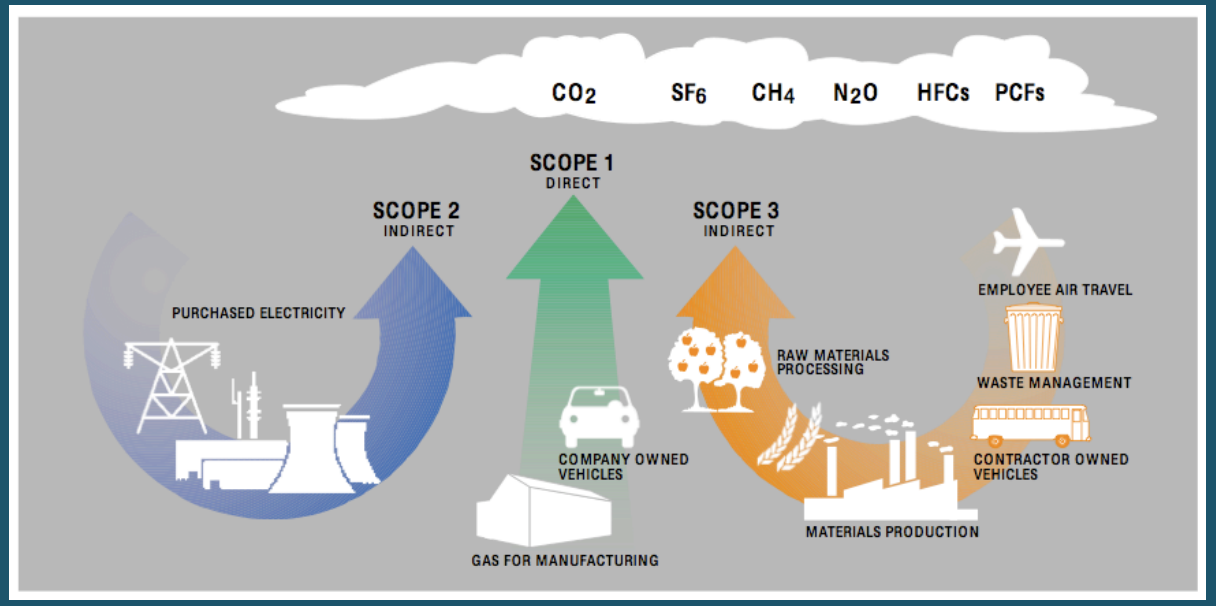
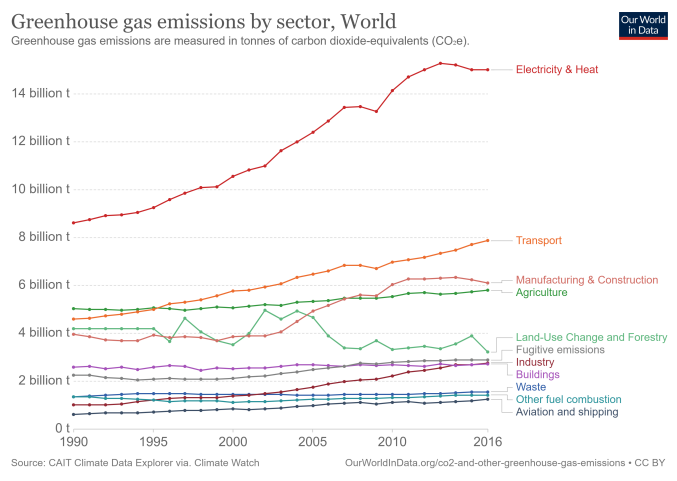
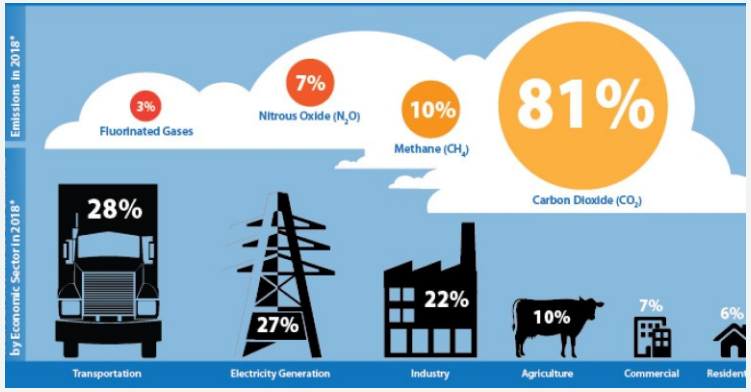
GREENHOUSE GAS EMISSIONS REGRESSION ANALYSIS



Presented by Samuel Robbins
METIS | September 2021

Project Premise





- Greenhouse Gases (GHG) contribute significantly to ongoing climate change and are key factors when considering the magnitude of future warning
- The premise behind this regression analysis is to model GHG emissions as a function of company size, industry, location, and other key features
- Societal Goal: predict the largest emitters based on the given criteria to target legislative, activist, and social lobbying campaigns

Why Model Greenhouse Gas Emissions?

VB VentureBeat

AI can estimate corporate greenhouse gas emissions

Researchers claim to have developed a model that can estimate the greenhouse gas emissions of companies in a range of industries.

7 hours ago

Data Model

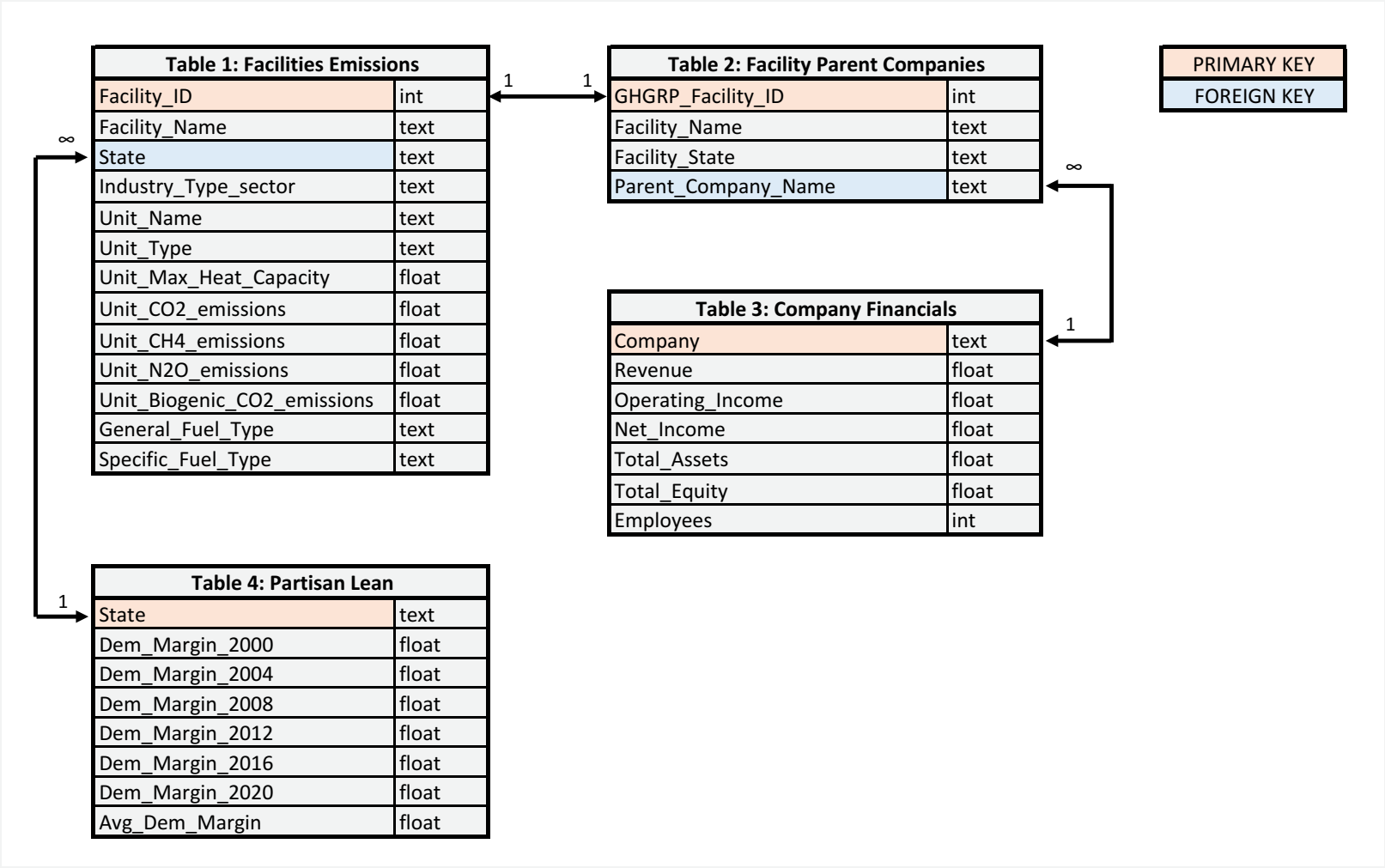
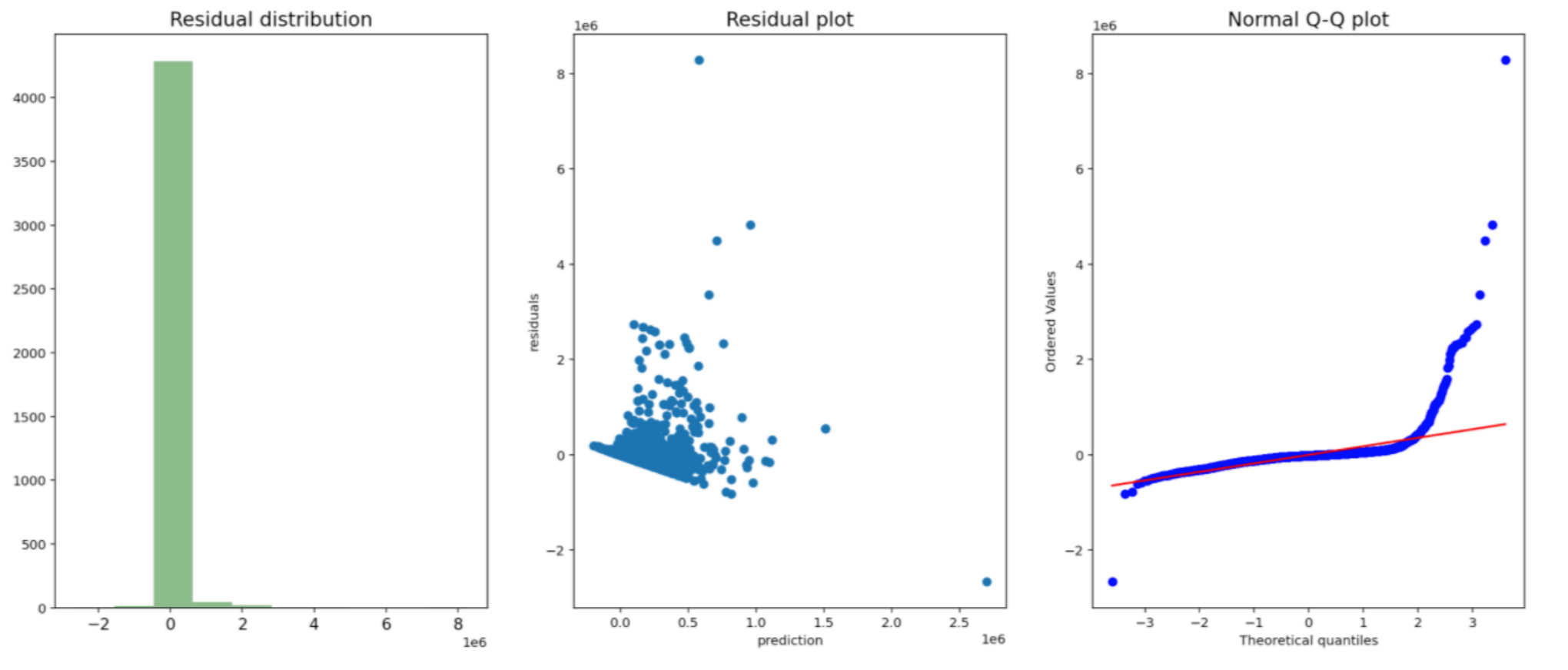


Table 1: Facilities Emissions
Facility_ID int
Facility_Name text
State text
Industry_Type_sector text
Unit_Name text
Unit_Type text
Unit_Max_Heat_Capacity float
Unit_CO2_emissions float
Unit_CH4_emissions float
Unit_N2O_emissions float
Unit_Biogenic_CO2_emissions float
General_Fuel_Type text
Specific_Fuel_Type text
Table 2: Facility Parent Companies
GHGRP_Facility_ID int
Facility_Name text
Facility_State text
Parent_Company_Name text
Table 3: Company Financials
Company text
Revenue float
Operating_Income float
Net_Income float
Total_Assets float
Total_Equity float
Employees int
Table 4: Partisan Lean
State text
Dem_Margin_2000 float
Dem_Margin_2004 float
Dem_Margin_2008 float
Dem_Margin_2012 float
Dem_Margin_2016 float
Dem_Margin_2020 float
Avg_Dem_Margin float
1
1
∞
1
∞
1
1
PRIMARY KEY
FOREIGN KEY

Final Dataset

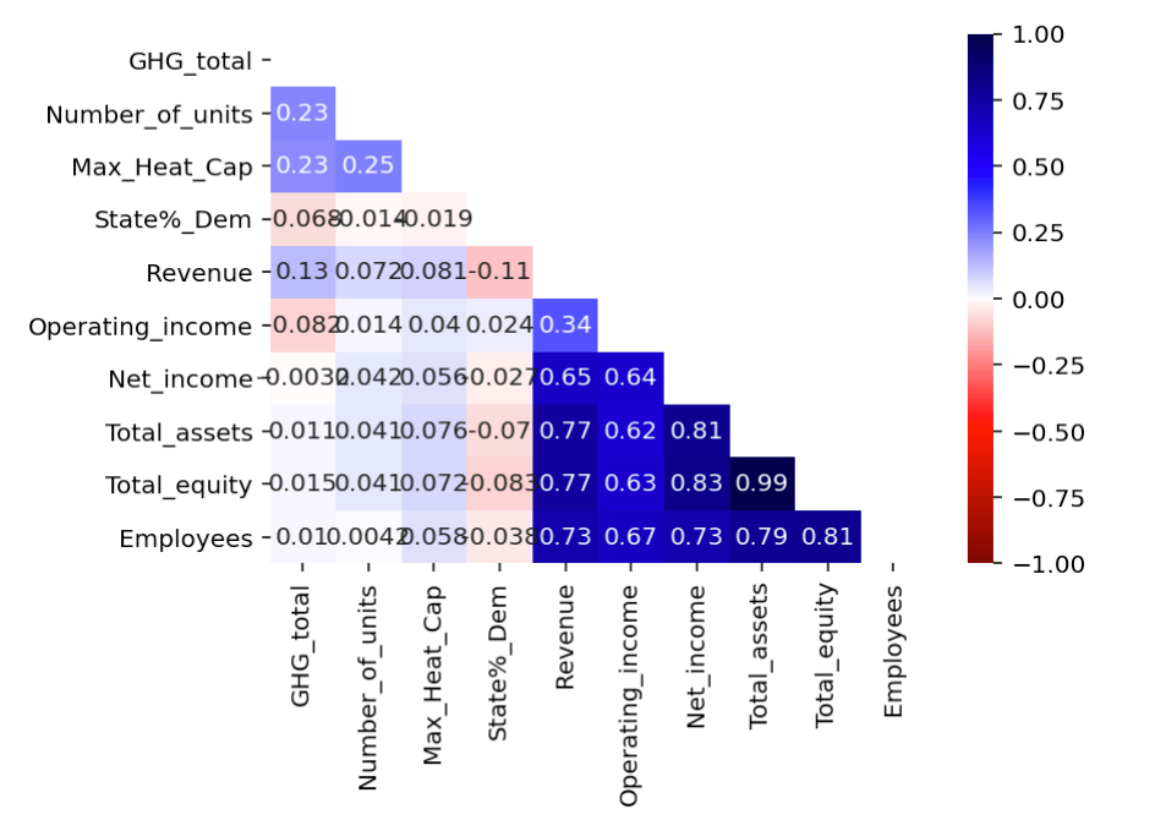
Final Modeling Dataset	
Variable	**Variable Type**
Total_GHG	**Target**
Unit Type	Categorical - ***9 subgroups***
General Fuel Type	Categorical - ***4 subgroups***
Industry	Categorical - ***9 subgroups***
Number of Units	Numerical
Max Heat Capacity	Numerical
State Dem Swing (%)	Numerical
Revenue	Numerical
Operating Income	Numerical
Net Income	Numerical
Total Assets	Numerical
Total Equity	Numerical
Number of Employees	Numerical

Modeling and Feature Transformations



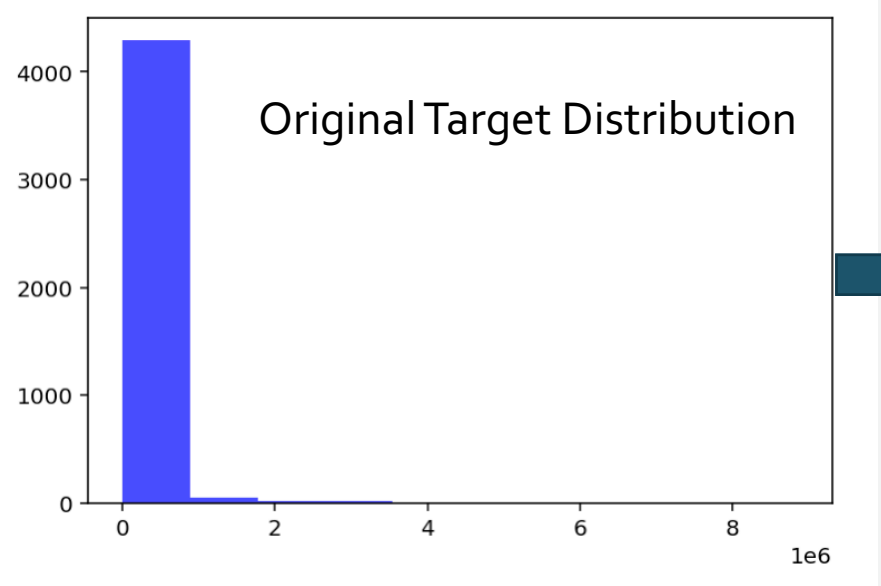
Baseline R^2 = .209

Modeling and Feature Transformations

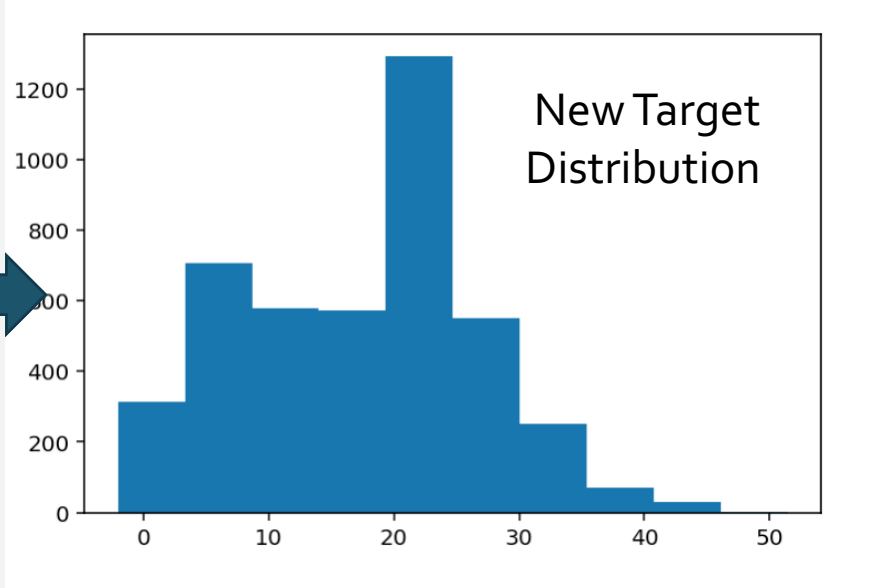


- Strong correlations within company financials
- Need to deal with multicollinearity issues

Modeling and Feature Transformations

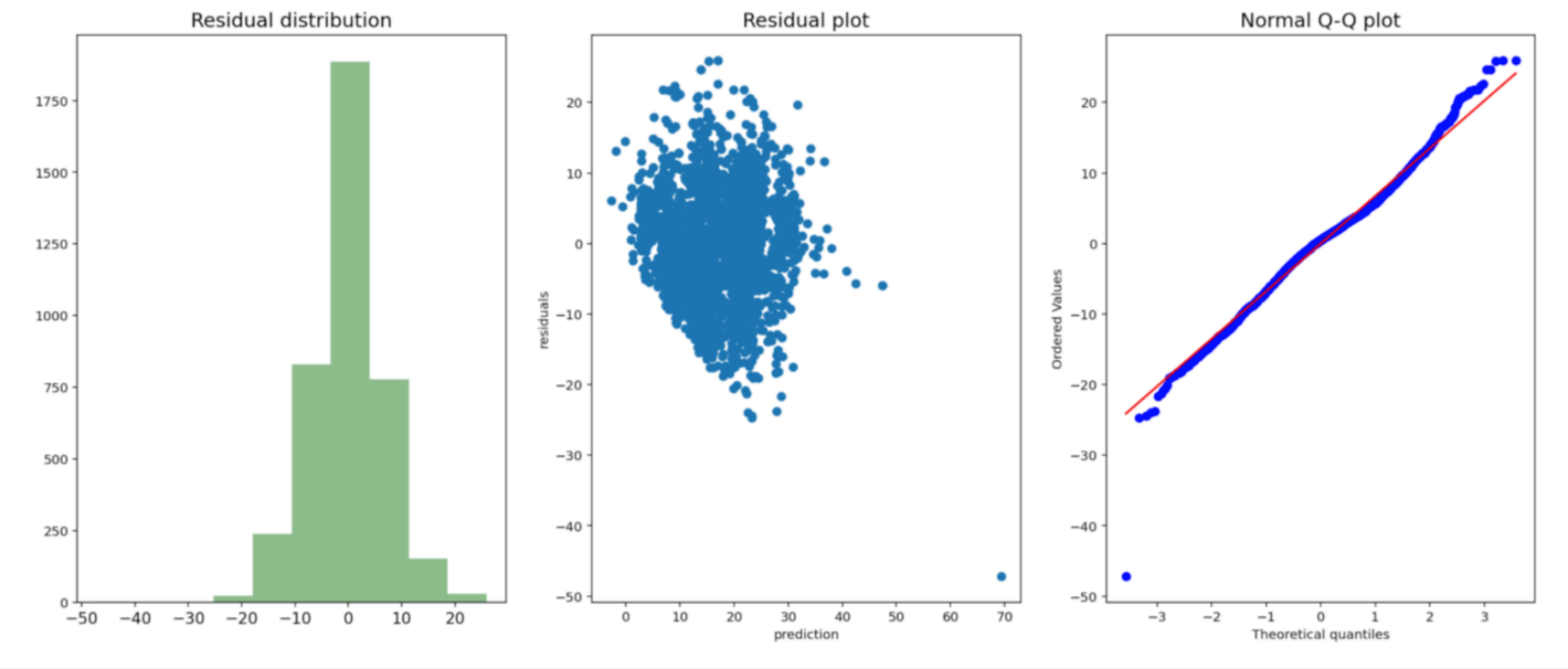


Box-Cox Transformation



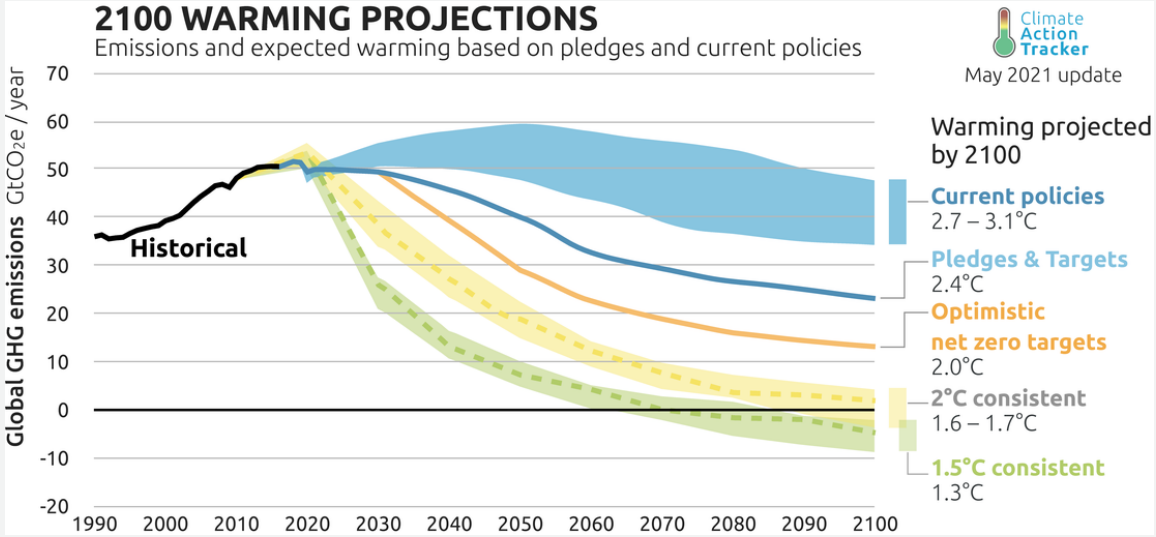
Final Model

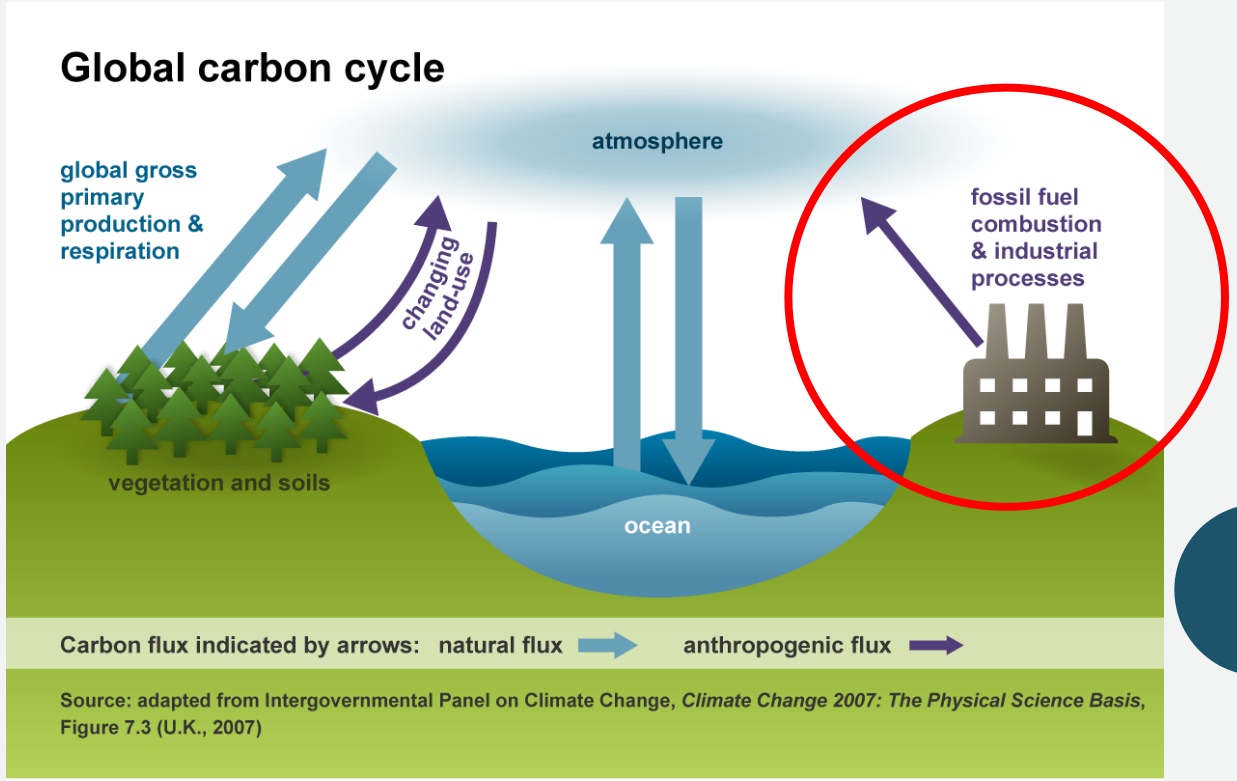
- Raised R^2 from baseline of 0.2099 to 0.4815 (LR) or 0.458 (RR)
  - Model parameters:
- dropped columns for Operating Income, Total Equity, and Net Income due to their multicollinearity
- Transformed y via box-cox transformation
- Another good model was the log of financial with a box-cox transformation on y



Closing Thoughts

- Difficult problem to model given inherent messiness of real world data
- Possible future work: narrow parent companies down to subsidiaries
  - EX. Berkshire Hathaway (Warren Buffets company) is a giant multinational corporation so that financial data is being trickled down to even their smallest facility





APPENDIX

References

WIKIPEDIA
The Free Encyclopedia

- https://www.epa.gov/ghgreporting/ghg-reporting-program-data-sets
  - Reported Parent Companies (xls)
  - Emissions by Unit and Fuel Type (zip)
- https://en.wikipedia.org/wiki/{ExxonMobil}
  - Parent Company Financial Data
- https://en.wikipedia.org/wiki/{2000}_United_States_presidential_election#Results
  - Election Results since 2000

Datasets

	Facility Id	Facility Name_x	State	Industry Type (sectors)	Unit Name	Unit Type	Unit Maximum Rated Heat Input Capacity (mmBTU/hr)	Unit CO2 emissions (non-biogenic)	Unit Methane (CH4) emissions	Unit Nitrous Oxide (N2O) emissions	Unit Biogenic CO2 emissions (metric tons)	Facility Name_y	General Fuel Type	Specific Fuel Type
0	1000112	23rd and 3rd	NY	Power Plants	2301	Electricity Generator	NaN	24768.9	11.50	14.90	0.0	23rd and 3rd	Natural Gas	Natural Gas (Weighted U.S. Average)
1	1000112	23rd and 3rd	NY	Power Plants	2302	Electricity Generator	NaN	19780.8	9.25	11.92	0.0	23rd and 3rd	Natural Gas	Natural Gas (Weighted U.S. Average)
2	1000112	23rd and 3rd	NY	Power Plants	Heatec1	PRH (Process Heater)	7.40000	30.2	0.00	0.00	0.0	23rd and 3rd	Natural Gas	Natural Gas (Weighted U.S. Average)
3	1000112	23rd and 3rd	NY	Power Plants	Heatec2	PRH (Process Heater)	7.40000	33.0	0.00	0.00	0.0	23rd and 3rd	Natural Gas	Natural Gas (Weighted U.S. Average)
4	1003742	31st Street Landfill	IL	Waste	CP-1	OCS (Other combustion source)	0.20125	246.9	0.00	0.00	0.0	31st Street Landfill	Natural Gas	Natural Gas (Weighted U.S. Average)

Datasets

	GHGRP FACILITY ID	FRS ID (FACILITY)	FACILITY NAME	FACILITY STATE	PARENT COMPANY NAME
0	1000355	1.100030e+11	#540 BONANZA CREEK ENERGY - DENVER BASIN	CO	BONANZA CREEK ENERGY INC
1	1004377	1.100438e+11	121 REGIONAL DISPOSAL FACILITY	TX	NORTH TEXAS MUNICIPAL WATER DISTRICT
2	1009238	1.100144e+11	220 Gulf Coast Basin DEC	OK	DEVON ENERGY CORP
3	1000112	1.100198e+11	23rd and 3rd	NY	NEW YORK POWER AUTHORITY
4	1012156	1.100701e+11	260 - East Texas Basin Gathering/Boosting	TX	BP AMERICA INC

Datasets

	Company	Revenue	Operating_income	Net_income	Total_assets	Total_equity	Employees
0	Air_Products_&_Chemicals	8.856000e+09	2.144000e+09	1.931000e+09	2.516920e+10	1.244300e+10	19275.0
1	Alliant_Energy_Corp	3.416000e+09	7.400000e+08	6.240000e+08	1.771031e+10	5.888000e+09	3375.0
2	Ameren_Corp	5.794000e+09	1.300000e+09	8.710000e+08	3.203031e+10	9.080000e+09	8615.0
3	American_Electric_Power	8.879000e+09	1.507000e+09	1.064000e+09	8.075731e+10	2.077400e+10	17666.0
4	Anheuser-Busch	1.558800e+10	NaN	9.811202e+09	NaN	NaN	NaN
...	...	...	...	...	...	...	...

Datasets

	State	Dem_margin%_2000	Dem_margin%_2004	Dem_margin%_2008	Dem_margin%_2012	Dem_margin%_2016	Dem_margin%_2020	Dem_margin_avg%
0	AL	-14.92	-25.62	-21.58	-22.19	-27.73	-25.46	-14.92
1	AK	-30.95	-25.55	-21.54	-13.99	-14.73	-10.06	-30.95
2	AZ	-6.29	-10.47	-8.52	-9.06	-3.50	0.31	-6.29
3	AR	-5.44	-9.76	-19.85	-23.69	-26.92	-27.62	-5.44
4	CA	11.80	9.95	24.06	23.12	30.11	29.16	11.80