# Machine Learning and the Politics of Climate Change

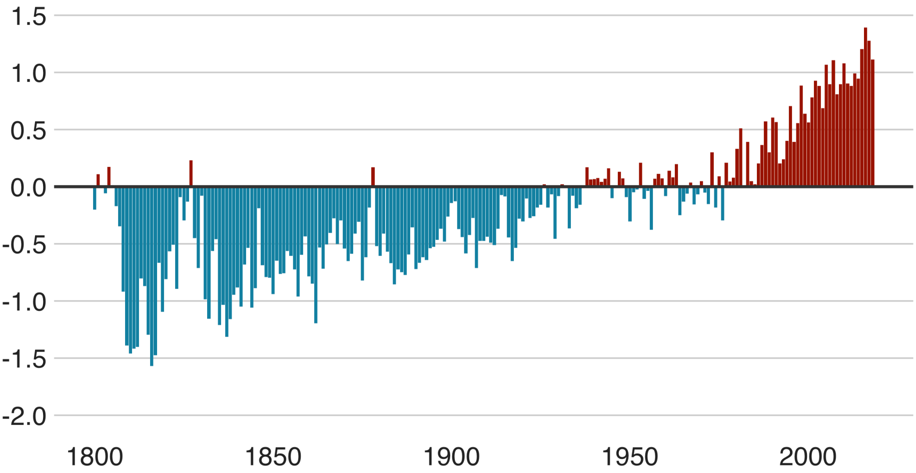
Liam F. Beiser-McGrath

www.liambeisermcgrath.com

Universität Konstanz & ETH Zürich

# The world has been getting warmer

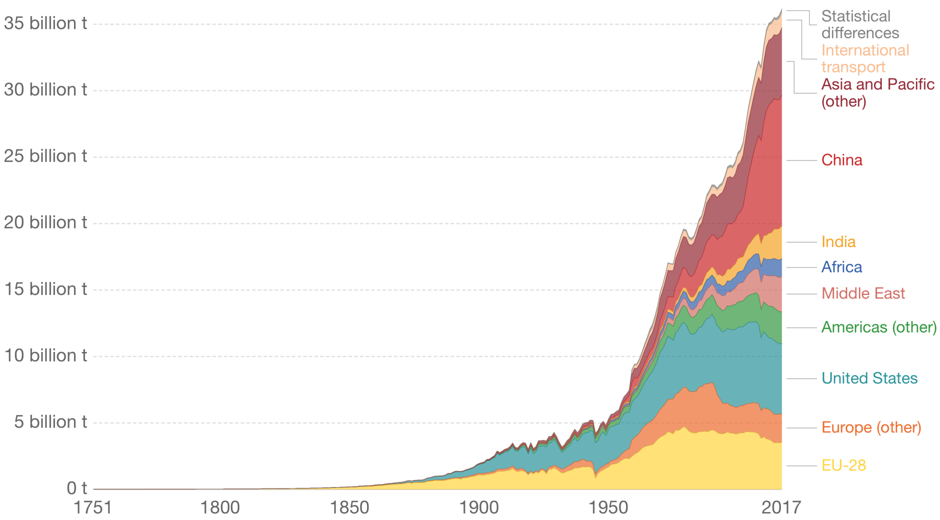
Annual mean land temperature above or below average (°C)




Note: Average is calculated from 1951-1980 land surface temperature data

Source: University of California Berkeley

# Annual total $CO_2$ emissions, by world region




Source: Carbon Dioxide Information Analysis Center (CDIAC); Global Carbon Project (GCP)
Note: "Statistical differences" notes the discrepancy between estimated global emissions and the sum of all national and international transport emissions.
OurWorldInData.org/co2-and-other-greenhouse-gas-emissions • CC BY

THE WALL STREET JOURNAL.

THURSDAY, JANUARY 17, 2019

**Original Co-Signatories Include (full list on reverse):**

**4** Former Chairs of the Federal Reserve (All)

**27** Nobel Laureate Economists

**15** Former Chairs of the Council of Economic Advisers

**2** Former Secretaries of the U.S. Department of Treasury

# Economists' Statement on Carbon Dividends


TRUMP
WV
COAL

# Machine Learning to Understand Climate Change Politics

**Complexity:** Multiple design choices and solutions

**Complexity:** Multiple design choices and solutions

$\Longrightarrow$ Inference in high-dimensional settings

# This Talk:

Value added of machine learning:

# This Talk:

Value added of machine learning:

1. Regional variation

# This Talk:

Value added of machine learning:

1. Regional variation
2. Individual heterogeneity

# Policy Design and Support for Carbon Taxation

SCIENCE ADVANCES | RESEARCH ARTICLE

SCIENCE POLICY

# Could revenue recycling make effective carbon taxation politically feasible?

Liam F. Beiser-McGrath*† and Thomas Bernauer*


A
B

# Effect of Carbon Tax Design Features Upon Political Feasibility

1. Price of Tax
2. Revenue Usage
3. Inclusion of Other Countries
4. Border Adjustments
5. Domestic Exemptions

| | |
|---|---|
| 1. Cost of carbon tax | 1. $10 per metric ton ($144 per year for average consumer)<br>2. $20 per metric ton ($288 per year for average consumer)<br>3. $30 per metric ton ($432 per year for average consumer)<br>4. $40 per metric ton ($576 per year for average consumer)<br>5. $50 per metric ton ($720 per year for average consumer)<br>6. $60 per metric ton ($864 per year for average consumer)<br>7. $70 per metric ton ($1008 per year for average consumer) |
| 2. Energy-intensive products imported from other countries | 1. Fully exempted (pay no carbon tax)<br>2. Taxed at half rate (pay only half of the carbon tax)<br>3. Taxed equally (pay full carbon tax) |
| 3. Domestic companies exporting energy-intensive products to other countries | 1. Fully exempted (pay no carbon tax)<br>2. Taxed at half rate (pay only half of the carbon tax)<br>3. Taxed equally (pay full carbon tax) |
| 4. Similar carbon tax introduced by | 1. No other countries<br>2. European countries (European Union)<br>3. China<br>4. United States<br>5. India<br>6. Canada<br>7. Japan<br>8. All industrialized countries<br>9. All developing countries |
| **[Randomly assigned to be seen by half of the respondents]**<br>5. Additional public revenue, i.e., carbon dividends, used for | 1. Tax rebate paid to everyone<br>2. Reduce federal government deficit<br>3. Fund renewable energy sources (e.g., solar, wind, and geothermal power)<br>4. Fund infrastructure (e.g., railways, roads, and public transportation)<br>5. Fund programs for low-income families<br>6. Reduce income tax<br>7. Reduce corporate tax<br>8. Fund retraining programs for workers in fossil fuel sector |

# Effect of Carbon Tax Design Features Upon Political Feasibility

31 Features = A-Beyond Z testing

# Effect of Carbon Tax Design Features Upon Political Feasibility

31 Features = A-Beyond Z testing

- Not so bad...

# Effect of Carbon Tax Design Features Upon Political Feasibility

31 Features = A-Beyond Z testing

- Not so bad...

...but

# Effect of Carbon Tax Design Features Upon Political Feasibility

31 Features = A-Beyond Z testing

- Not so bad...

...but

- What if effect of price depends on revenue use?

# Effect of Carbon Tax Design Features Upon Political Feasibility

31 Features = A-Beyond Z testing

- Not so bad...

...but

- What if effect of price depends on revenue use?
- What if effect of border adjustment depends on other countries involvement?

# Effect of Carbon Tax Design Features Upon Political Feasibility

31 Features = A-Beyond Z testing

- Not so bad...

...but

- What if effect of price depends on revenue use?
- What if effect of border adjustment depends on other countries involvement?

= 366 features

# Effect of Carbon Tax Design Features Upon Political Feasibility

366 Features

# Effect of Carbon Tax Design Features Upon Political Feasibility

366 Features

1. Regional Heterogeneity

# Effect of Carbon Tax Design Features Upon Political Feasibility

366 Features

1. Regional Heterogeneity
   - 50 US States $\times$ 366 Features $=$ 18300

# Effect of Carbon Tax Design Features Upon Political Feasibility

366 Features

1. Regional Heterogeneity
   - 50 US States $\times$ 366 Features $=$ 18300
2. Individual Heterogeneity

# Effect of Carbon Tax Design Features Upon Political Feasibility

366 Features

1. Regional Heterogeneity
   - 50 US States $\times$ 366 Features $=$ 18300
2. Individual Heterogeneity
   - $\{\text{age}, \text{sex}, \text{income}, \text{PID}\} \times$ 366 Features $\approx$ 4026

# Effect of Carbon Tax Design Features Upon Political Feasibility

366 Features

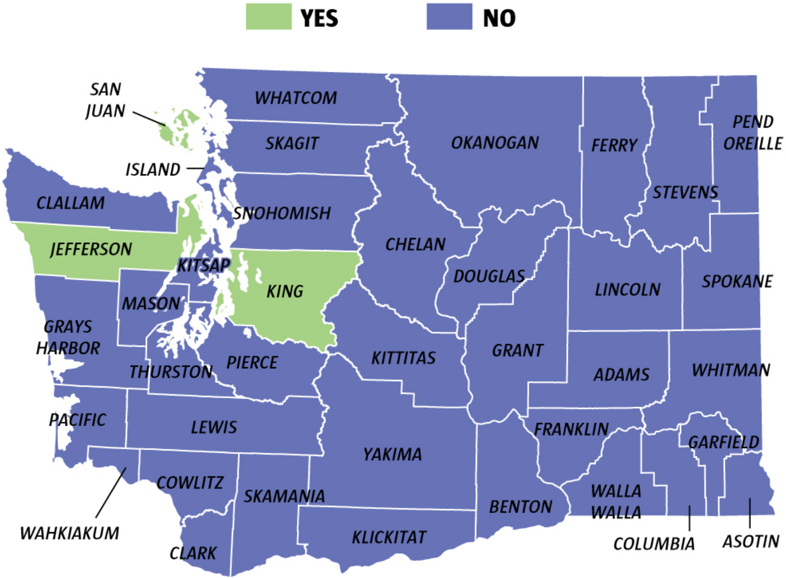
1. Regional Heterogeneity
   - 50 US States $\times$ 366 Features $=$ 18300
2. Individual Heterogeneity
   - $\{\text{age}, \text{sex}, \text{income}, \text{PID}\} \times$ 366 Features $\approx$ 4026

$\Longrightarrow$ Need for Machine Learning

# Geographic Heterogeneity

YES ON
1631

County-by-county results, in Tuesday's vote count.




Source: Washington Secretary of State

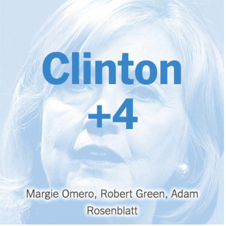
MARK NOWLIN / THE SEATTLE TIMES

# We Gave Four Good Pollsters the Same Raw Data. They Had Four Different Results.

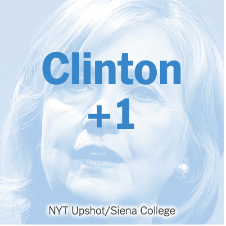
By NATE COHN SEPT. 20, 2016

How four pollsters, and The Upshot, interpreted 867 poll responses:









*American Political Science Review* (2019) 113, 4, 1060–1065
doi:10.1017/S0003055419000480 

# Letter

# BARP: Improving Mister P Using Bayesian Additive Regression Trees

JAMES BISBEE *New York University*

# BARP: Bayesian Additive Regression Trees with Post-Stratification

# BARP: Bayesian Additive Regression Trees with Post-Stratification

1. Bayesian Additive Regression Trees to predict individual support

# BARP: Bayesian Additive Regression Trees with Post-Stratification

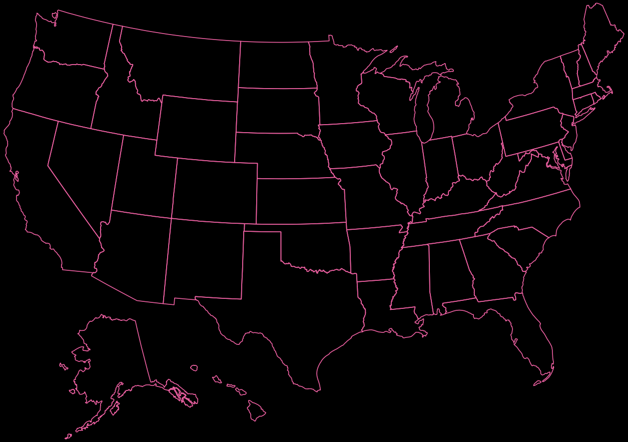
1. Bayesian Additive Regression Trees to predict individual support
2. Combine with state demographic data

# BARP: Bayesian Additive Regression Trees with Post-Stratification

1. Bayesian Additive Regression Trees to predict individual support
2. Combine with state demographic data

$\Longrightarrow$ robust regional predictions from individual data

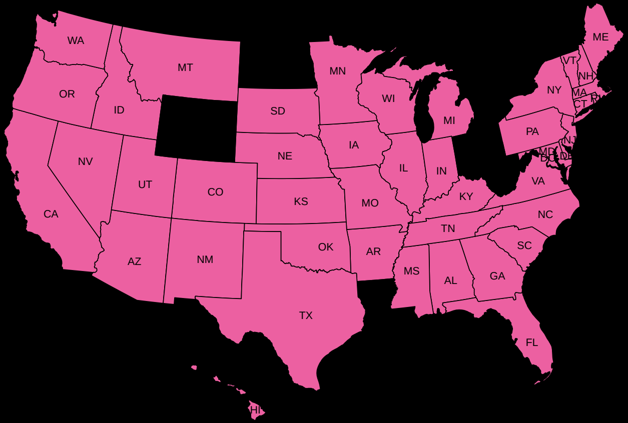
# $50 Carbon Tax: Support by State



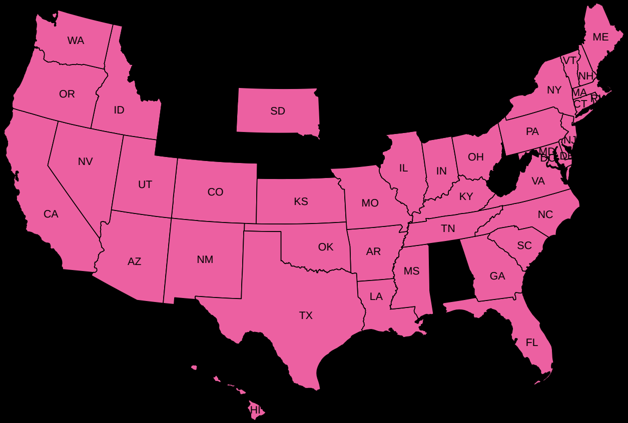
# $50 Carbon Tax: No Revenue Use & No Other Countries

# $50 Carbon Tax: No Revenue Use & No Other Countries

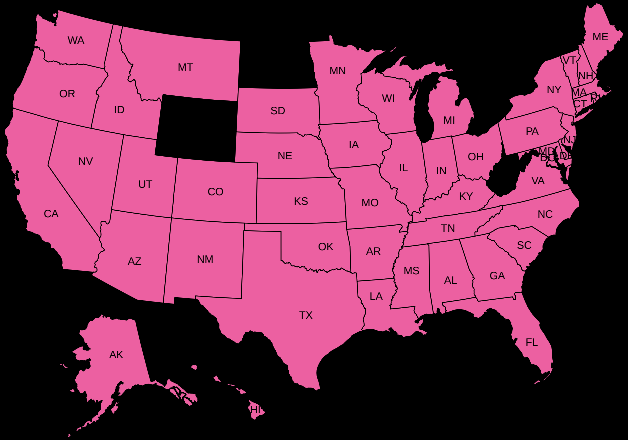
# $50 Carbon Tax: Tax Rebate & No Other Countries



# $50 Carbon Tax: No Revenue Use & Industrialised Countries



# $50 Carbon Tax: Tax Rebate & Industrialised Countries



# Individual Heterogeneity

# Optimising Individual Treatment Assignment

- **Standard Goal:** Maximise ability to predict outcome

## Optimising Individual Treatment Assignment

- **Standard Goal:** Maximise ability to predict outcome
- **Alternative Goal:** Maximise based on subgroup effect in subgroups *("lift")*

*The Annals of Statistics*
2019, Vol. 47, No. 2, 1148–1178
https://doi.org/10.1214/18-AOS1709


# GENERALIZED RANDOM FORESTS

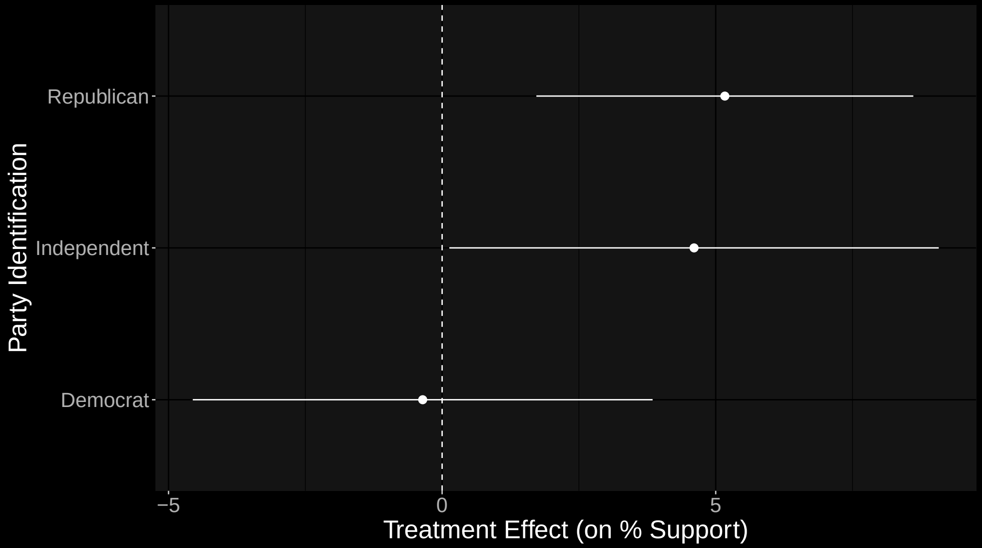
BY SUSAN ATHEY*, JULIE TIBSHIRANI† AND STEFAN WAGER*

*Stanford University* and Elasticsearch BV*†*

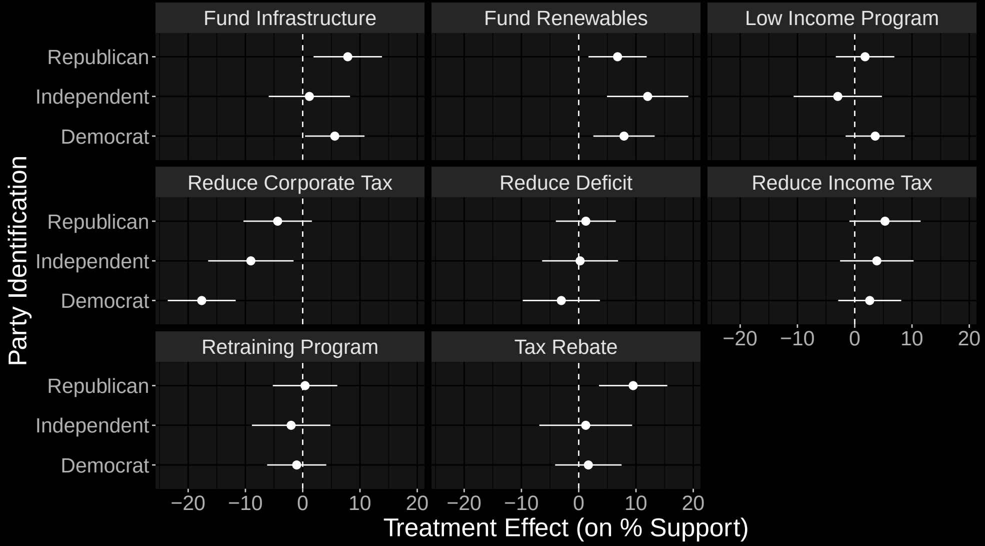
# Individual Characteristics

- Age
- Climate Scepticism
- Education
- Income
- Party Identification
- Sex

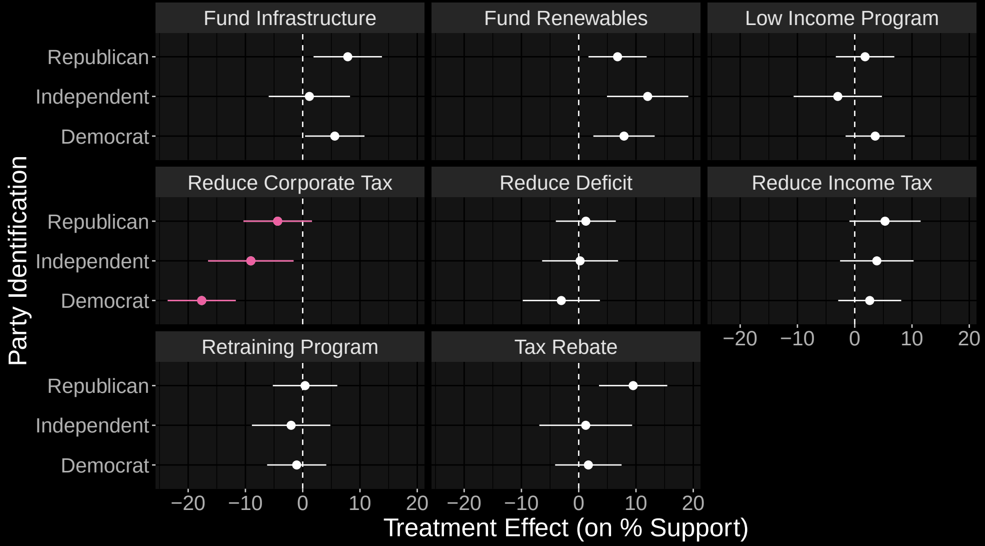
# Effect of Revenue Information by Party Identification



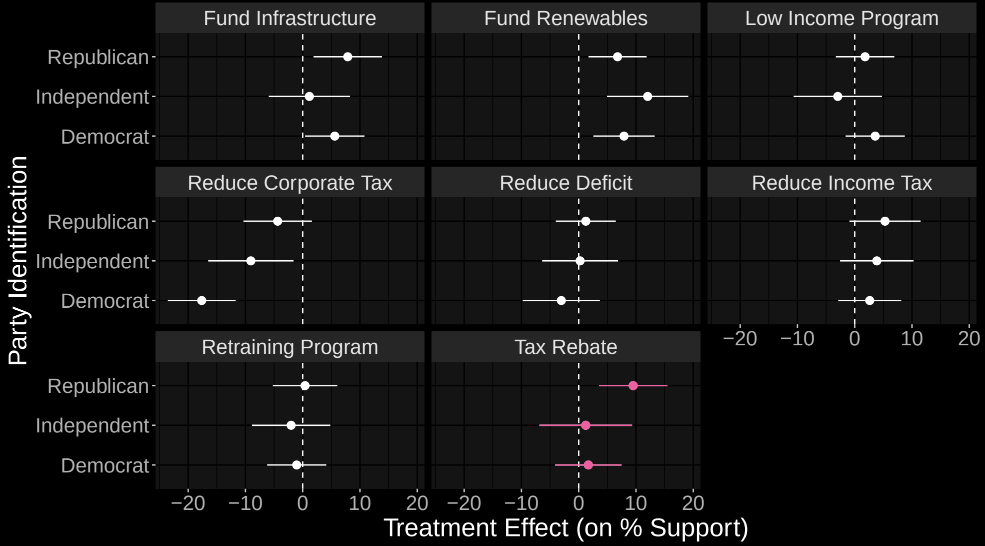
# Effect of Revenue Usage by Party Identification



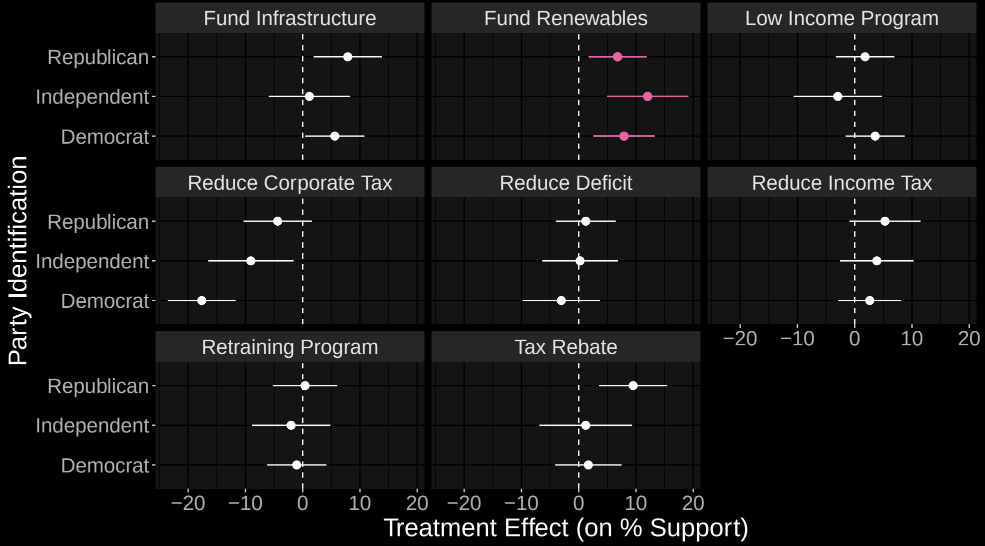
# Effect of Revenue Usage by Party Identification



# Effect of Revenue Usage by Party Identification



# Effect of Revenue Usage by Party Identification



# Conclusion

# Conclusion

Politics integral to Climate Change

# Conclusion

Politics integral to Climate Change

Complexity

# Conclusion

Politics integral to Climate Change

Complexity

Machine Learning provides additional answers

# Conclusion

Politics integral to Climate Change

Complexity

Machine Learning provides additional answers

- Robust estimates of individual and regional heterogeneity
- Allowing for conditional effects

# Conclusion

Politics integral to Climate Change

Complexity

Machine Learning provides additional answers

- Robust estimates of individual and regional heterogeneity
- Allowing for conditional effects

Thank you!

www.liambeisermcgrath.com