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

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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.

Carbon Emissions per Capita In 2018

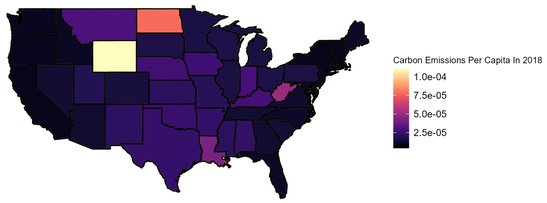

Figure 1. Map of carbon emissions (in million metric tons) per capita in 2018. The data shows that states on either coast of the United States produce less carbon emissions per capita comparable to the Midwest.

Change In Carbon Emissions From 2018-2019

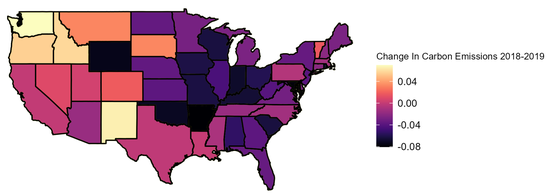

Figure 2. Map of change in carbon emissions (in million metric tons) from 2018 to 2019. The data shows the difference between these two years over the measurement of carbon emissions in 2018.

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.

Carbon Emissions Per Capita in 2018 Histogram

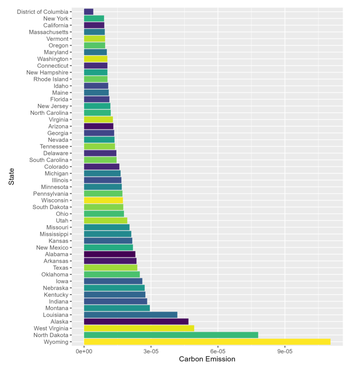

Figure 3. Histogram of carbon emissions (in million metric tons) for each state in 2018 from lowest to highest. The total carbon emission in each state was divided by the population to account for state size and population density. The histogram shows that the states on either coast produced fewer carbon emissions comparable to the Midwest in 2018. Wyoming has the highest carbon emission per capita.

Average Gasoline Tax Per State in 2018 Histogram

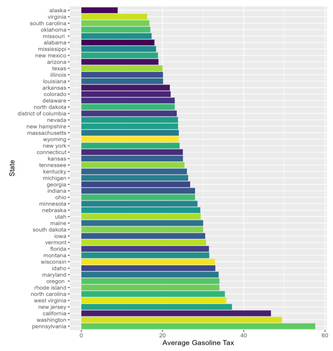

Figure 4. Histogram of the gasoline tax of each state in 2018. This visualization shows that the states with the highest average gasoline tax are on either coast, with Pennsylvania as the state with the highest average gasoline tax in 2018.

RESULTS

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

	Correlation Coefficient	P Value	Statical Significance
Diesel	3.29	0.088	This coefficient is not statistically significant at the 5% level ($p > 0.05$), suggesting that we cannot be confident that the tax rate on diesel has a predictable impact on GHG emissions based on the 2018 data.
Gasoline	-5.24	0.026	This coefficient is statistically significant at the 5% level ($p < 0.05$), indicating a reliable negative relationship between the tax rate on gasoline and GHG emissions

2020 Regression Analysis

	Correlation Coefficient	P Value	Statical Significance
Diesel	-0.34	0.646	This coefficient is not statistically significant at the 5% level ($p > 0.05$), meaning that there is no clear evidence that an increase in the diesel tax rate is associated with a decrease in GHG emissions based on the 2020 data.
Gasoline	-0.68	0.434	This coefficient is not statistically significant at the 5% level ($p > 0.05$), indicating that the negative relationship observed in 2018 between the tax rate on gasoline and GHG emissions is not evident in the 2020 data.

INTERPRETATION

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.** With the clear indication that higher taxes on gasoline correlate with reduced emissions, governments could consider raising gasoline taxes as part of a comprehensive strategy to incentivize the use of cleaner energy sources and discourage the use of fossil fuels. Additionally, the revenue generated from these taxes could be invested in sustainable infrastructure or subsidies for green technology, further amplifying the environmental benefits.

The regression analysis, while insightful, is constrained by the quality of the data and the complexity of the variables influencing GHG emissions. The inclusion of income as a confounding variable in our analysis could influence the observed relationship between tax rates and GHG emissions. While our results suggest a correlation, this association is relatively weak. For potential future study, it will be imperative to incorporate more state-specific variables that could affect the relationship between tax rates and emissions, such as public transit usage, industrial activity, and technological changes in the automotive industry.

ACKNOWLEDGEMENT

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- 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

Appendix

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