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# American Belief in Climate Change

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STAT-415/615

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# Introduction



- Fewer than half of all Americans believe that climate change is due to human activity.
  - More than 20% of Americans do not believe that climate change is occurring at all.
  - What factors influence American belief in climate change?
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# Variables

What might influence belief in climate change in the US?

Estimated % of adults who think global warming is happening, 2020



## Response Variable:

- % of adults who think global warming is happening

## Predictor Variable(s):

- Political party affiliation
  - Weather and climate disasters (with losses exceeding \$1 billion)
  - Educational attainment (bachelor's degree or higher)
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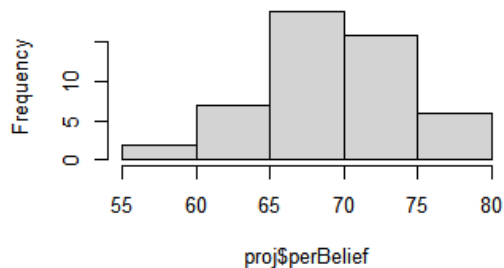
# Data Sources



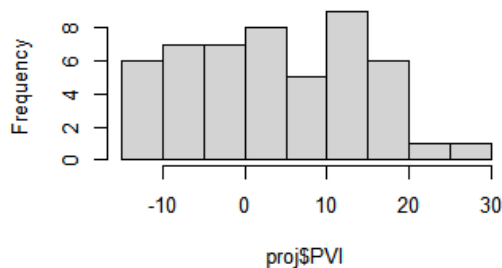
- **Yale Climate Opinion Maps 2020 - (perBeLief)**
    - estimated % of adults who think global warming is happening
    - public opinion survey about global warming, collected spring 2020
  - **Cook Partisan Voting Index - (PVI)**
    - measurement of how strongly a state leans toward the Democratic or Republican Party (compared to the nation as a whole), e.g. Vermont D+15, Wyoming R+26
    - results based on results from 2016 and 2020 elections
  - **Billion-Dollar Weather and Climate Disasters - (disEvents)**
    - weather and climate disasters where overall damages/costs reached or exceeded \$1 billion, using events that occurred 2019-2020
  - **Educational Attainment: Bachelor's Degree or higher - (perBachelor)**
    - populations' educational attainment for all people of at least 25 years of age
    - U.S. Census Bureau's American Community Survey in 2019
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# Exploratory Data Analysis

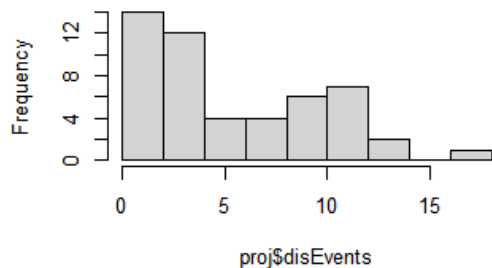
**Histogram of proj\$perBelief**



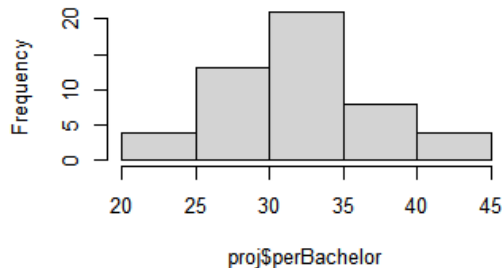
**Histogram of proj\$PVI**



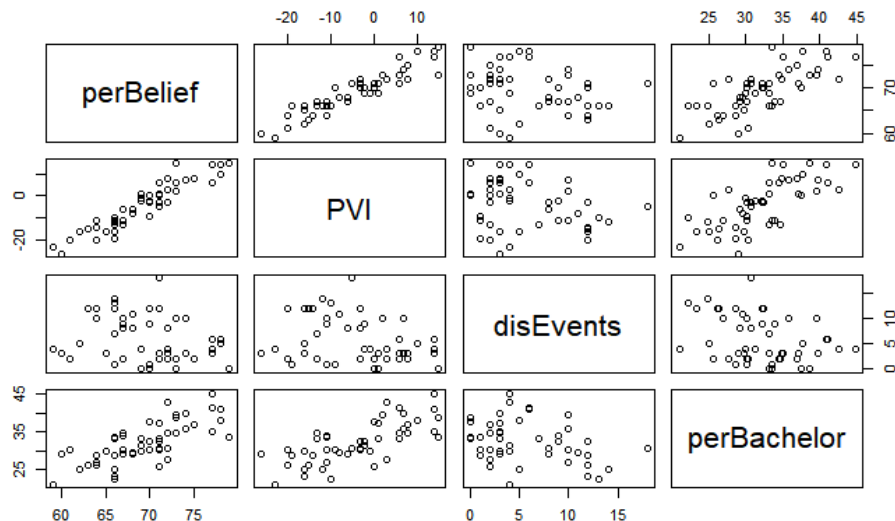
**Histogram of proj\$disEvents**



**Histogram of proj\$perBachelor**



# Exploratory Data Analysis



```
##           perBelief      PVI  disEvents perBachelor
## perBelief    1.0000000  0.9401619 -0.2211267   0.7279898
## PVI          0.9401619  1.0000000 -0.2962750   0.7180707
## disEvents   -0.2211267 -0.2962750  1.0000000  -0.3328239
## perBachelor  0.7279898  0.7180707 -0.3328239  1.0000000
```

# Model

Call:

```
lm(formula = perBelief ~ PVI + disEvents + perBachelor, data = proj)
```

Residuals:

	Min	1Q	Median	3Q	Max
	-3.9710	-1.0627	-0.1624	0.8593	3.3262

Coefficients:

	Estimate	Std. Error	t value	Pr(> t )	
(Intercept)	66.63342	2.19348	30.378	<2e-16	***
PVI	0.38906	0.03073	12.662	<2e-16	***
disEvents	0.08482	0.05389	1.574	0.1224	
perBachelor	0.11644	0.06291	1.851	0.0706	.

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Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.608 on 46 degrees of freedom

Multiple R-squared: 0.8953, Adjusted R-squared: 0.8885

F-statistic: 131.1 on 3 and 46 DF, p-value: < 2.2e-16

$$\widehat{perBelief} = 66.63 + 0.3891(PVI) + 0.08482(disEvents) + 0.1164(perBachelor)$$

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# Variable Selection (Stepwise)

```
# AIC
step(reg1, direction="both")
```

```
## Start:  AIC=51.33
## perBelief ~ PVI + disEvents + perBachelor
##
##           Df Sum of Sq    RSS    AIC
## <none>                 118.94  51.330
## - disEvents    1      6.40 125.34  51.952
## - perBachelor  1      8.86 127.80  52.922
## - PVI          1     414.53 533.47 124.369
```

```
##
## Call:
## lm(formula = perBelief ~ PVI + disEvents + perBachelor, data = proj)
##
## Coefficients:
## (Intercept)          PVI    disEvents  perBachelor
##    66.63342     0.38906     0.08482     0.11644
```

```
# BIC
step(reg1, direction="both", k=log(length(reg1$fit)))
```

```
## Start:  AIC=58.98
## perBelief ~ PVI + disEvents + perBachelor
##
##           Df Sum of Sq    RSS    AIC
## - disEvents    1      6.40 125.34  57.688
## - perBachelor  1      8.86 127.80  58.658
## <none>                 118.94  58.978
## - PVI          1     414.53 533.47 130.105
##
## Step:  AIC=57.69
## perBelief ~ PVI + perBachelor
##
##           Df Sum of Sq    RSS    AIC
## - perBachelor  1      6.56 131.91  56.327
## <none>                 125.34  57.688
## + disEvents    1      6.40 118.94  58.978
## - PVI          1     408.70 534.04 126.246
##
```

```
## Step:  AIC=56.33
## perBelief ~ PVI
##
##           Df Sum of Sq    RSS    AIC
## <none>                 131.91  56.327
## + perBachelor  1      6.56 125.34  57.688
## + disEvents    1      4.11 127.80  58.658
## - PVI          1    1004.27 1136.18 160.082
```

```
##
## Call:
## lm(formula = perBelief ~ PVI, data = proj)
##
## Coefficients:
## (Intercept)          PVI
##    70.9987       0.4199
```



# Model Selection - Comparison

`perBelief ~ PVI + disEvents + perBachelor`

(from AIC stepwise)

	rsq	adj.rsq	aic	bic	press
[1,]	0.8953162	0.888489	<u>51.32967</u>	58.97776	141.591

`perBelief ~ PVI`

(from BIC stepwise)

	rsq	adj.rsq	aic	bic	press
[1,]	0.8839044	0.8814858	52.50312	<u>56.32716</u>	145.4168

# ANOVA

$$H_0 : \beta_2 = \beta_3 = 0$$

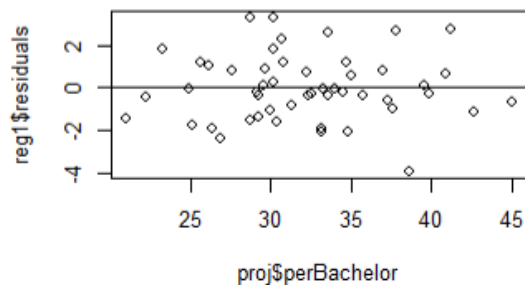
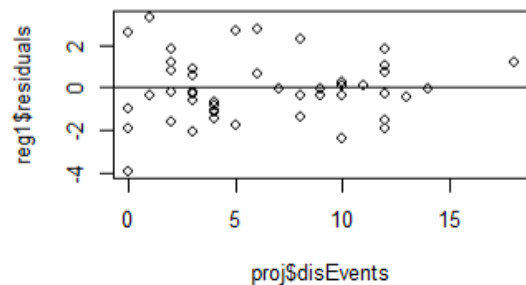
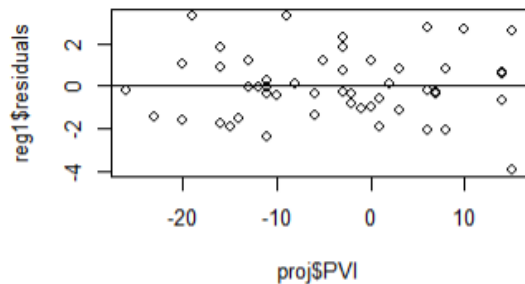
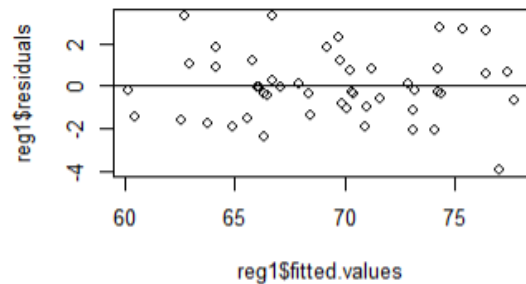
$$H_a : ALOI$$

```
## Analysis of Variance Table
##
## Model 1: perBelief ~ PVI
## Model 2: perBelief ~ PVI + disEvents + perBachelor
##   Res.Df    RSS Df Sum of Sq    F    Pr(>F)
## 1      48 131.91
## 2      46 118.94  2    12.966 2.5073 0.09257 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

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# Residuals



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# Influential Cases

```
inflm.proj <- influence.measures(reg1)  
which(apply(inflm.proj$is.inf, 1, any))
```

```
## 45 50
```

```
## 45 50
```

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# Influential Cases

```
inflm.proj <- influence.measures(reg1)  
which(apply(inflm.proj$is.inf, 1, any))
```

```
## 45 50
```

```
## 45 50
```

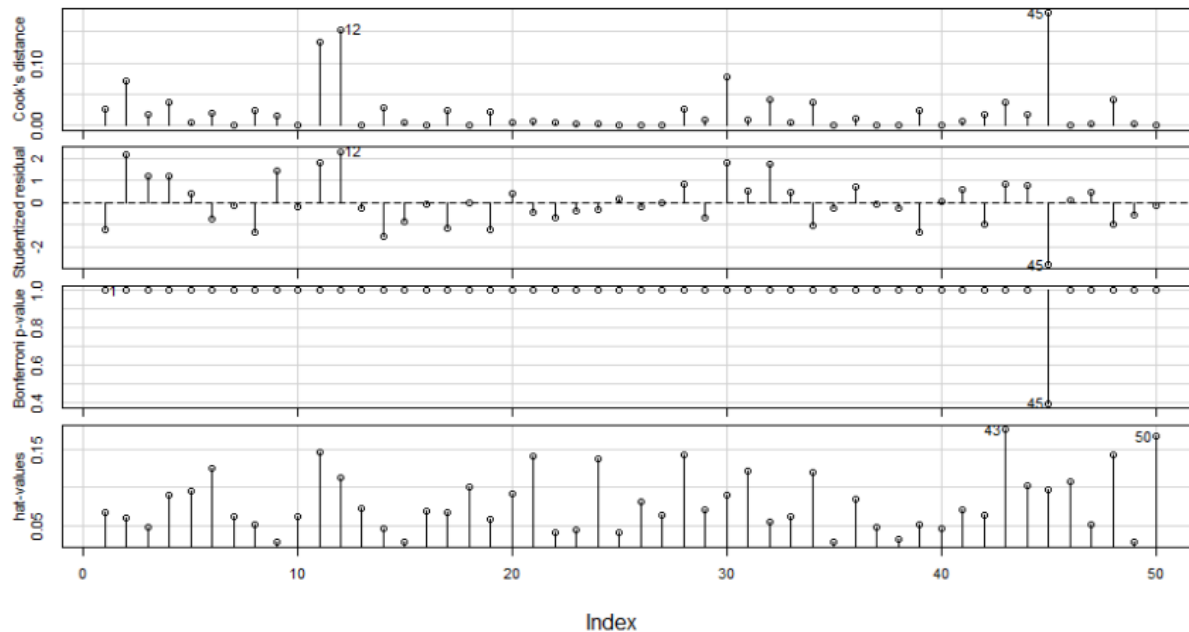
## Wyoming and Vermont

- Most Republican & Democratic leaning states (respectively)

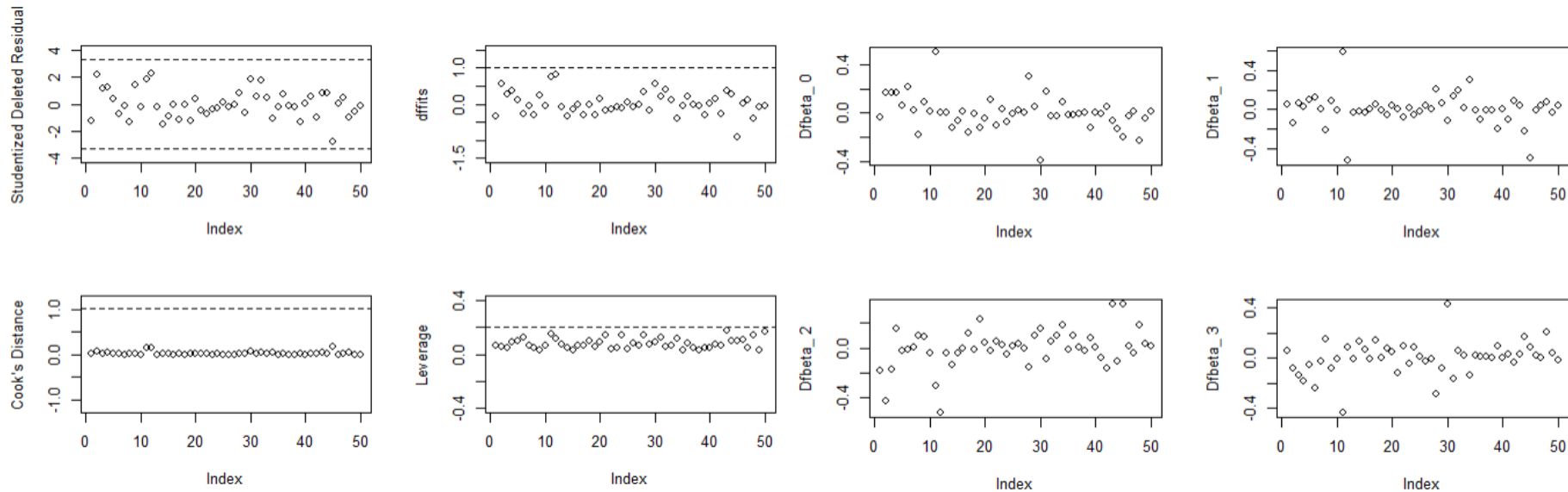


# Diagnostics

Diagnostic Plots



# Diagnostics



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# Conclusions

- Political lean/affiliation appears to be the dominant predictor for American belief in climate change
  - Disaster events and/or bachelor's degree may not appear to have a significant effect on climate change belief  
*(but may need to revise research question/models to assess this further)*
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## Limitations

- Small dataset
- High association with political affiliation
  - More variables to be considered?
- Could have considered control variables and/or interactions

## Opportunities

- In-depth analysis for political affiliations and specific climate policies
    - Account for political nuances, local economies, variety for disasters
    - Test more than belief; i.e. support for policies like a carbon tax, individual behaviors
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# References

- Yale Climate Opinion Maps 2020  
<https://climatecommunication.yale.edu/visualizations-data/ycom-us/>
  - Cook Partisan Voting Index  
[https://en.wikipedia.org/wiki/Cook\\_Partisan\\_Voting\\_Index](https://en.wikipedia.org/wiki/Cook_Partisan_Voting_Index)
  - NOAA National Centers for Environmental Information  
<https://www.ncdc.noaa.gov/billions/>
  - U.S. Census Bureau, American Community Survey  
[https://en.wikipedia.org/wiki/List\\_of\\_U.S.\\_states\\_and\\_territories\\_by\\_educational\\_attainment](https://en.wikipedia.org/wiki/List_of_U.S._states_and_territories_by_educational_attainment)
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