Areas: Employment Status of the Civilian Noninstitutional Population, 1976 to 2012 Annual Averages*. Available at www.bls.gov/lau/staadata.txt. Accessed January 31, 2014.
53. Berry WD, Ringquist EJ, Fording RC, Hanson RL (1998) Measuring citizen and government ideology in the American States, 1960-1993. *Am J Pol Sci* 42(1):327–348.
54. Berry WD, Fording RC, Rinquist EJ, Hanson RL, Klarner C (2010) Measuring citizen and government ideology in the American states: A re-appraisal. *State Polit Policy Q* 10(2):117–135.
55. Dietz T, Kalof L (1992) Environmentalism among nation states. *Soc Indic Res* 26(4):353–366.
56. Roberts JT (1996) Predicting participation in environmental treaties: A world-systems analysis. *Sociol Inq* 66(1):38–57.
57. Roberts JT, Parks BC, Vásquez AA (2004) Who ratifies environmental treaties and why? Institutionalism, structuralism and participation by 192 nations in 22 treaties. *Glob Environ Polit* 4(3):22–64.
58. League of Conservation Voters (2013) *National Environmental Scorecard*. Available at scorecard.lcv.org/sites/scorecard.lcv.org/files/, various years. Accessed January 31, 2014.
59. Jacoby WG, Schneider SK (2009) A new measure of policy spending priorities in the American states. *Polit Anal* 17(1):1–24.
60. Hirsch B, Macpherson D (2013) *Union Membership, Coverage, Density, and Employment by State and Sector, 1983-2013*. Available at unionstats.gsu.edu/. Accessed January 31, 2014.
61. Center for American Women in Politics, Eagleton Institute of Politics (2014) *Women in State Legislature 1975-2012 Full Fact Sheet by Year*. Available at www.cawp.rutgers.edu/research/resources/archived_fact_sheets.php. Accessed January 31, 2014.
62. Raudenbush SW, Bryk AS, Congdon R (2004) *HLM 6 for Windows* (Scientific Software International, Lincolnwood, IL).