SOCIAL, POLITICAL, EARTH & ENVIRONMENTAL RESEARCH GROUP

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The Influence of Social Dominance Orientation on Public Support for Carbon Capture and Storage with the Risk of Induced Seismicity

2023 SPEER Survey Findings

Heather Bedle, Ph.D.
The University of Oklahoma

August 2024

CONTACT: speer@ou.edu

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The Influence of Social Dominance Orientation on Public Support for Carbon Capture and Storage with the Risk of Induced Seismicity

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Abstract

We present social survey findings regarding the influence of social dominance orientation (SDO) on public support for carbon capture, utilization, and underground storage (CCUS) technologies with the risk of induced seismicity. Using data from a nationally representative survey of 2,188 U.S. adults conducted in Spring 2023, regression analyses are used to examine how SDO shapes attitudes towards CCUS while controlling for demographic factors, political affiliations, and religious beliefs. The findings reveal a positive correlation between higher SDO scores and support for CCUS, particularly related to SDO-dominance beliefs. Additionally, political ideology, education, income, and religious beliefs emerged as significant predictors of CCUS acceptance, and regional variations in CCUS support and SDO were observed across U.S. Census divisions. These results suggest a complex interplay between psychological, social, and demographic factors in shaping public attitudes towards climate change mitigation technologies, that warrant further research to provide insights for policymakers and communicators seeking to promote CCUS adoption while addressing potential social and environmental concerns.

1. Introduction

Climate change mitigation is an established global priority, which has led to the development and exploration of newer mitigation strategies, including carbon capture, utilization, and underground storage (CCUS). CCUS involves capturing carbon dioxide emissions from industrial sources or directly from the atmosphere and injecting them into underground storage sites. While CCUS has significant potential to reduce greenhouse gas emissions, it also carries the risk of inducing small earthquakes that may cause slight damage to personal property (Ellsworth, 2013; Walsh and Zoback, 2015; Zoback & Gorelick, 2012).

We previously explored the relationship between public perceptions of induced seismicity in Oklahoma as a precursor to work on the acceptance of induced seismicity (Bedle et al., 2022). Using an explainable artificial intelligence method called SHapley Additive exPlanations (SHAP) to analyze survey data,

revealing several key findings. Personal experience with earthquakes emerged as the most significant factor in shaping respondents' perceptions of past and future seismic activity. Additionally, individuals who noticed an increased frequency of extreme weather events were more likely to be concerned about future seismicity and overestimate past seismic activity. Age also played a role, with younger people tending to overestimate past seismicity but expect fewer earthquakes in the future, while older individuals showed the opposite trend. Importantly, the Bedle et al. (2022) also investigated cultural worldviews, and noted that social and psychological factors such as cultural worldviews and social capital also played a role in perceptions of induced seismicity. These findings highlight the complex interplay between personal experience, demographics, social and psychological factors in the acceptance of climate mitigation solutions, and spurred on additional research, including the SPEER 2023 survey.

Recent studies have highlighted the importance of social dominance orientation (SDO) in understanding environmental attitudes. SDO, which measures an individual's inclination towards group-based hierarchy and inequality, has emerged as a significant factor in environmental research (Pratto et al., 1994). Numerous investigations have consistently revealed an inverse relationship between SDO and various aspects of environmentalism, including beliefs about climate change (e.g., Stanley et al., 2017; Jylhä & Akrami, 2015). However, many of these studies have been constrained by a lack of comprehensive control variables, making it challenging to determine the unique impact of SDO beyond other socioeconomic and demographic factors.

The literature consistently demonstrates a negative correlation between SDO and pro-environmental attitudes and behaviors. A cross-cultural study by Milfont et al. (2018) found that SDO was negatively associated with environmentalism across 25 nations, indicating that those who endorse group-based hierarchies are less likely to support environmental protection efforts. In a similar vein, Stanley et al. (2017) demonstrated that SDO predicted opposition to pro-environmental policies and a reduced willingness to make personal sacrifices for environmental causes. These findings underscore SDO's role as a psychological obstacle to addressing critical environmental issues, including climate change.

Recent advancements in SDO research have identified two distinct subdimensions: SDO-Dominance (SDO-D) and SDO-Egalitarianism (SDO-E) (Ho et al., 2015; Ho et al., 2012). SDO-D reflects a preference for overt forms of group-based dominance and oppression, while SDO-E represents opposition to intergroup equality and a preference for more subtle hierarchy-enhancing ideologies and policies. These subdimensions have shown differential associations with various social and political attitudes, including those related to the environment (Ho et al., 2015; Jylhä & Akrami, 2015; Milfont et al., 2018).

Studies suggest that SDO-E is a stronger predictor of climate change denial and opposition to pro-environmental policies compared to SDO-D (Jylhä & Akrami, 2015; Stanley & Wilson, 2019). This implies that resistance to environmental action may be more strongly driven by opposition to egalitarian social change rather than by overt dominance motives. These ideas were backed up with other data from the SPEER 2023 study that investigated SDO in relation to the belief in climate change (Bedle & Garneau, 2024)

Additionally, the relationship between SDO and climate change denial appears to be partially mediated by system justification and perceived threats from climate change mitigation efforts (Jylhä & Akrami, 2015; Hoffarth & Hodson, 2016). This suggests that individuals high in SDO may reject climate science

and policy solutions as a means of preserving the status quo and maintaining existing social hierarchies. Other work on the SPEER survey has shown positive correlation between SDO-E and SDO-D and climate change denial (Bedle & Garneau, 2024)

Understanding these psychological and social factors is important for developing effective communication strategies and policies to promote public acceptance of climate change mitigation efforts, including CCUS. As these technologies are implemented, it will be essential to monitor and address public concerns, particularly in areas where induced seismicity may occur. In so, this report aims to further investigate the relationship between SDO and public support for CCUS with the risk of induced seismicity, while controlling for demographic factors, political affiliations, and religious beliefs.

2. Survey Methods

Data and Availability

Data was collected through an online survey administered at the University of Oklahoma. The survey, conducted using the Qualtrics platform, targeted a nationally representative sample of 2,188 adults in the United States between May and June 2023. To ensure the sample accurately represented the U.S. population, quota-based sampling was employed, taking into account factors such as age, gender, income, education, race/ethnicity, and U.S. census region.

Survey procedures were reviewed and approved by the University of Oklahoma Institutional Review Board under protocol #15823, ensuring compliance with ethical standards and guidelines for human subjects' research. Data sharing is subject to the IRB's data collection and sharing guidelines, which are in place to protect participant confidentiality and maintain the integrity of the research process. For a comprehensive description of the data collection and sharing procedures, please refer to the full details in the survey report (Bedle et al., 2024).

Dependent Variables

Support for carbon capture was measured by asking respondents' opinion on whether they would oppose or favor carbon capture and storage. The exact wording of the question was as follows: "How much do you oppose or favor injecting and storing carbon dioxide in the ground to reduce greenhouse gases, even if it triggers small earthquakes that occasionally cause slight damage such as knocking items off bookshelves or picture frames off walls?" The participants were given a 6-point scale ranging from 'strongly oppose' to 'strongly favor', and we treat this as a continuous variable.

Independent Variables

We employed a 4-item Social Dominance Orientation (SDO) scale, drawing inspiration from the work of Aichholzer et al. (2022), Ho et al. (2015), and Pratto et al. (1994). Two items were designed to measure high SDO, specifically assessing SDO-Dominance (SDO-D), which reflects a preference for explicit group-based dominance and oppression. These items were: SDO1) "An ideal society necessitates a hierarchy with some groups at the top and others at the bottom," and SDO2) "Certain groups are inherently superior to others."

To assess low SDO and egalitarian views, two additional items were included: SDO3) "We ought to strive for equalizing conditions across different groups," and SDO4) "Our efforts should focus on providing equal opportunities for all groups to thrive." These items were subsequently reverse-coded to evaluate SDO-Egalitarianism (SDO-E), which represents opposition to intergroup equality and a preference for more subtle hierarchy-enhancing ideologies and policies.

Responses were collected using a 6-point Likert scale ranging from strong opposition to strong favor. An overall SDO score was calculated by creating an additive index comprising the high SDO items and the reverse-coded low SDO items. The final composite SDO score was derived by averaging the four items ($\alpha = 0.74$). In addition to analyzing the composite SDO score, we examined the relationships between individual SDO items and support for carbon capture with the risk of induced earthquakes (CCUSeq).

Control Variables

To enhance the validity of our results, we incorporate a wide array of control variables that previous studies have identified as influential in shaping environmental attitudes. Literature consistently highlights political party affiliation as a determinant of views on climate change and related actions (e.g., Dunlap & McCright, 2016; Hornsey et al., 2016). By including these variables, we aim to distinguish the specific impact of SDO on CCUS support from broader political influences.

Our analysis also accounts for various socioeconomic and demographic factors that research has linked to perceptions of CCUS and other environmental concerns (e.g., Boudet et al., 2014; Drummond & Fischhoff, 2017; Hamilton, 2011). These include age (mean-centered and with a quadratic term where relevant), gender, ethnicity, educational attainment, household income, family structure, religious practices, faith-based identities, scriptural interpretations, urban-rural residence, and geographical location within the United States.

This approach to controlling for potential confounding variables allows for a more precise evaluation of SDO's unique role in shaping public attitudes towards CCUS, particularly in the context of induced seismic risk.

Analysis

To investigate the relationship between SDO and the acceptance of carbon capture and storage with the risk of induced earthquakes, we employed ordinary least squares (OLS) regression analysis while controlling for other variables. The dependent variable for all models is the linear measure of carbon capture and storage with earthquake risk acceptance. All regression models are fully controlled. We also include figures to provide visual representations of the findings.

3. Results

Our analysis of CCUSeq support across the United States, based on respondents' zip codes and compiled into the nine U.S. Census divisions, reveals notable regional variations (Figure 1). The West, Mountain West, and West South Central regions demonstrate the highest levels of acceptance, while the East South Central and New England states show the least support.

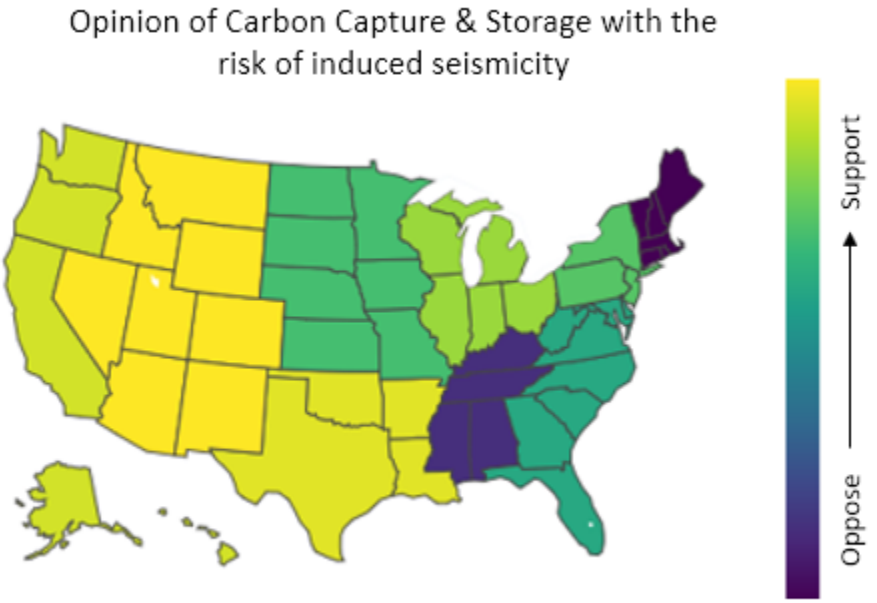
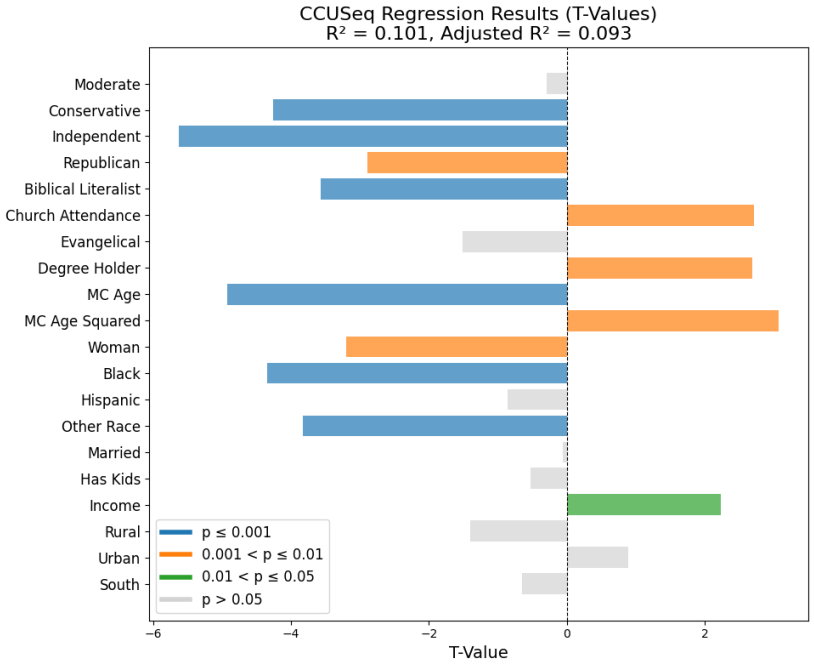


Figure 1: Map across the nine US Census divisions for carbon capture with the risk of induced earthquakes support.

We began our analysis with a regression model incorporating control variables (Figure 2), accounting for demographics, political affiliations, and religious beliefs. This model reveals that, compared to Democratic Party members, individuals identifying as Independent or Republican are less likely to accept CCUSeq. Similarly, Biblical literalists, women, Black individuals, and those of non-white, non-Hispanic races also show lower acceptance. Conversely, higher education levels, increased income, and more frequent church attendance positively correlate with greater support for carbon capture and underground storage with the risk of induced seismicity.

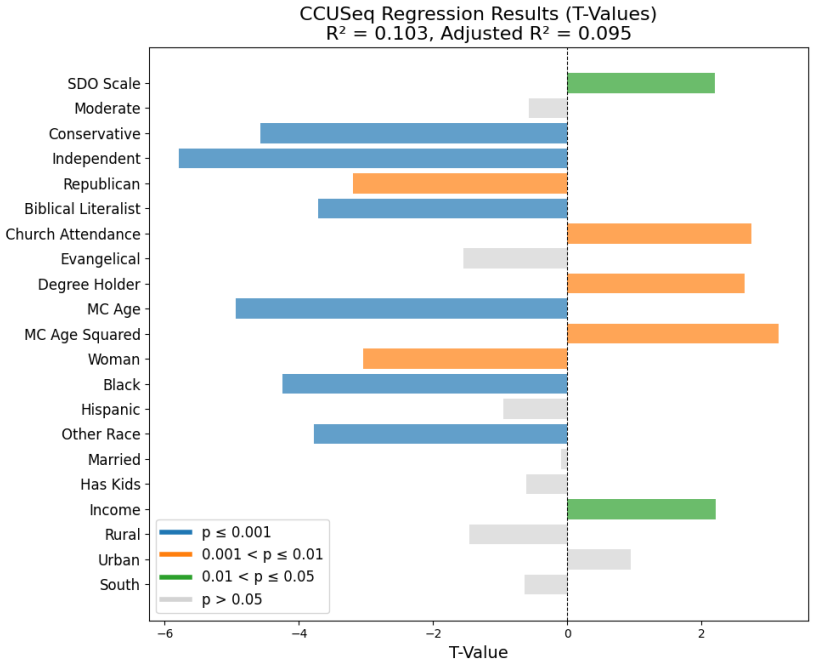


IV	coef	std err	t	P>|t|	2.5%	97.5%
Moderate	-0.020	0.069	-0.287	0.774	-0.156	0.116
Conservative	-0.380	0.089	-4.264	0.000	-0.554	-0.205
Independent	-0.383	0.068	-5.624	0.000	-0.516	-0.249
Republican	-0.259	0.090	-2.888	0.004	-0.435	-0.083
Biblical Literalist	-0.294	0.082	-3.573	0.000	-0.455	-0.132
Church Attendance	0.037	0.014	2.719	0.007	0.010	0.064
Evangelical	-0.116	0.077	-1.508	0.132	-0.266	0.035
Degree Holder	0.164	0.061	2.684	0.007	0.044	0.284
MC Age	-0.009	0.002	-4.928	0.000	-0.013	-0.005
MC Age Squared	0.000	0.000	3.067	0.002	0.000	0.000
Woman	-0.175	0.055	-3.194	0.001	-0.282	-0.067
Black	-0.449	0.103	-4.342	0.000	-0.651	-0.246
Hispanic	-0.083	0.097	-0.858	0.391	-0.273	0.107
Other Race	-0.300	0.078	-3.830	0.000	-0.454	-0.146
Married	-0.003	0.063	-0.053	0.958	-0.128	0.121
Has Kids	-0.035	0.067	-0.523	0.601	-0.166	0.096
Income	0.045	0.020	2.230	0.026	0.005	0.084
Rural	-0.097	0.069	-1.396	0.163	-0.232	0.039
Urban	0.057	0.064	0.894	0.371	-0.068	0.183
South	-0.041	0.063	-0.650	0.516	-0.163	0.082

Figure 2: OLS Regression results for carbon capture with the risk of induced earthquakes support with control variables.

Next, we incorporated the SDO Scale into our model alongside the control variables (Figure 3). The results demonstrate that SDO plays a significant role in shaping public opinion on CCUS with the risk of induced seismicity. Specifically, higher SDO scores positively correlate with support for CCUS.

Figure 4 illustrates the distribution of SDO Scale scores across the nine U.S. Census divisions. The Pacific, East South Central, and New England regions exhibit the lowest SDO scores, while the Middle Atlantic region shows the highest. It's important to note that this distribution doesn't directly mirror CCUSeq support patterns, which is expected given the influence of other factors such as political affiliation and demographic characteristics (as shown in Figure 3).



IV	coef	std err	t	P>|t|	2.5%	97.5%
SDO Scale	0.016	0.007	2.199	0.028	0.002	0.030
Moderate	-0.040	0.070	-0.578	0.563	-0.178	0.097
Conservative	-0.413	0.090	-4.572	0.000	-0.590	-0.236
Independent	-0.395	0.068	-5.787	0.000	-0.528	-0.261
Republican	-0.290	0.091	-3.195	0.001	-0.468	-0.112
Biblical Literalist	-0.305	0.082	-3.709	0.000	-0.467	-0.144
Church Attendance	0.037	0.014	2.741	0.006	0.011	0.064
Evangelical	-0.119	0.077	-1.548	0.122	-0.269	0.032
Degree Holder	0.161	0.061	2.647	0.008	0.042	0.281
MC Age	-0.009	0.002	-4.947	0.000	-0.013	-0.005
MC Age Squared	0.000	0.000	3.148	0.002	0.000	0.000
Woman	-0.167	0.055	-3.048	0.002	-0.274	-0.059
Black	-0.439	0.103	-4.246	0.000	-0.641	-0.236
Hispanic	-0.092	0.097	-0.954	0.340	-0.282	0.097
Other Race	-0.296	0.078	-3.781	0.000	-0.450	-0.143
Married	-0.006	0.063	-0.094	0.925	-0.130	0.118
Has Kids	-0.041	0.067	-0.615	0.538	-0.172	0.090
Income	0.044	0.020	2.211	0.027	0.005	0.084
Rural	-0.101	0.069	-1.454	0.146	-0.236	0.035
Urban	0.061	0.064	0.948	0.343	-0.065	0.186
South	-0.040	0.062	-0.639	0.523	-0.162	0.083

Figure 3: OLS Regression results for carbon capture with the risk of induced earthquakes support with the combined SDO Scale.

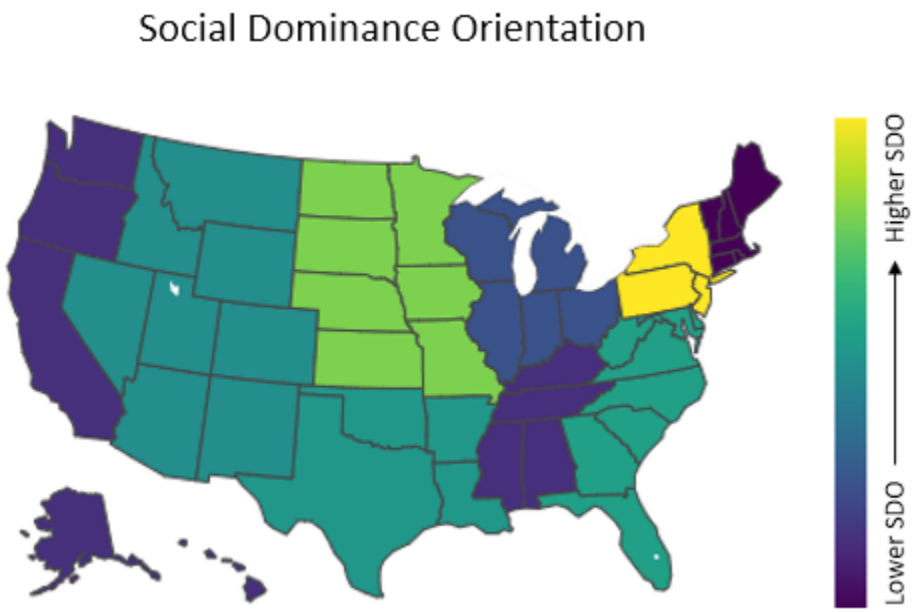
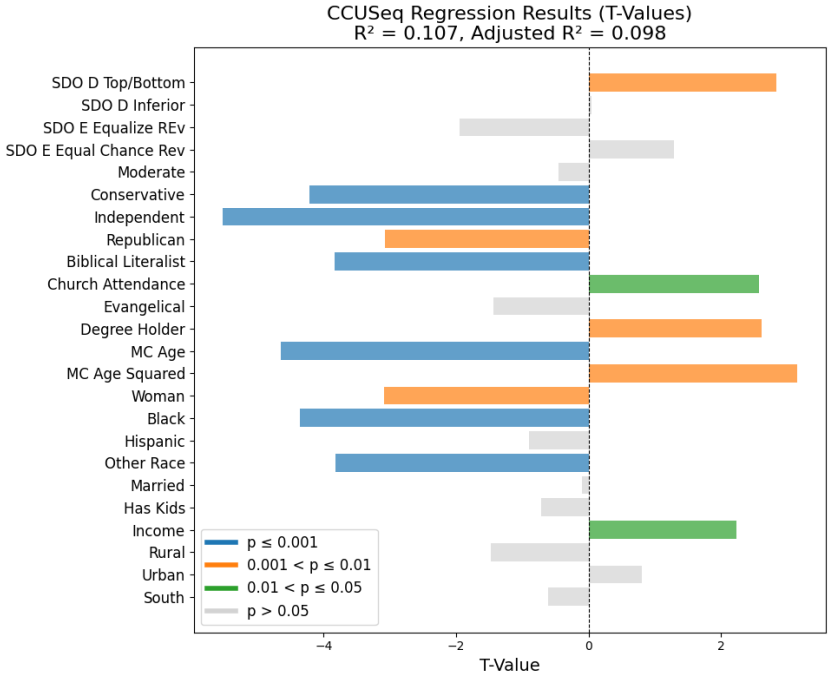


Figure 4: Map of SDO Scale for nine US census divisions

To gain a more nuanced understanding of how different aspects of SDO relate to carbon capture with the risk of induced earthquakes support, we disaggregated the SDO Scale into its individual components: two questions assessing SDO-dominance and two reverse-coded questions evaluating SDO-egalitarian tendencies. Our analysis (Figure 5) reveals that only one SDO-dominance item significantly correlates

with CCUSeq support: agreement with the statement "An ideal society requires some groups to be on top and others to be on the bottom."

The geographical distribution of this specific SDO measure (Figure 6) shows highest scores in the Middle and South Atlantic states, with lowest scores in New England and the East South Central region. To further explore the demographic characteristics associated with high scores on this first SDO-D item, we conducted an additional OLS regression (Figure 7). The results indicate that Conservative and Moderate political ideologies, compared to Liberal orientations, predict higher SDO1-D scores. Republican Party affiliation (relative to Democratic Party membership) and identification as a Biblical literalist also positively correlate with this belief. Conversely, identifying as female is negatively associated with endorsement of this SDO-dominance item.



IV	coef	std err	t	P>|t|	2.5%	97.5%
SDO D Top/Bottom	0.069	0.024	2.835	0.005	0.021	0.116
SDO D Inferior	0.001	0.023	0.041	0.967	-0.045	0.047
SDO E Equalize REv	-0.049	0.025	-1.950	0.051	-0.098	0.000
SDO E Equal Chance Rev	0.039	0.030	1.291	0.197	-0.020	0.097
Moderate	-0.032	0.070	-0.456	0.648	-0.169	0.105
Conservative	-0.383	0.091	-4.218	0.000	-0.561	-0.205
Independent	-0.378	0.068	-5.530	0.000	-0.512	-0.244
Republican	-0.279	0.091	-3.071	0.002	-0.456	-0.101
Biblical Literalist	-0.317	0.083	-3.836	0.000	-0.478	-0.155
Church Attendance	0.035	0.014	2.573	0.010	0.008	0.062
Evangelical	-0.111	0.077	-1.441	0.150	-0.261	0.040
Degree Holder	0.159	0.061	2.617	0.009	0.040	0.279
MC Age	-0.009	0.002	-4.650	0.000	-0.012	-0.005
MC Age Squared	0.000	0.000	3.150	0.002	0.000	0.000
Woman	-0.169	0.055	-3.090	0.002	-0.276	-0.062
Black	-0.450	0.103	-4.354	0.000	-0.652	-0.247
Hispanic	-0.087	0.097	-0.901	0.367	-0.277	0.102
Other Race	-0.299	0.078	-3.823	0.000	-0.452	-0.146
Married	-0.006	0.063	-0.101	0.919	-0.131	0.118
Has Kids	-0.048	0.067	-0.715	0.474	-0.179	0.083
Income	0.045	0.020	2.233	0.026	0.005	0.084
Rural	-0.102	0.069	-1.481	0.139	-0.238	0.033
Urban	0.052	0.064	0.810	0.418	-0.074	0.177
South	-0.039	0.062	-0.616	0.538	-0.161	0.084

Figure 5: OLS Regression results for carbon capture with the risk of induced earthquakes support with individual SDO variables.

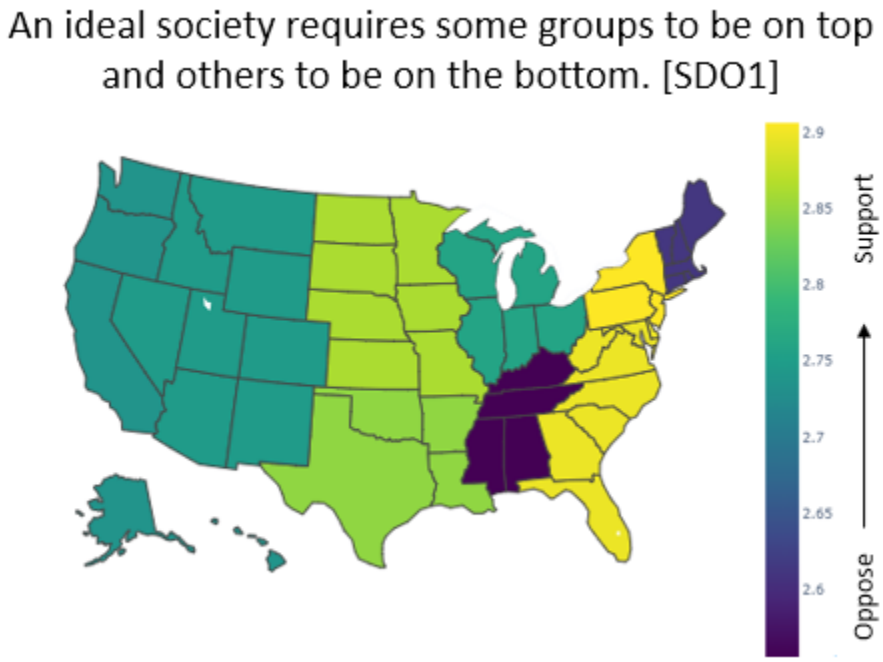
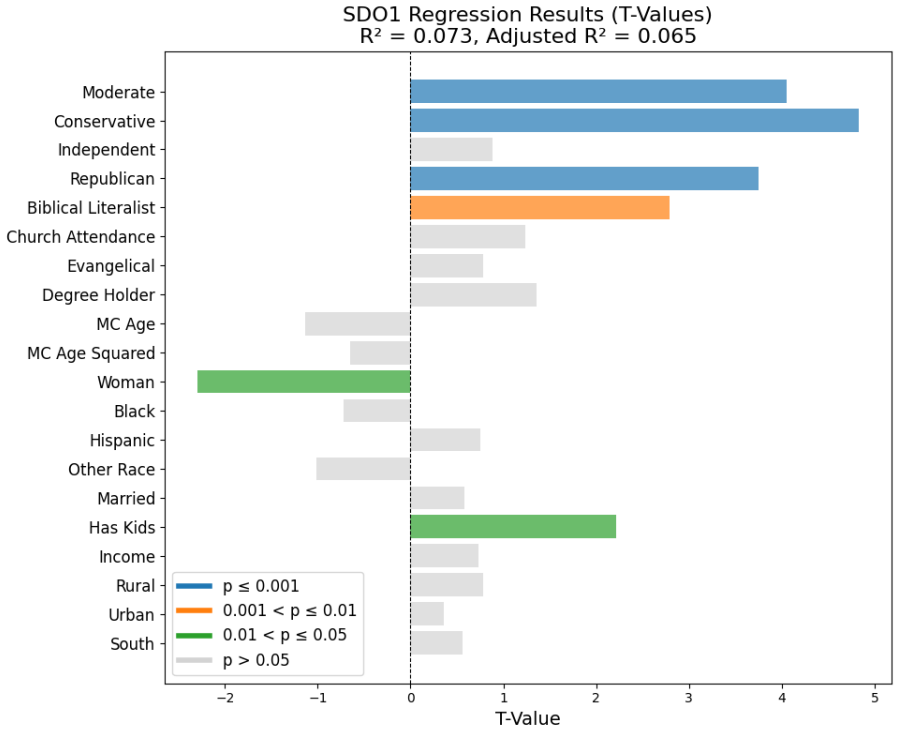


Figure 6: Average sore of SDO1-D item.



IV	coef	std err	t	P>|t|	2.5%	97.5%
Moderate	0.311	0.077	4.048	0.000	0.161	0.462
Conservative	0.475	0.098	4.826	0.000	0.282	0.668
Independent	0.067	0.075	0.886	0.376	-0.081	0.214
Republican	0.372	0.099	3.749	0.000	0.178	0.567
Biblical Literalist	0.254	0.091	2.790	0.005	0.076	0.433
Church Attendance	0.019	0.015	1.236	0.217	-0.011	0.048
Evangelical	0.067	0.085	0.786	0.432	-0.100	0.233
Degree Holder	0.092	0.068	1.360	0.174	-0.041	0.225
MC Age	-0.002	0.002	-1.132	0.258	-0.006	0.002
MC Age Squared	-0.000	0.000	-0.652	0.515	-0.000	0.000
Woman	-0.139	0.061	-2.292	0.022	-0.258	-0.020
Black	-0.082	0.114	-0.717	0.474	-0.306	0.142
Hispanic	0.081	0.107	0.754	0.451	-0.129	0.291
Other Race	-0.088	0.087	-1.009	0.313	-0.259	0.083
Married	0.041	0.070	0.576	0.565	-0.097	0.179
Has Kids	0.165	0.074	2.218	0.027	0.019	0.311
Income	0.016	0.022	0.728	0.467	-0.027	0.060
Rural	0.060	0.077	0.786	0.432	-0.090	0.211
Urban	0.026	0.071	0.363	0.717	-0.113	0.165
South	0.039	0.069	0.561	0.575	-0.097	0.175

Figure 7: Demographics of SDO1- D item.

4. Discussion

The SPEER 2023 survey reveals several insights into the complex relationship between social dominance orientation and public support for carbon capture, utilization, and storage technology, particularly in the context of induced seismic risk. We hope that these findings contribute to the growing body of literature on the psychological and social factors influencing climate change mitigation attitudes and behaviors.

Regional Variations in CCUS Support

The observed regional variations in CCUS support across the United States highlight the importance of considering geographical and cultural contexts when implementing climate change mitigation strategies. The higher levels of acceptance in the West, Mountain West, and West South Central regions may be attributed to various factors, including differing exposure to environmental issues, economic considerations, or cultural values. These regional differences underscore the need for tailored communication and policy approaches to promote CCUS adoption across diverse communities.

The Role of SDO in CCUS Acceptance

Our results demonstrate a positive correlation between higher SDO scores and support for CCUS, even when controlling for demographic factors, political affiliations, and religious beliefs. This finding adds nuance to the existing literature, which has generally found negative associations between SDO and pro-environmental attitudes (e.g., Milfont et al., 2018; Stanley et al., 2017; Bedle and Garneau, 2024). The positive relationship in the SPEER data might be explained by the unique nature of CCUS as a technological solution that doesn't necessarily challenge existing social hierarchies or economic structures.

Interestingly, when examining individual SDO components, we found that only one SDO-dominance item – agreement with the statement "An ideal society requires some groups to be on top and others to be on the bottom" – significantly predicted CCUS support. This aligns with previous research suggesting that SDO-Dominance (SDO-D) and SDO-Egalitarianism (SDO-E) may have differential effects on environmental attitudes (Ho et al., 2015; Jylhä & Akrami, 2015).

Demographic and Ideological Factors

Our analysis revealed several demographic and ideological factors associated with CCUS support and SDO. The lower acceptance among women, Black individuals, and non-white, non-Hispanic races echoes findings from previous environmental attitude research (e.g., Boudet et al., 2014). These disparities may reflect differing risk perceptions, trust in institutions, or experiences with environmental justice issues.

The positive correlation between education, income, and CCUS support suggests that socioeconomic factors play a role in shaping attitudes towards climate change mitigation technologies. This finding underscores the importance of inclusive and accessible public engagement strategies to ensure that CCUS initiatives don't exacerbate existing social inequalities.

Political affiliation and ideology emerged as significant predictors of both CCUS support and SDO-dominance beliefs. The lower acceptance among Republicans and Independents, compared to Democrats, aligns with the well-documented partisan divide on climate change issues (Dunlap & McCright, 2016). However, the positive association between conservative ideologies and SDO-

dominance scores suggests a more complex interplay between political beliefs, social attitudes, and support for technological climate solutions.

Implications for CCUS Implementation and Communication

Our findings have several implications for policymakers and communicators seeking to promote CCUS adoption:

- Targeted messaging: Communication strategies should be tailored to address the concerns and values of different demographic and ideological groups, acknowledging the role of SDO in shaping attitudes.
- Addressing regional variations: Efforts to implement CCUS technologies should consider regional variations in support and underlying factors influencing these differences.
- Emphasizing co-benefits: Framing CCUS as a solution that can maintain economic stability while addressing climate change may appeal to individuals with higher SDO scores.

5. Concluding Thoughts

While this survey provides insights, it has limitations that future research should address. The cross-sectional nature of our data limits causal inferences, and longitudinal studies could help elucidate how SDO and CCUS attitudes evolve over time. Additionally, investigating the potential mediating roles of system justification and perceived threats from climate change mitigation efforts (Jylhä & Akrami, 2015; Hoffarth & Hodson, 2016) in the context of CCUS could further our understanding of these relationships.

Future studies could also explore how SDO interacts with other psychological constructs, such as risk perception and trust in science, to influence CCUS attitudes. Also, examining public perceptions of different CCUS applications (e.g., industrial sources vs. direct air capture) could provide more nuanced insights for technology development and deployment strategies.

Overall, the survey demonstrates the complex interplay between SDO, demographic factors, and ideological beliefs in shaping public support for CCUS with induced seismic risk. We hope that by better understanding these relationships, policymakers and communicators can develop more effective strategies to promote the adoption of this critical climate change mitigation technology while addressing potential social and environmental concerns.

Data and Code Availability

As much as is allowed by the IRB and survey collection agreements, data and code can be made available by contacting speer@ou.edu.

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