Modeling Concern for Electrical Grid Infrastructure and Willingness-to-Pay for Electrical Grid Improvements in Oklahoma

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Research Questions

What factors are associated with concern for the electrical grid infrastructure among Oklahoma residents?

What factors are associated with willingness-to-pay (WTP) for electrical grid infrastructure improvements among Oklahoma residents?

Theory (Expectations)

- Risk perceptions
  - Weather-related risks
  - Risks from electrical outages
- Trust
- Beliefs about climate change
- Price/Cost
- Socio-demographics
  - Gender
  - Political ideology
  - Race/ethnicity
  - Income
  - Rural vs. urban

Methodology: M-SISNet Data

Panel survey of over 2,000 Oklahoma residents that asks for advice and guidance on how to develop socially sustainable solutions to water, carbon, and infrastructure problems in Oklahoma

Wave 2

Open: November 22, 2021– January 7, 2022

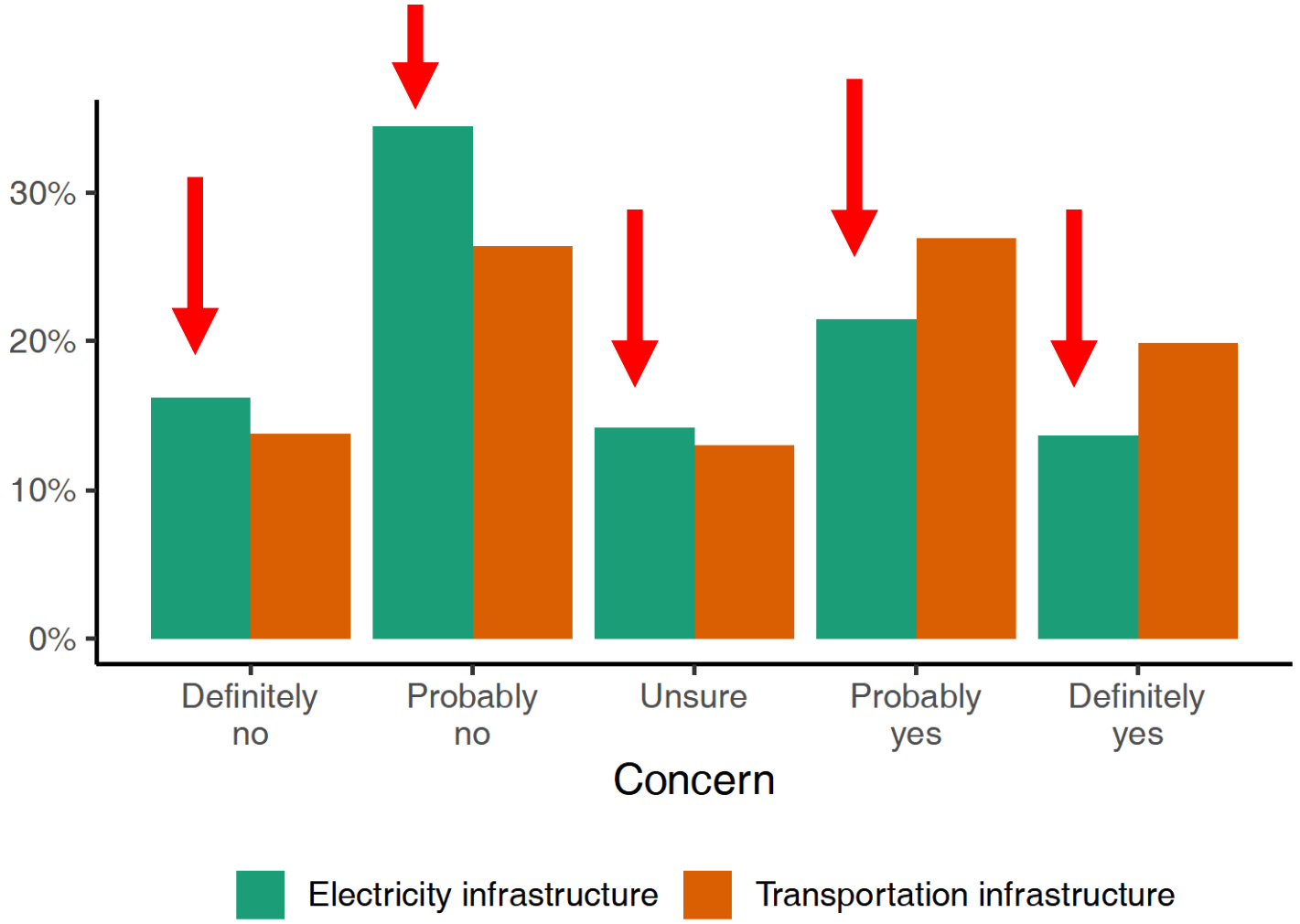
n: 2,180 respondents

Included questions asking Oklahomans about the problems they worry most about, to describe those problems specifically, and indicate their perceptions of the priority of those problems.

M-SISNet: Infrastructure

Do you have any concerns about […] in your region of Oklahoma?

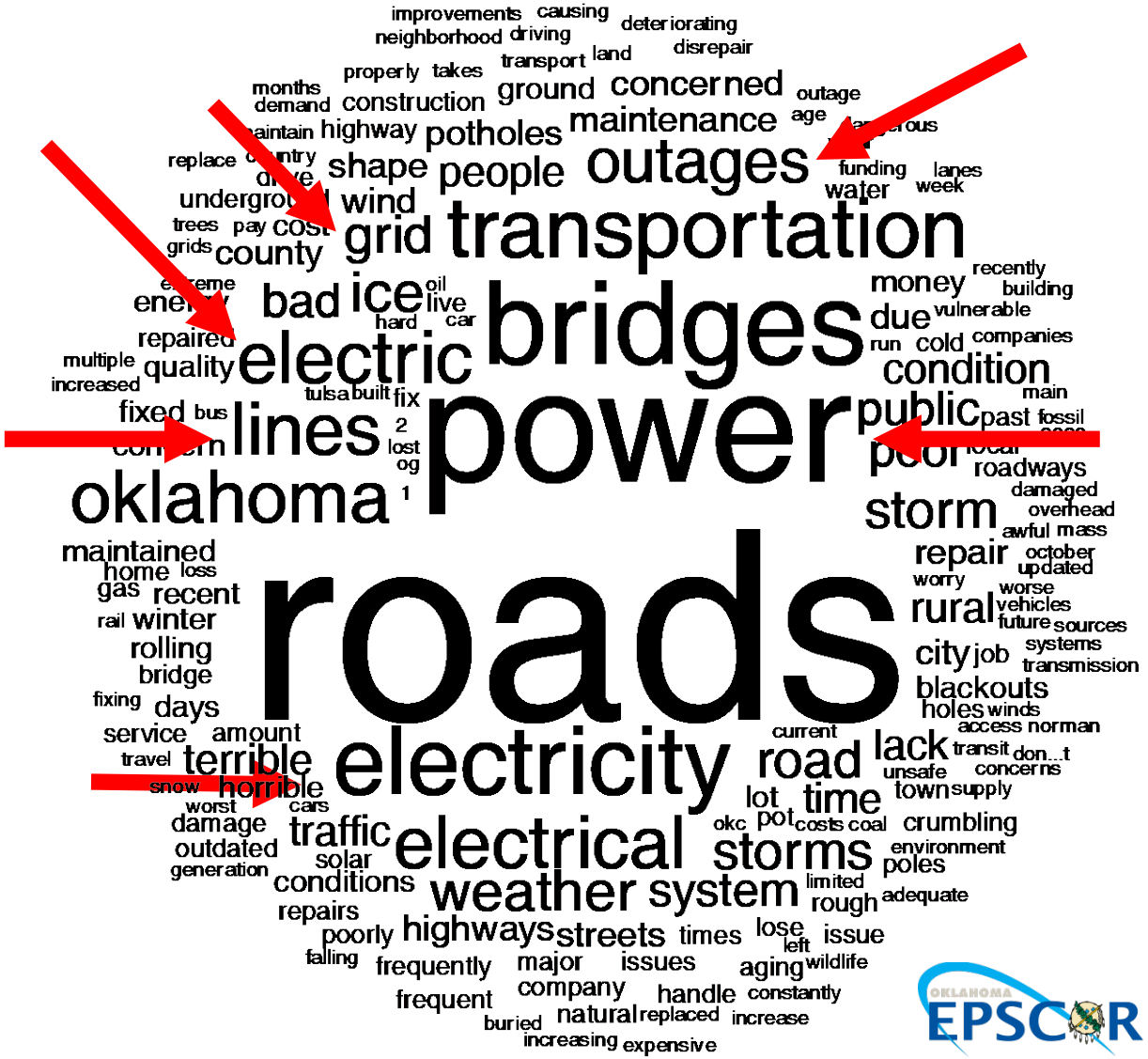
- **Electricity infrastructure:** the generation facilities, substations, and transmission and distribution lines that deliver electricity to businesses and homes
- **Transportation infrastructure:** the roads, bridges, waterways, railways, and airways that facilitate transportation from place to place



M-SISNet: Infrastructure

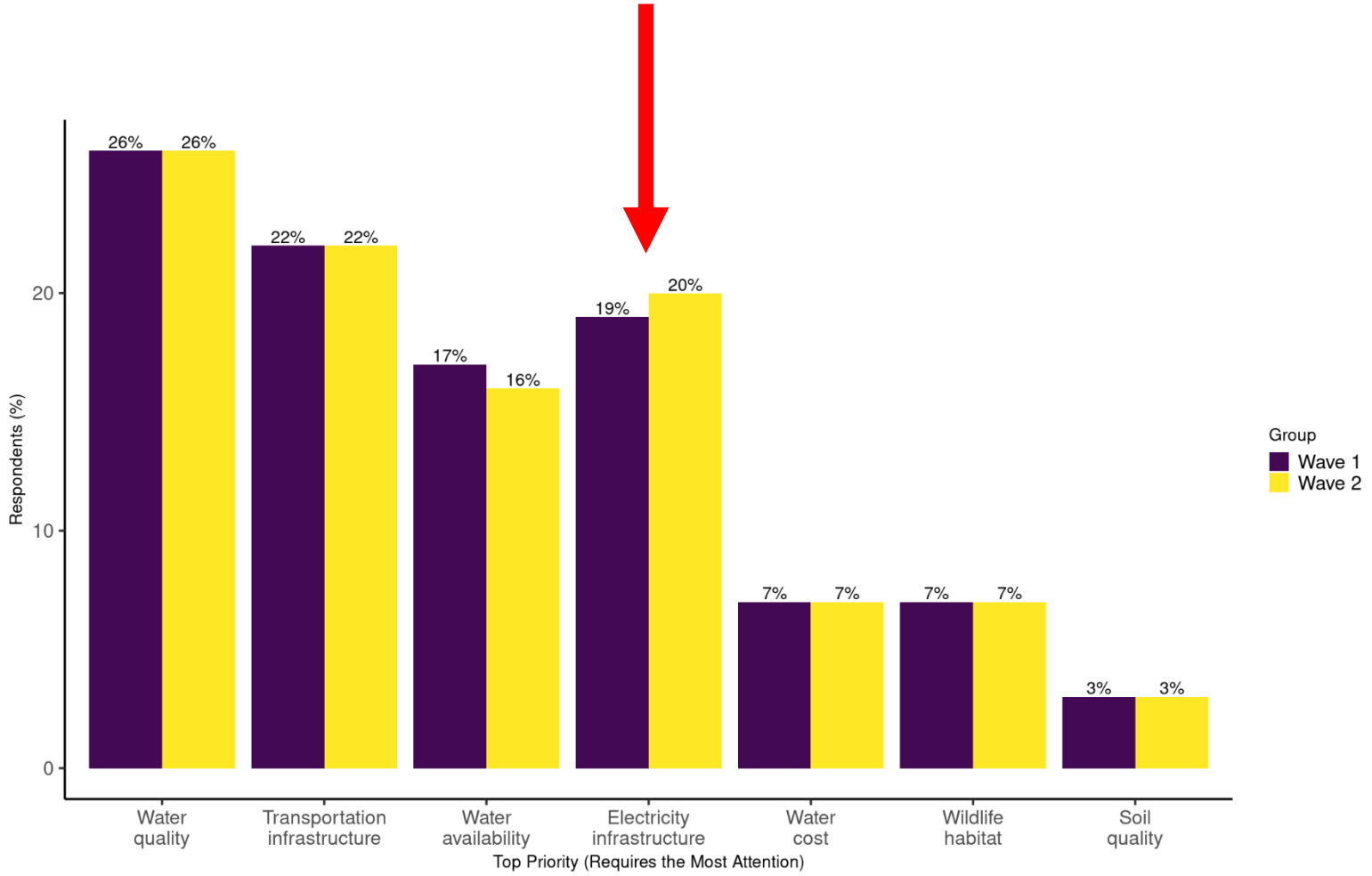
Can you briefly describe the problem(s) that concern you?

- **Electricity infrastructure [53%]:** *As seen from the ice storm of 2020, the electric infrastructure of Oklahoma is very outdated and mostly above ground, which makes it vulnerable…*
- **Transportation infrastructure [60%]:** *Quality and condition of highways, main roads, and side streets. Excessive wear and age of bridges and overpasses…*



M-SISNet: Most Attention

If you were advising the scientists and policymakers who are working on this project, which of the following would you tell them require the most attention?



M-SISNet: Grid Modernization

Officials in private companies and government organizations are considering a program that will reduce the risks of severe electric outages. The program is expensive, but estimates suggest that it will reduce the risk of severe electricity outages by [10% | 40% | 70%] in Oklahoma.

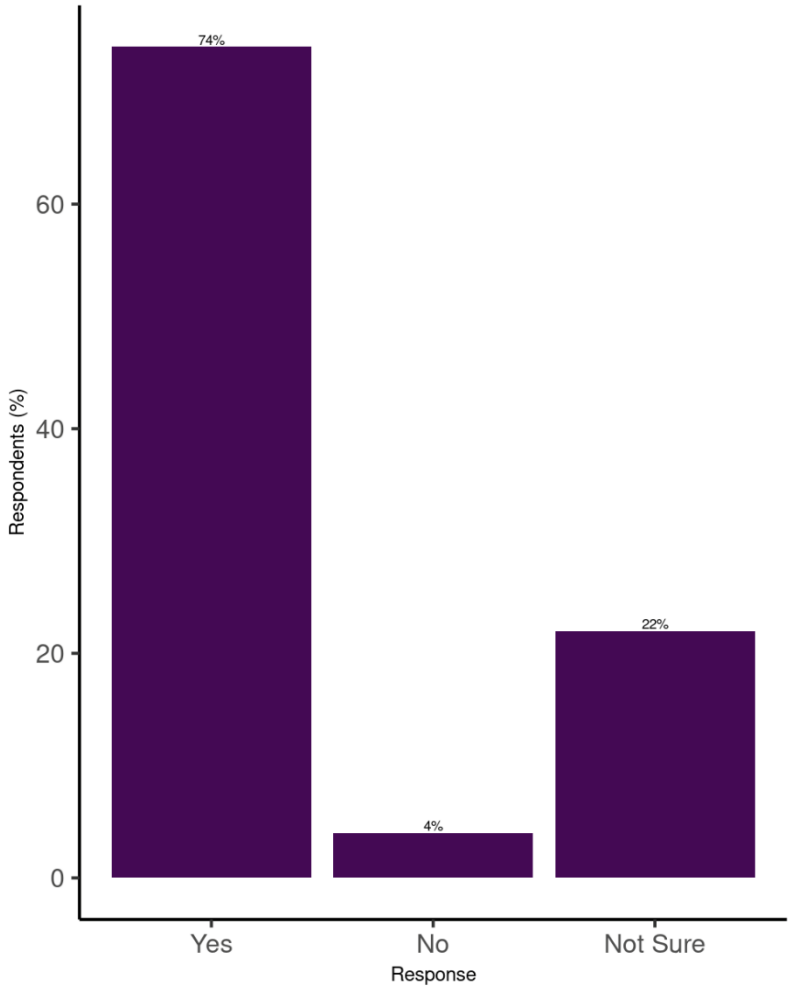
Imagine that government officials were asking you to vote on the program. If it would not cost you anything, would you vote for or against the program to improve the electric grid in Oklahoma?

Would you vote for the grid improvement program if it were to increase your electricity bill by [$1 to $30] each month for the next 120 months (10 years)?

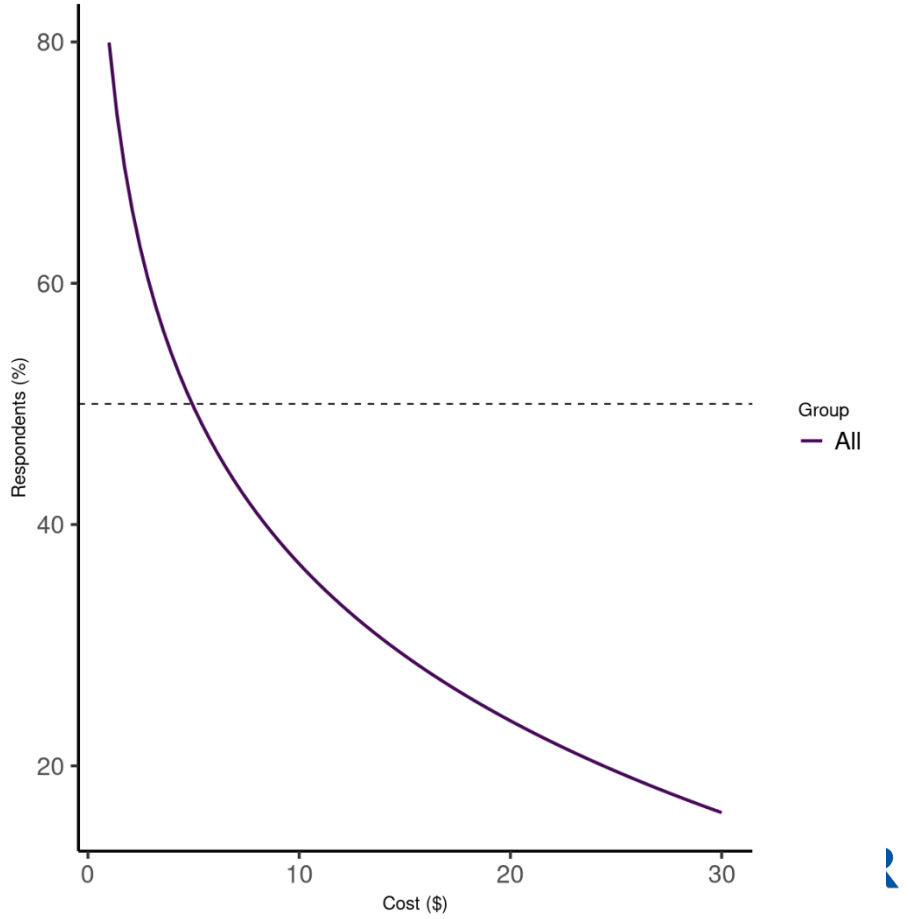
OKLAHOMA EPSCoR

M-SISNet: Grid Modernization

If it would not cost you anything, would you vote for the program?



Would you vote for the grid improvement program if it were to increase your electricity bill by [**$1** to **$30**] each month for the next **120** months (**10** years)?



Methodology: Modeling

- Structural Equation Modeling (SEM)
  - Allows us to examine the two research questions simultaneously
  - Latent variables – combine multiple survey questions into one composite indicator
    - Symbolized by ovals
  - Observed variables – single survey question used as a variable
    - Symbolized by rectangles

Methodology: Modeling

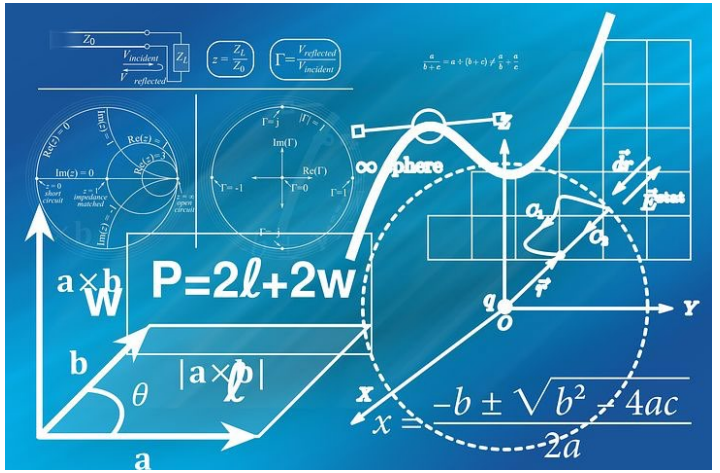
Confirmatory Factor Analysis Results for the Measurement Model

Factor/Observed Variable	Mean	St. Deviation	Standardized Factor Loading	α
Trust in Electrical Grid Maintenance [a]				0.68
How much trust do you have in the electric utility that maintains the grid in your area?	3.42	0.86	0.74	
How much trust do you have in the government agencies that maintain the electric grid in your area?	2.83	0.85	0.68	
If your utility asks its customers to voluntarily reduce electric consumption/conserve electricity, how much trust do you have that these people and businesses in your area will voluntarily conserve electricity to maintain grid operations?	2.59	0.81	0.50	
Risks from Electrical Outages [b]				0.86
How would you rate the risk of severe electricity outages to you and the people you live with?	2.78	0.87	0.75	
How would you rate the risk of severe electricity outages to economic well-being in Oklahoma?	3.09	0.88	0.83	
How would you rate the risk of severe electricity outages to public safety in Oklahoma?	3.13	0.88	0.86	
Perceptions of Future Weather Risks [c]				
When you think about the next 25 years in Oklahoma do you think the risk (frequency and severity) of these weather hazards will increase, decrease, or stay about the same?				0.87
Tornadoes	3.45	0.78	0.75	
Hail	3.38	0.70	0.80	
Wind	3.36	0.71	0.76	
Lightning	3.34	0.65	0.79	
Flood	3.48	0.78	0.70	
Snow/ice	3.37	0.80	0.63	

Notes: All standardized factor loadings are statistically significant at $p<0.001$. [a] items scored on a scale where 1=no trust to 5=complete trust; [b] items scored on a scale where 1=no risk to 5=extreme risk, [c] items scored on a scale where 1=significantly decrease to 5=significantly increase.

Measurement: Observed Variables

- Price (randomized price to respondent)
- Gender (0 = female, 1 = male)
- Race (0 = white, 1 = non-white)
- Political ideology (1 = strong liberal to 7 = strong conservative)
- Rural (0=non rural resident, 1= rural resident)

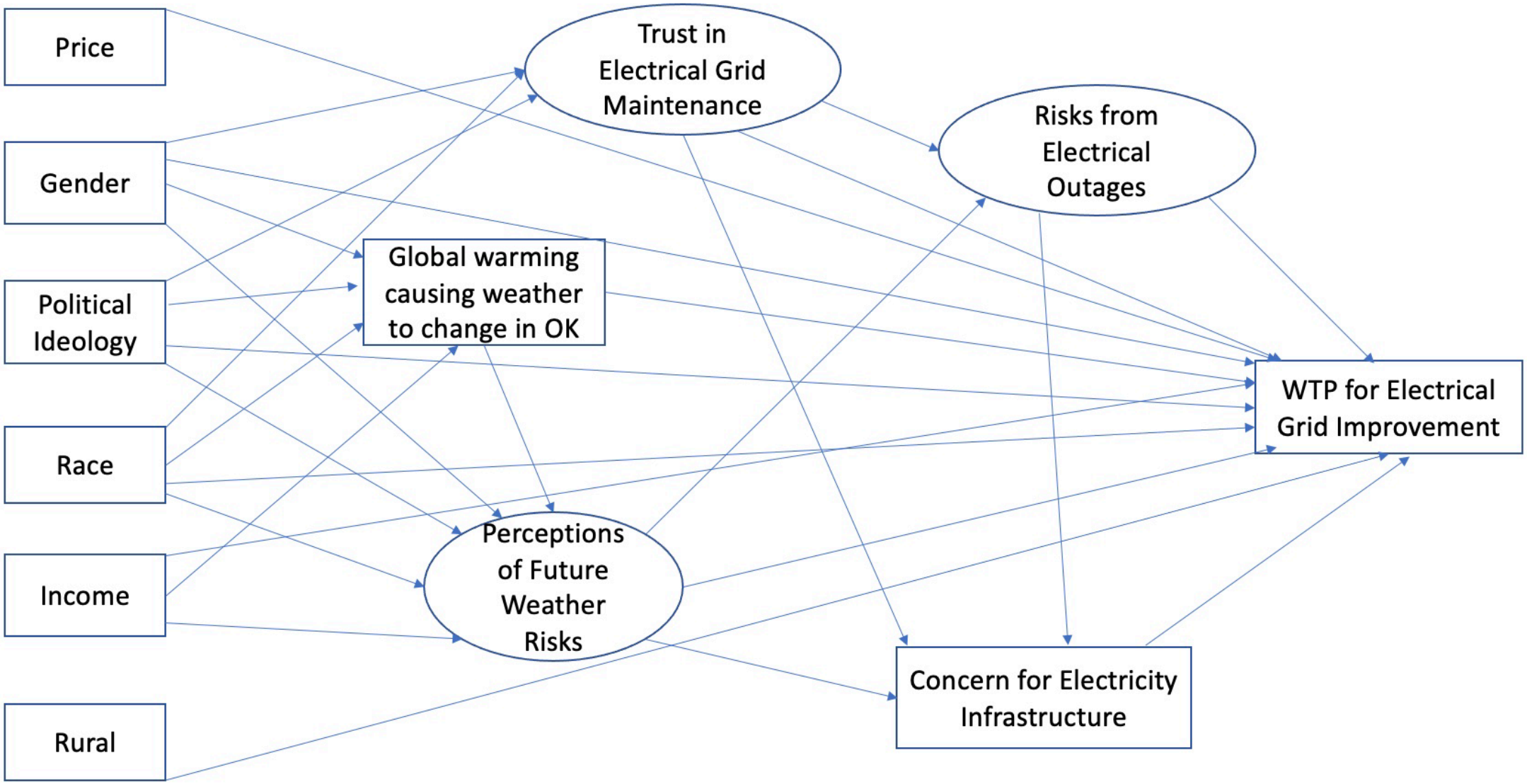


Measurement: Observed Variables

- Was the estimated annual income for your household in 2020: (1 = Less than $50,000 to 4 = $150,00 or more).
- In your view, is global warming causing the weather patterns in Oklahoma to change (0 = no/don't know, 1 = yes)
- Concern with electricity infrastructure – Do you have any concerns about electricity infrastructure in your region of Oklahoma? (1 = definitely no to 5 = definitely yes)
- WTP for electrical grid improvement (0=respondent is not willing to pay or not certain that they are willing to pay, 1 = respondent is certain that they are willing to pay

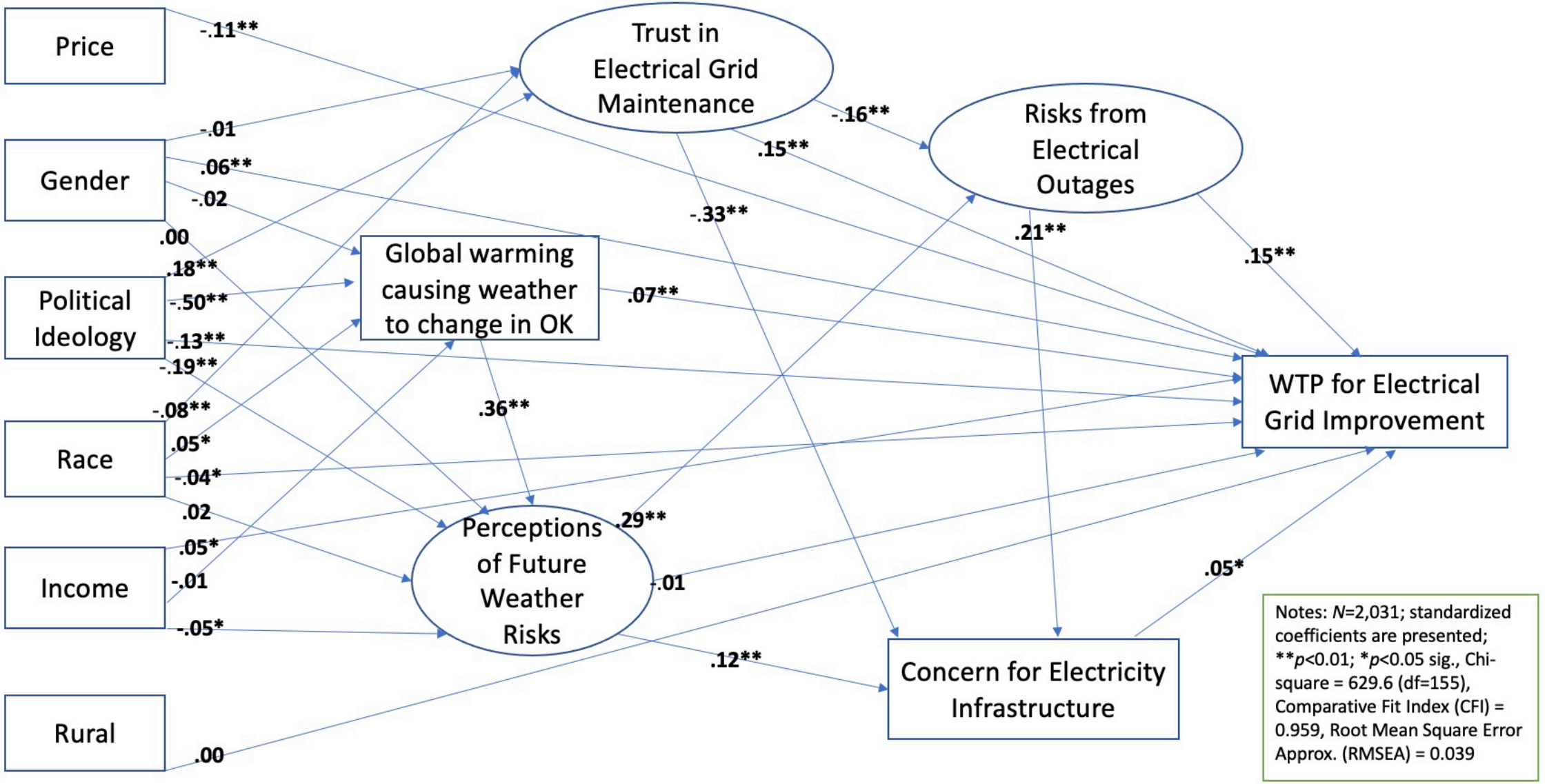
Measurement: Observed Variables

Figure 1. Predicted Empirical Relationships Among Constructs and Variables



Measurement: Observed Variables

Figure 2. Empirical Relationships Among Constructs and Variables

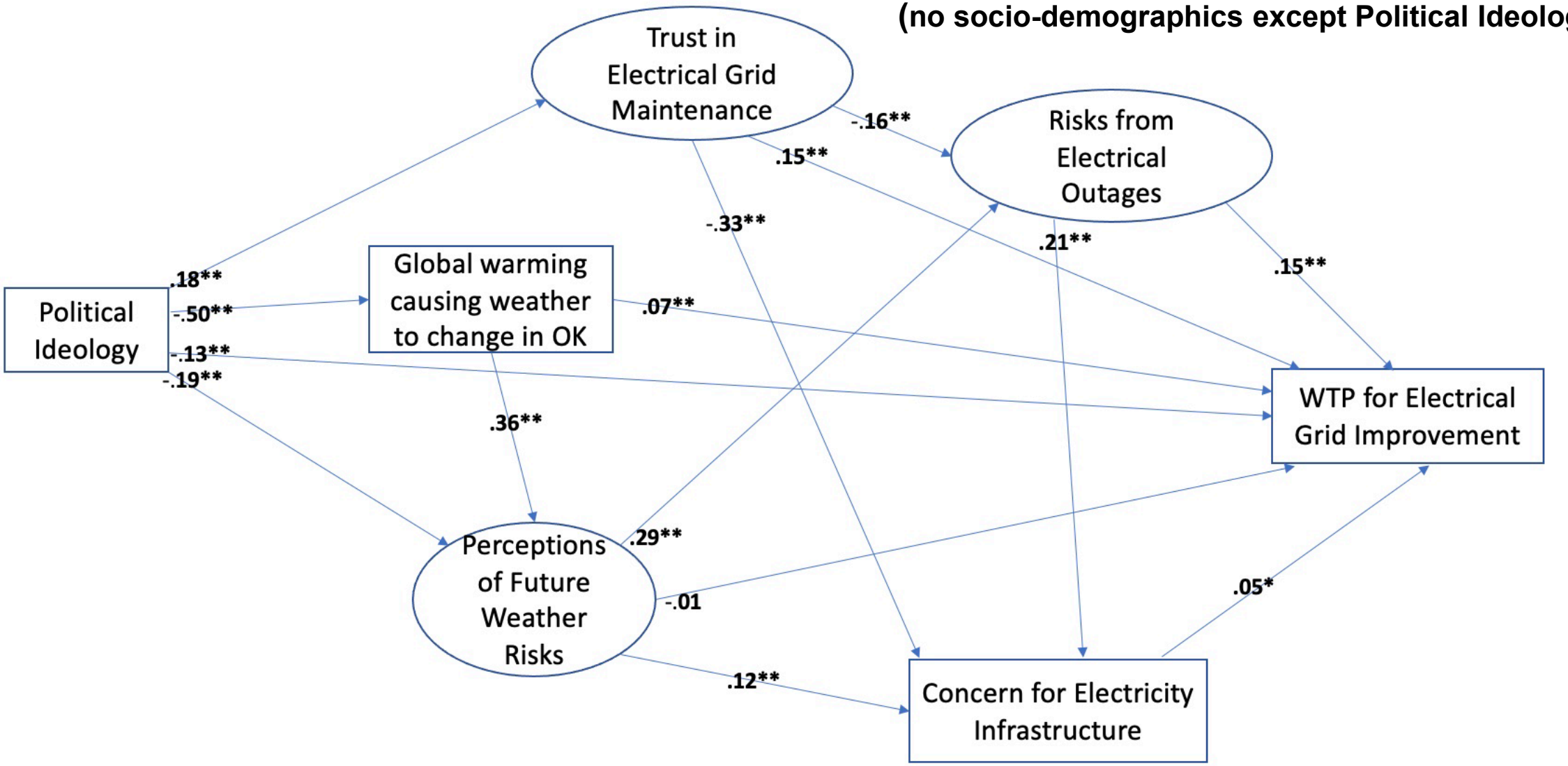


Notes: *N*=2,031; standardized coefficients are presented; **$p<0.01$; *$p<0.05$ sig., Chi-square = 629.6 (df=155), Comparative Fit Index (CFI) = 0.959, Root Mean Square Error Approx. (RMSEA) = 0.039

Measurement: Observed Variables

Figure 3. Empirical Relationships Among Constructs and Variables

(no socio-demographics except Political Ideology)



Results: Concern for Electricity Infrastructure

- Perceptions of Future Weather Risks (more weather risks, more concern for infrastructure)
- Trust in Electrical Grid Maintenance (less trust, more concern for infrastructure)
- Risks from Electrical Outages (more risks, more concern for infrastructure)

Results: WTP for Electrical Grid Improvements

- Price (higher cost/price, lower WTP)
- Gender (males higher WTP than females)
- Political Ideology (more conservative, lower WTP)
- Race (non-whites lower WTP than whites)
- Income (higher income, higher WTP)
- Global warming causing weather to change in OK (yes to global warming, higher WTP)
- Trust in Electrical Grid Maintenance (more trust, higher WTP)
- Risk of Electrical Outages (more risks, higher WTP)
- Concern for Electrical Infrastructure (more concern, higher WTP)

Results: Views on global warming

- Global Warming
  - Political ideology
    - (more liberal, more likely to believe global warming is causing weather to change in OK)
  - Race
    - (non-whites believe that global warming is causing weather to change more, compared to whites)

Results: Views on perceptions of future weather risks

- Perceptions of Future Weather Risks
  - Global warming
    - (more likely to believe that global warming is causing weather to change in OK, more likely to perceive future weather risks)
  - Political ideology
    - (more liberal, more likely to perceive future weather risks)
  - Income
    - (higher income, lower future weather risks)

Discussion

- These findings highlight linkages between S3OK research areas: SD, S2S, and SI.
- Our model suggests that concern for the electrical grid and WTP for electrical grid improvement are the results of a combination of factors, including:
  - political ideology, views on global warming, perceptions of future weather risks, trust in grid maintenance, and risks from electrical outages.

Policy

- How do we use these results to inform policy and other S3OK research areas?
  - There appears to be opportunities to (1) decrease concern for electrical infrastructure, (2) increase WTP for electrical grid improvement, among the OK public, by focusing on:
    - Increasing the trust in electrical grid maintenance
    - Being more prepared for the perceived increases in weather related risks
    - Reducing the frequency and intensity of electrical outages