Gasoline and Diesel Taxes Impact in Reducing Carbon Emissions in the United States: a Case Study in 2018

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Acknowledgement

- Special thanks to the instructions from Dr. Ben Miller to make this study possible
- https://www.census.gov/topics/income/poverty/income/data/tables.html
- https://www.eia.gov/environment/emissions/state/
- https://www.fhwa.dot.gov/policyinformation/statistics/2020/pdf/mf205.pdf

Introduction

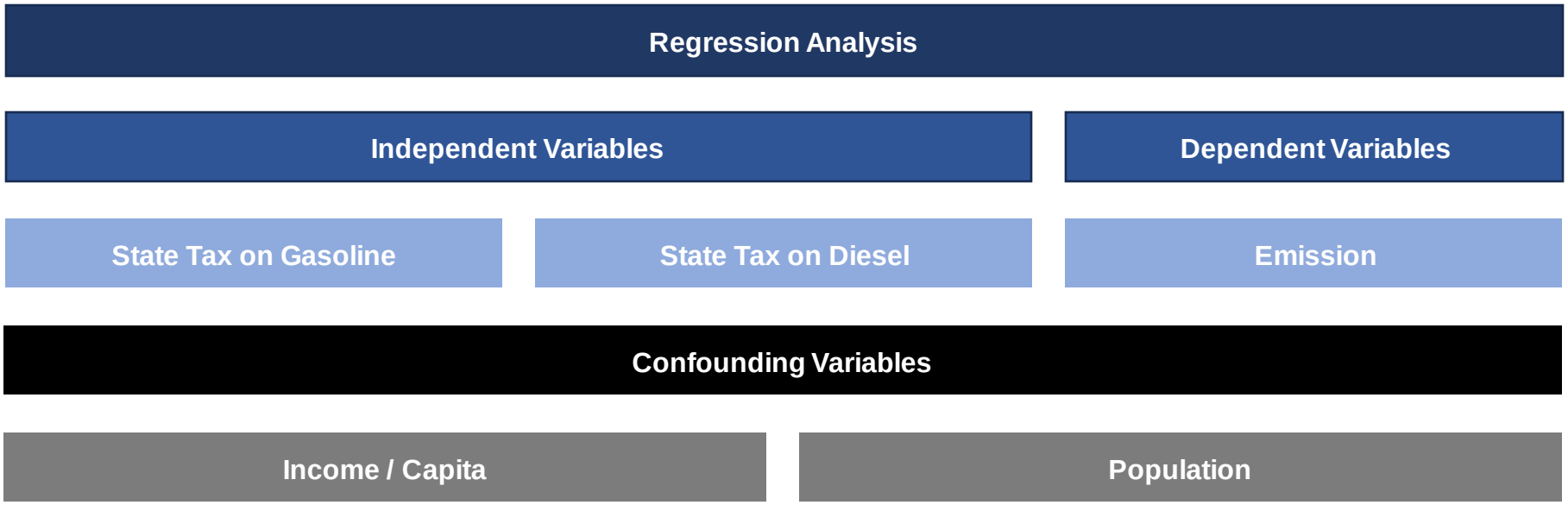
Over the past century, the world has experienced exponential growth in industrialization. That said, as contemporaries argue over the efficiency of technological advances, there are currently increased global concerns over air quality - which, according to the University of Chicago news, "...remains the world's greatest external risk to human health, with the impact on life expectancy comparable to that of smoking..." (University of Chicago, 2023).

With industrialization comes the production of greenhouse gasses such as carbon dioxide, nitrous oxide, and methane. Scientists at the MIT Technology Review recognize that "removing methane is a trickier task than capturing carbon dioxide, mainly because it's far more dilute in the atmosphere..." (Temple, 2019). Therefore, the scientific community has selected carbon dioxide as the variable of interest in hypothesizing ways to mitigate the current climate crisis. As such, this study explores environmental taxes as a potential treatment for reducing national carbon emissions in the United States.

(n.d.). Federal Highway Administration (FHWA). Retrieved December 3, 2023, from https://highways.dot.gov/
Global air pollution poses huge risk to human health, Air Quality Life Index finds. (2023, August 30). UChicago News. Retrieved December 3, 2023, from https://news.uchicago.edu/story/global-air-pollution-poses-huge-risk-human-health-air-quality-life-index-finds
State Carbon Dioxide Emissions Data - U.S. Energy Information Administration. (2018). EIA. Retrieved December 3, 2023, from https://www.eia.gov/environment/emissions/state/
Temple, J., & Nordrum, A. (2019, May 20). Turning one greenhouse gas into another could combat climate change. MIT Technology Review. Retrieved December 3, 2023, from https://www.technologyreview.com/2019/05/20/960/turning-one-greenhouse-gas-into-another-could-combat-climate-change/
2018 Median Household Income in the United States. (2019, September 26). Census Bureau. Retrieved December 3, 2023, from https://www.census.gov/library/visualizations/interactive/2018-median-household-income.html

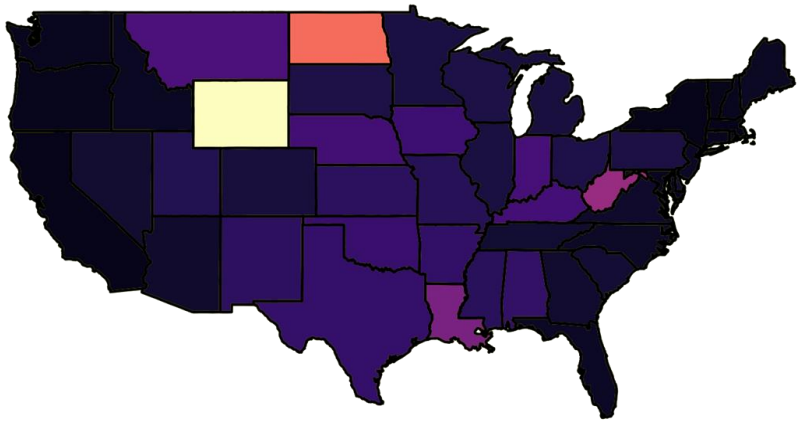
Materials / Methods

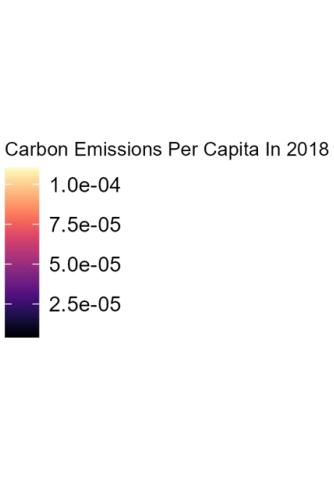
For this study, our original intent was to analyze the effect of environmental taxation on pollution and waste internationally. We rejected this model because of a lack of a representative sample. Subsequently, this study assesses local data in the United States as a base model from which we can base future and more complicated statistical analyses. We used carbon emissions per state as a proxy for waste production. Our analysis includes data from the U.S. Energy Administration, U.S. Federal Highway Administration, and the United States Census, focusing on data from 2018 to reduce confounding from the COVID-19 pandemic. Here, we address different confounders, such as population density and average income, incorporating regression analysis to assess the impact of environmental taxation on pollution reduction. This study utilizes the ggplot2, tidyverse, ggthemes, ggmaps, and viridis packages in R and functions in Excel for our statistical analysis.

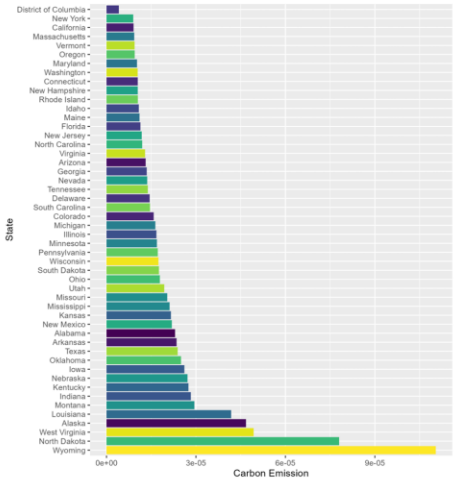


Data Visualization

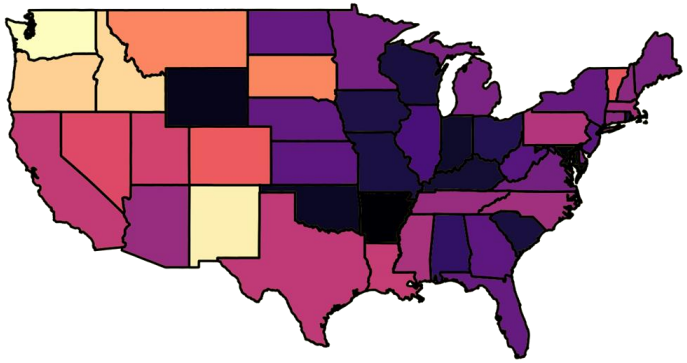
Carbon Emissions Per Capita in 2018

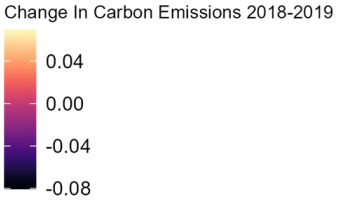




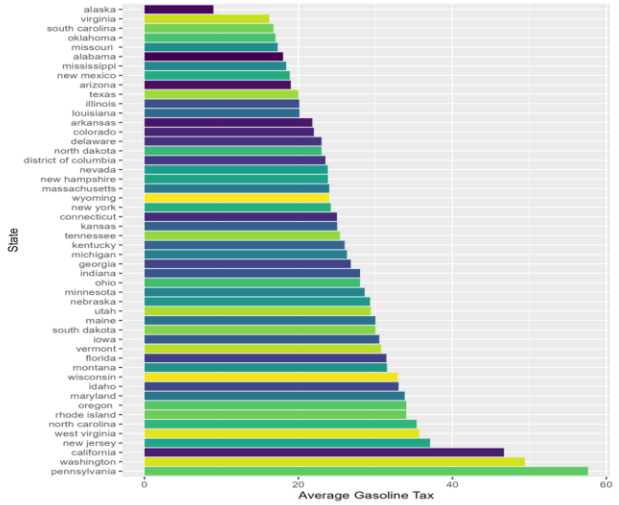


Change in Carbon Emissions from 2018-19





Average Gasoline Tax per State in 2018



Regression Analysis – Output

To provide an analysis of how tax rates impact GHG emissions based on the regression results from 2018 and 2020, we interpreted the coefficients for the tax rate on gasoline and diesel fuel, identifying the negative correlation between the gasoline tax rate and GHG emission at the state level. We also acknowledge that the drastic consumer behavioral change during COVID-19 deviated from our analysis outcome for 2020, which made the outcome not very representative of the tangible impact.

2018 Regression Analysis

	Corr. Coeff.	P Value	Statical Significance
Diesel	3.29	0.088	This coefficient is not statistically significant at the 5% level (p > 0.05)
Gasoline	-5.24	0.026	This coefficient is statistically significant at the 5% level (p > 0.05)

2020 Regression Analysis

	Corr. Coeff.	P Value	Statical Significance
Diesel	-0.34	0.646	This coefficient is not statistically significant at the 5% level (p > 0.05)
Gasoline	-0.68	0.434	This coefficient is not statistically significant at the 5% level (p > 0.05)

Regression Analysis – Interpretation

Conclusion

In analyzing the impact of environmental tax policies on greenhouse gas (GHG) emissions, our regression analysis for 2018 and 2020 reveals intriguing insights into the efficacy of such fiscal tools.

- The gasoline tax showed a significant negative relationship with GHG emissions in 2018, suggesting that higher gasoline taxes could contribute to reduced emissions. However, this effect was not statistically significant in 2020 because of the change in people's behavior during COVID-19.
- The tax on diesel did not show a consistent or statistically significant relationship with GHG emissions in either year. The positive coefficient in 2018 and the negative one in 2020 suggest an inconsistent impact, and neither was significant enough to assert a reliable effect.
- The lack of statistical significance in 2020 for gasoline and diesel taxes may be due to various factors during COVID-19. For instance, the shift in consumer behaviors, the changes in external economic factors, and government fiscal policies - potentially not captured by the model.

The significant negative relationship between gasoline taxes and GHG emissions in 2018 suggests that **increased gasoline taxes can be a potent tool in a government's policy arsenal to combat climate change**.

Limitations

- **Potential confounders:**
- Differences in climate in the different regions of the US.
- Mining sites affect the amount of particulate matter.
- International trade potentially contributes to an increase in carbon emissions around the coast.
- We don't know how much vehicle emissions contribute to total carbon emissions.
- We are not looking at the most recent data.
- **Future study:**
- We could look at the chemical differences between diesel and gasoline and determine how much either contributes to the total carbon emissions.
- We could investigate the quantity of traffic in each state to standardize carbon emissions rather than using the population.

Thank you!