Supplemental Material for Does Political Sophistication Minimize Value Conflict? Evidence from a Heteroskedastic Graded IRT Model of Opinions toward Climate Change

Supplemental material A

Supplemental material A contains the question wording for each survey indicator as well as descriptive statistics for each variable and scale reliability estimates for any indexes. We also include factor loadings for each scale. Since these consist of ordinal items we use the polychoric correlation matrix for non-linear relationships.

Outcome variable

Policy preference "A number of policy options have been proposed to deal with the problem of Global Warming and Climate Change. I am going to read a number of policy options to you. For each policy option, please indicate whether you: strongly support, support, oppose, or strongly oppose that policy."

- *Tax industry*: "Impose a tax on industry to discourage industry practices that contribute to Global Warming and Climate Change."
- *Tax individuals*: "Impose a tax on individuals that discourages them from practices that contribute to Global Warming and Climate Change."
- *Educate public*: "Educate the public on the human causes of Global Warming and Climate Change."
- *Adjust costs*: "Set higher prices for types of energy and other consumer goods that are not environmentally friendly." *item reversed for one-half of sample*

- *Reduce emissions*: "Use market incentives to encourage industries to reduce emissions."
- *Kyoto Protocol*: "Ratify the Kyoto Protocol, committing the US to reducing carbon dioxide emissions."
- *Efficiency laws*: "Legally require more energy efficient appliances, and industrial systems."
- *Renewable energy*: "Develop renewable energy sources, like hydro power, solar power, and windmills that emit no carbon dioxide."
- *Reduce methane*: "Improve agricultural management practices by reducing the level of methane produced in raising cattle and in rice farming."
- *Seawalls*: "Protect coastal settlements and water supplies from rising sea levels with publicly funded dikes and sea walls."
- *Efficient vehicles*: "Require automobile companies to build more fuel-efficient vehicles."
- *Fossil fuel tax*: "Increase the price of fossil fuels (like gasoline) to encourage people to save energy, and encourage the development of energy efficient devices."

Explanatory variables

Race: "From the following options, do you consider yourself to be black or African American, White, Asian, American Indian, Native Hawaiian or other Pacific Islander."

Education: "What is the highest level of education you have completed? Elementary or some high school, high school graduate/GED/trade or vocational certificate, some college/associates degree, college graduate, or post-graduate degree."

Ideology: "Which of the following categories best describes your political views? Would you say that you are strongly liberal, liberal, slightly liberal, middle of the road, slightly conservative, conservative, strongly conservative."

Partisanship: "Suppose you were in the voting booth and you came across an office for which two candidates, a Democrat and a Republican, were running and you had never heard of either one. Which would you choose—the Democrat, the Republican, or would you just not vote for that office?"

Risk perceptions: "Do you strongly agree, agree, disagree, or strongly disagree with the following statements?"

- "Global Warming and climate change will have a noticeably negative impact on my health in the next 25 years."
- "Global Warming and climate change will have a noticeably negative impact on my economic and financial situation in the next 25 years."
- "Global Warming and climate change will have a noticeably negative impact on the environment in which my family and I live."

Social network:

- "How much have you talked with members of your family about Global Warming and Climate Change? A lot, some, not much, not at all."
- "How much have you talked to friends about Global Warming and Climate Change? A lot, some, not much, not at all."
- "Has anyone ever asked you for your opinion on Global Warming and Climate Change? Yes or no."
- "Has anyone tried to influence your opinion on Global Warming and Climate Change? Yes or no."

Environmental value: "I am going to read you some statements about human beings and the physical environment. For each statement, please indicate whether you: strongly agree, agree, disagree, or strongly disagree."

- "We are approaching the limit of the number of people the earth can support."
- "When humans interfere with nature it often produces disastrous consequences."
- "Humans are severely abusing the environment."
- "The earth is like a spaceship with very limited room and resources."
- "The balance of nature is very delicate and easily upset."
- "If things continue on their present course, we will soon experience a major ecological catastrophe."

Economic value: "The following statements are about government and the environment. Please indicate if you strongly agree, agree, disagree, strongly disagree."

- "Economic growth is more important than environmental protection."
- "Government regulation of the environment has gone too far."

Domain-specific knowledge: "I'm going to read you a list of statements about possible causes and effects of global warming. For each one, tell me whether you think the statement is true or false."

- "Nitrous Oxide is a greenhouse gas."
- "The major causes of increased atmospheric concentration of greenhouse gases is human burning of fossil fuels."

- "Aerosols are airborne particles that are known to contribute to the formation of clouds and precipitation."
- "Water vapor is the principal greenhouse gas."

Table 1: Descriptive statistics for discrete variables

Variable				
Gender	56% men	44% women	-	-
Race	84% white	16% non-white	-	-
Ideology	33% liberal	25% moderate	42% conservative	-
Partisanship	23% Republican	32% Democrat	43% no preference	-
Education	24% high school or less	28% some college	31% college	17% post-grad

The percentages for the categories less than high school and high school/vocational degree are combined here for presentations purposes, but separated in the analysis.

Table 2: Descriptive statistics for continuous index variables

Variable	mean	sd	min-max	alpha	factor score
Policy opinion	2.98	.43	1 to 4	.86	Eigen=5.37
Tax industry					.75
Tax individuals					.74
Educate public					.74
Adjust costs					.64
Reduce emissions					.44
Kyoto Protocol					.80
Efficiency laws					.75
Renewable energy					.60
Reduce methane					.69
Seawalls					.44
Efficient vehicles					.75
Fossil fuel tax					.56
Risk perceptions	.56	.21	0 to 1	.84	Eigen=2.05
Risk to health					.85
Risk to finances					.78
Risk to immediate environment					.84
Social network	.44	.31	0 to 1	.74	Eigen=2.37
Talked with family about climate change					.75
Talked to friends about climate change					.81
Anyone asked opinion on climate change					.77
Anyone offered opinion on climate change					.73
Environmental value	.60	.16	0 to 1	.78	Eigen=2.71
Environmental crisis impending					.75
Approaching limit of people the earth can support					.58
Humans interfere with nature leads to disastrous					.66
Humans abuse environment					.74
Earth has limited room and resources					.56
Balance of nature is delicate and easily upset					.69
Economic value	.43	.23	0 to 1	.54	Eigen=.63
Economic growth most important					.56
Government regulation gone too far					.56
Domain-specific information	.45	.26	0 to 1	.28	
Nitrous oxide is a greenhouse gas					.51
Fossil fuels responsible for climate change					.43
Aerosols contribute to clouds and precipitation					.33
Water vapor is greenhouse gas					.17

Bolded items represent scale composed of non-bolded items below. sd represents the standard deviation. alpha is Cronbach's alpha reliability estimate. The factor score column consist of the factor eigenvalue for the bolded scale and factor loadings for each individual item. The correlation matrix for the factor score are estimated using the polychoric correlation matrix for ordinal response scales.

Supplemental material B

Supplemental material B provides robustness checks on the results via changes in the model specification. First, we examine the relationship between partisanship and policy support to better understand if items that promote the economy and the environment (renewable energy and building fuel efficient vehicles) have a different relationship with partisanship than the other policy items. Next, the model is estimated eliminating the risk perceptions and identity variables since these variables might attenuate the role of political ideology and partisanship in the estimates reported in the paper. Finally, we estimate the models collapsing the ordered response policy items into binary response items since some of the items exhibit skewed distributions. This ensures the robustness of the results when the response options are constrained to those that support versus oppose policies regarding climate change.

In order to see if Democrats are more likely to support the items regarding renewable energy and fuel efficient vehicles (since these items have been promoted as providing economic growth and environmental benefits), we estimated the Spearman correlation between each policy item and partisanship. These correlations are shown in Table 3. There is a positive statistically significant relationship between partisanship and each policy item except for the reduce emissions item. This means that Democrats are more likely than Republicans and respondents without a party preference to support these policies. We show the strongest party support for the Kyoto Protocol and a gasoline tax. The lowest correlation is among the reduce emissions item and the development of renewable energy sources. The fuel efficient vehicles item (.13) and the renewable energy items (.09) show a small correlation with partisanship alleviating some concern that partisanship plays a unique role in support for these two policy items.

We also combined the renewable energy and fuel efficient vehicles items into a single factor variable using a factor analysis using the polychoric correlation for non-linear ordi-

Table 3: Spearman correlation between partisanship and outcome variables

Policy item	Rho	$p > \|t\|$
Kyoto Protocol	.31	.00
Gasoline tax	.25	.00
Tax industry	.22	.00
Tax individuals	.22	.00
Efficiency laws	.22	.00
Reduce methane	.21	.00
Adjust prices	.18	.00
Educate public	.15	.00
Efficient vehicles	.13	.00
Seawalls	.11	.00
Renewable energy	.09	.00
Reduce emissions	.05	.06

Coefficients reflect Spearman correlation between partisanship and each policy item.

nal indicators. We then regressed this indicator on the environmental and economic value variables subsetting the data on Republican and Democratic partisanship to see if values regarding the environment and the economy were likely have a different effect on these policy items among different partisans. These estimates are shown in Table 4. The results show both values influence these items in a similar manner for Republicans as they do Democrats. Respondents that value the environment are more likely to support these policies, while respondents that value the economy are less likely to support these policies. Thus, both Republicans and Democrats use these values in a similar manner on these items. A test of equality of the coefficients show the influence of the environmental value is equivalent among Democrats and Republicans, $\chi^2 = .12$, $p < .72$. A similar test shows that the economy is more important among Democrats than Republicans $\chi^2 = 3.94$, $p < .04$, which is at odds with the notion that Democrats are more likely to be able to support these items since they view them as contributing to both economic growth and the environment.

Next, we re-estimate the models removing identity variables (gender and race) and risk perceptions. Gender and identity might also shape risk perceptions in addition to climate

Table 4: Partisanship and the variability estimates regarding climate change policy preferences

explanatory variables	Republicans	se	Democrats	se
Economic value	-.28*	(.11)	-.58*	(.09)
Environmental value	.70 *	(.15)	.62*	(.15)
N	245		345	
R^2	.13		.17	

Notes $*p < 0.05$. Estimates are from a linear regression model on a composite index of support for renewable energy and fuel efficient vehicles.

change policy preferences. Model 1 of Table 5 shows the estimates when these variables are removed. Ideology, partisanship and both values are statistically significant in the preference equation. The coefficient size on ideology and partisanship suggest that the role of these variables is not being attenuated in the models reported in the paper by the inclusion of risk perceptions, gender, or race. In addition, the estimates of the variance equation remain robust. The interaction between value pluralism and education remains negative and statistically significant consistent with the sophistication-interaction hypothesis. Model 2 of Table 5 removes the value measures from the preference equation. Removing these variables substantially increases the role that partisanship has on people's policy preferences.[1] The interaction between value pluralism and education remains negative and statistically significant consistent with the sophistication-interaction hypothesis.

We also test whether the skewness of the ordinal policy items (most respondents strongly agree or agree with each policy item) influences the model estimates. Each of the ordered items were reduced into a binary response (strongly support and support into a single category and strongly oppose and oppose into a single category). We then estimate these binary policy items using a heteroskedastic item response theory model H-IRT instead of the heteroskedastic graded item response theory model HG-IRT. The discrimination point

[1]The Spearman correlation between partisanship and the environmental value is modest and positive (rho=.25, $p < .00$), while the the correlation between partisanship and the economic value is modest and negative (rho=-.23, $p < .00$.)

Table 5: Alternative specifications of the preference model

preference equation	Model 1	SE	Model 2	SE
Education	0.02	(0.01)	0.33*	(0.03)
Ideology	-0.04*	(0.01)	-0.08*	(0.02)
Partisanship	0.06*	(0.02)	0.61*	(0.06)
Social network	0.14	(0.05)	0.80	(0.12)
Environmental value	1.22*	(0.16)	-	-
Economic value	-0.57*	(0.09)	-	-
variance equation				
Domain knowledge	0.07	(0.03)	0.06	(0.03)
Education	0.04	(0.01)	0.05*	(0.01)
Value pluralism	0.23	(0.12)	0.16	(0.11)
Education $*$ value pluralism	-0.14*	(0.03)	-0.13*	(0.03)
Log likelihood	-9944	-	-10530	-

Notes $*p < 0.05$. N = 982. Estimates are from a heteroskedastic graded item response theory model. The structural model estimates are the relationship between the predictors and the latent policy preference variable. The variance model estimates are the relationship between the predictors and the variance around the latent policy preference. Standard errors, shown in parentheses, are rounded to the second decimal.

estimates from the H-IRT model are shown as dots in Figure 1. The solid lines represent the 95% confidence intervals. Overall, the results are fairly consistent with those reported in the paper. The items with the highest discrimination remain to be support for the Kyoto treaty, efficient vehicles, and taxing industry. The items with the lowest discrimination remain to be support for reducing emissions, building seawalls, increasing a fossil fuel tax, increasing use of renewable resources, and adjusting prices on goods and services that contribute to climate change. The one exception is that taxing individuals moves into the middle of the discrimination estimates. But this movement is based off of the point estimate, while the confidence intervals suggest the estimate could be the same as reported in the paper. Small difference in point estimates and larger standard errors (potentially arising from the loss of information from reducing each item to a binary response) are also noticeable. However, the confidence intervals of the discrimination estimates from the graded item response model in the paper and the binary item response model here overlap for each item suggesting no real

difference between the estimates.

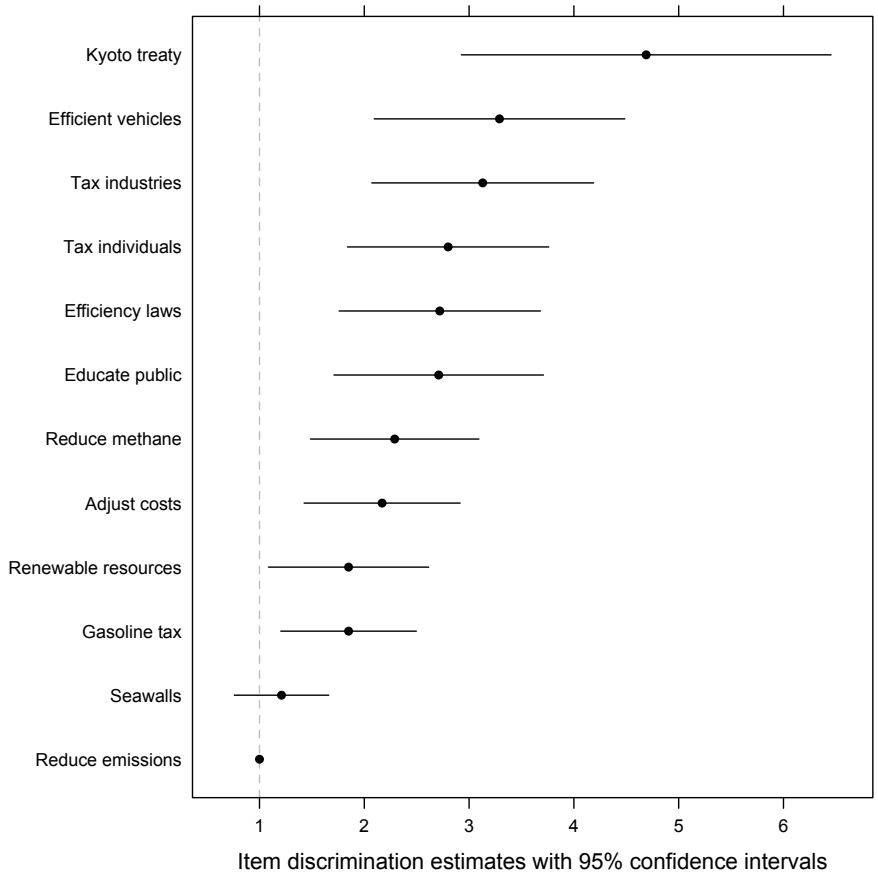

Figure 1: Discrimination estimates with binary response items

Next, we examine the preference and variance estimates from the item response model with binary indicators. The coefficient sizes are different from the coefficient sizes reported in the model reflecting the change in the estimator link function (i.e., moving from probit to ordered probit). However, the relative size of the coefficients are similar to those reported in the paper. Environmental and economic value, along with risk perceptions and ideology, remain statistically significant and show the largest substantive effect on policy support. Education and social network interest are no longer significant in the preference equation. However, neither are germane to our argument.

The key hypothesis of the sophistication-interaction hypothesis is also supported in the item response model with binary indicators. In 4 out of 4 models, the interaction between education and value pluralism is negative and statistically significant. We find no evidence that respondent's are uncertain about their climate change policy preferences or that partisanship and ideology help reduce response instability on this issue.

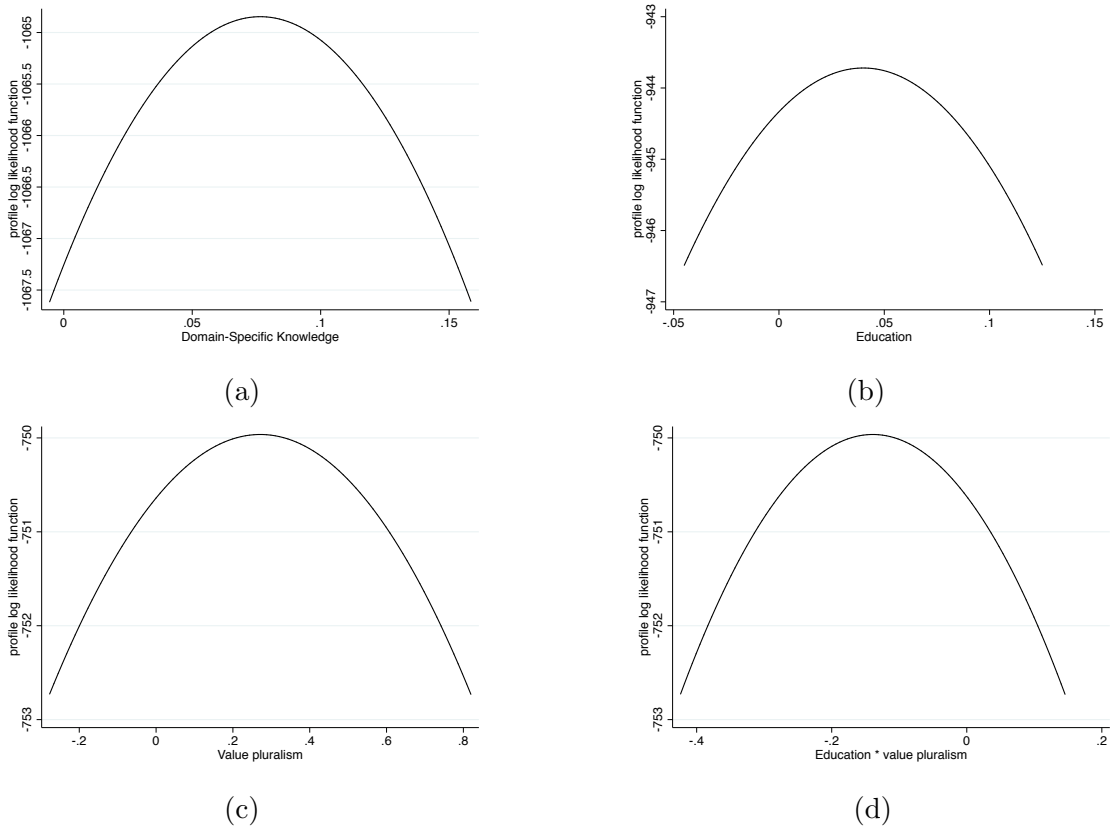

Figure 2: Profile Likelihood Plots of Variance Estimates

Supplemental material C

Supplemental material C provides evidence relating to the convergence of the model. First, the educational conditioning model was estimated with informative and uninformative starting values. The informative starting values were provided from prior estimates from the literature. The uninformative starting values were zero for each parameter. These uninformative starting values are what is reported in the paper. However, both sets of starting values show convergence on the model estimates reported in the manuscript. Second, we examined the estimated likelihood profiles for the variance estimates for the educational conditioning model to ensure the curvature of each estimate identified a maximum rather than a flat space or apex. These are shown in Figure 2. None of the profile plots show a flat apex or evidence of non-convergence.

Table 6: Estimation of public preferences toward climate changes policies and the variability in those preferences (binary response items)

preference equation	baseline model	SE	domain knowledge conditioning model	SE	education conditioning model	SE	value trade-off model	SE
Race (white=1)	-0.01	(0.03)	-0.01	(0.03)	-0.01	(0.03)	-0.03	(0.06)
Gender (male=1)	-0.03	(0.02)	-0.03	(0.02)	-0.04	(0.03)	-0.07	(0.04)
Education	0.00	(0.01)	0.00	(0.01)	0.00	(0.01)	0.02	(0.02)
Ideology	-0.02*	(0.00)	-0.02*	(0.00)	-0.02*	(0.00)	-0.04*	(0.01)
Partisanship	0.05*	(0.02)	0.05*	(0.02)	0.05*	(0.02)	0.10*	(0.04)
Risk perception	0.46*	(0.10)	0.46*	(0.10)	0.53*	(0.12)	0.94*	(0.24)
Environmental value	0.46*	(0.11)	0.46*	(0.11)	0.54*	(0.13)	1.30*	(0.37)
Economic value	-0.38*	(0.09)	-0.38*	(0.09)	-0.44*	(0.10)	-0.79*	(0.19)
Social network	0.04	(0.04)	0.04	(0.04)	0.05	(0.04)	0.11	(0.07)
variance equation								
Domain knowledge	0.09	(0.08)	0.08	(0.11)	0.08	(0.08)	0.02	(0.08)
Education	-0.03	(0.02)	-0.02	(0.02)	0.01	(0.02)	0.02	(0.03)
Value pluralism	-0.34*	(0.08)	-0.36*	(0.17)	0.14	(0.25)	0.27	(0.27)
Domain knowledge $*$ value pluralism	-	-	0.03	(0.31)	-	-	-	-
Education $*$ value pluralism	-	-	-	-	-0.14*	(0.06)	-0.14*	(0.07)
Environmental value	-	-	-	-	-	-	0.21*	(0.15)
Economic value	-	-	-	-	-	-	0.79*	(0.16)
Log likelihood	-4063	-	-4063	-	-4061		-4047	-

Notes $*p < 0.05$. N = 982. Estimates are from a heteroskedastic item response theory model with binary item responses. The structural model estimates are the relationship between the predictors and the latent policy preference variable. The variance model estimates are the relationship between the predictors and the variance around the latent policy preference. Standard errors, shown in parentheses, are rounded to the second decimal.

Table 7: Estimation of public preferences toward climate changes policies and the variability in those preferences (binary response items)

preference equation	ideological strength model	SE	partisanship model	SE
Race (white=1)	-0.01	(0.03)	-0.01	(0.04)
Gender (male=1)	-0.04	(0.03)	-0.04	(0.03)
Education	0.00	(0.01)	0.00	(0.01)
Ideology	-0.02*	(0.01)	-0.02*	(0.01)
Partisanship	0.06*	(0.02)	0.08*	(0.03)
Risk perception	0.54*	(0.12)	0.57*	(0.13)
Environmental value	0.54*	(0.14)	0.57*	(0.14)
Economic value	-0.44*	(0.10)	-0.46*	(0.11)
Social network	0.05	(0.04)	0.05	(0.04)
variance equation				
Domain knowledge	0.08	(0.08)	0.07	(0.08)
Education	0.00	(0.03)	0.00	(0.03)
Value pluralism	0.13	(0.25)	0.04	(0.28)
Education $*$ value pluralism	-0.13*	(0.06)	-0.12*	(0.07)
Ideological strength	0.02	(0.02)	-	-
Partisanship	-	-	-0.04	(0.02)
Partisanship * value pluralism	-	-	-0.12	(0.10)
Log likelihood	-4061	-	-4058	-

Notes $*p < 0.05$. N = 982. Estimates are from a heteroskedastic item response theory model with binary items. The structural model estimates are the relationship between the predictors and the latent policy preference variable. The variance model estimates are the relationship between the predictors and the variance around the latent policy preference. Standard errors, shown in parentheses, are rounded to the second decimal.