

Fuel Economy Analysis Report (2008 vs. 2018)



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Table of Contents

- **Introduction**
- **Key Findings**
- **Detailed Analysis**
 - ❖ **1. Analysis of 2008 and 2018 Datasets Separately**
 - **Descriptive Statistics of MPG**
 - **Distribution of MPG**
 - **Vehicle Class Analysis**
 - **Fuel Type Analysis**
 - ❖ **2. Analysis of Combined Dataset**
 - **2.1. Overall MPG Improvement**
 - **2.2. Shift in MPG Distribution**
 - **2.3. Changes in Fuel Type Proportions**
 - **2.4. Evolution of Vehicle Class Distribution**
 - **2.5. Time-Based Trends within Specific Categories**
 - **2.6. Impact of "SmartWay" Over Time**
 - **2.7. Correlation Changes Over Time**
- **Conclusion**
- **Limitations**
- **Further Research**
- **Appendix: Visualizations**

Introduction

This report analyzes trends in vehicle fuel economy and related factors between 2008 and 2018. The goal is to understand how fuel efficiency has changed over this period, the factors that have contributed to these changes, and the implications for emissions and the automotive industry. The analysis is based on a dataset of vehicle information from those years. The report will first examine the 2008 and 2018 datasets separately to understand their individual characteristics, then combine the data for a more direct comparison of trends over time.

Key Findings

Here's a summary of the main takeaways:

- Initial Observations (2008 and 2018 Separately):
 - The 2018 dataset has fewer data points than the 2008 dataset.
 - The range of MPG values is wider in 2018, with a higher maximum MPG.
 - Gasoline is the dominant fuel type in both years, but its dominance decreases in 2018.
- Overall Improvement: The average fuel economy of vehicles in our dataset improved significantly from 2008 to 2018.
- Shift to More Efficient Vehicles: More vehicles in 2018 achieved higher miles per gallon (MPG) compared to 2008. The distribution of fuel economy shifted towards the higher end.
- Rise of Alternative Fuels: While gasoline remained the dominant fuel type, alternative fuels like ethanol/gasoline blends and hybrids gained a noticeable share of the market.
- Improvements Within Vehicle Classes: Most vehicle classes showed improvements in average MPG, indicating that technology has made even traditional vehicle types more efficient.
- SmartWay Trends: The proportion of SmartWay certified vehicles decreased from 2008 to 2018. However, the SmartWay vehicles in 2018 were more fuel-efficient and had lower emissions than those in 2008.
- Engine Size and MPG: The negative relationship between engine size and fuel economy weakened slightly, suggesting that newer large-engine vehicles are somewhat more efficient than older ones.
- MPG and Emissions: The strong link between higher MPG (better fuel economy) and lower greenhouse gas emissions became even stronger in 2018.

Detailed Analysis

1. Analysis of 2008 and 2018 Datasets Separately

1.1. Descriptive Statistics of MPG

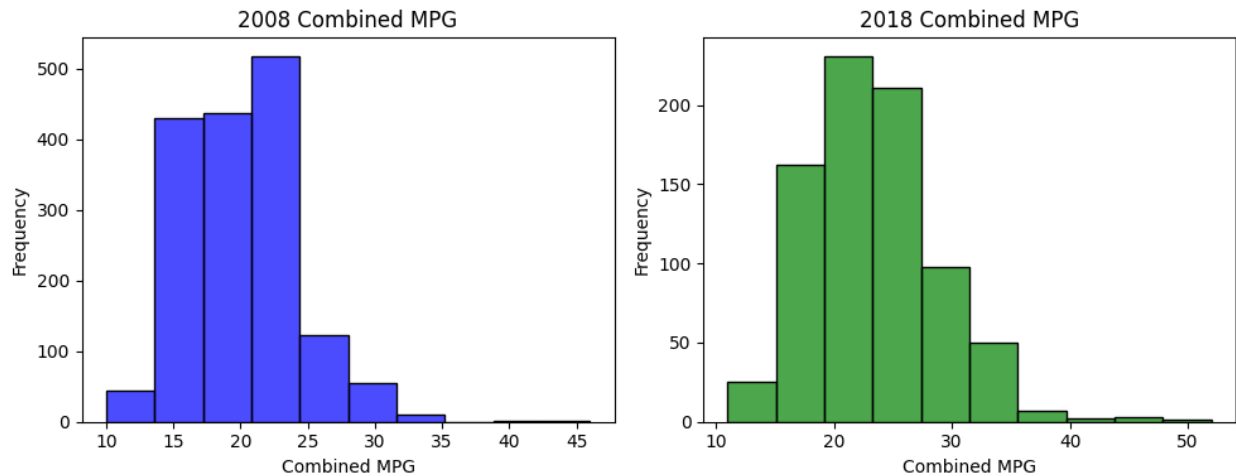
A preliminary look at the MPG values in each dataset reveals the following:

Statistic	2008	2018
Count	1623	790
Mean	20.00	23.59
Standard Dev	4.19	5.21
Min	10	11
25th Percentile	17	20
Median	20	23
75th Percentile	23	27
Max	46	52

- The 2018 dataset has fewer data points (790) compared to the 2008 dataset (1623).
- The average MPG is higher in 2018 (23.59) than in 2008 (20.00).
- The maximum MPG is higher in 2018 (52) than in 2008 (46), indicating the presence of more fuel-efficient vehicles.
- The spread of MPG values, as measured by the standard deviation, is slightly larger in 2018.

1.2. Distribution of MPG

Histograms of the MPG values for 2008 and 2018 show a clear shift towards higher MPG in 2018.



1.3. Vehicle Class Analysis

The distribution of vehicle classes also changed between the two years:

Vehicle Class	2008 (%)	2018 (%)
Small Car	31.61	34.74
SUV	28.59	-
Midsize Car	13.31	17.19
Pickup	11.58	8.53
Large Car	6.16	9.98
Station Wagon	5.55	4.69
Minivan	1.91	0.60
Van	1.29	-
Small SUV	-	13.46

Standard SUV	-	9.38
Special Purpose	-	1.44

- Small cars remain a significant portion of the market in both years.
- Midsize cars increased in popularity.
- The broad SUV category in 2008 is split into Small SUV and Standard SUV in 2018.
- Minivans declined in popularity.

1.4. Fuel Type Analysis

The proportion of different fuel types also shifted:

Fuel Type	2008 (%)	2018 (%)
Gasoline	99.38	92.67
Diesel	0.43	2.28
CNG	0.12	-
Ethanol	0.06	-
Ethanol/Gas	-	3.61
Gasoline/Electricity	-	1.44

- Gasoline is the dominant fuel type in both years, but its share decreases in 2018.
- Alternative fuels like Ethanol/Gasoline and Gasoline/Electricity gain market share in 2018.

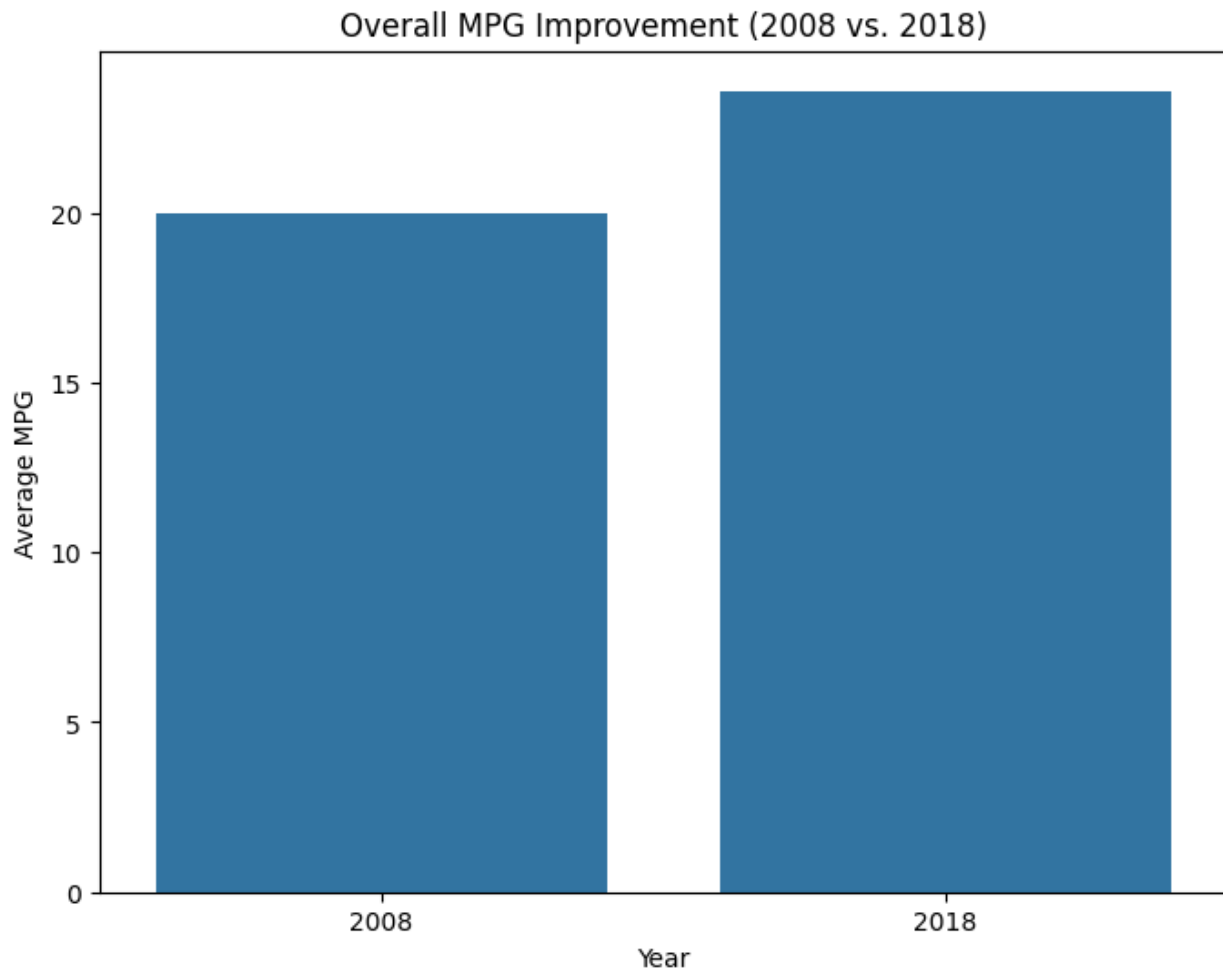
2. Analysis of Combined Dataset

2.1. Overall MPG Improvement

The average combined MPG for all vehicles in the dataset increased from 20.00 MPG in 2008 to 23.59 MPG in 2018. This represents an improvement of 3.60 MPG. This shows that, overall, cars got more efficient.

To illustrate this improvement, we can use a simple bar chart:

Overall MPG Improvement (2008 vs. 2018)



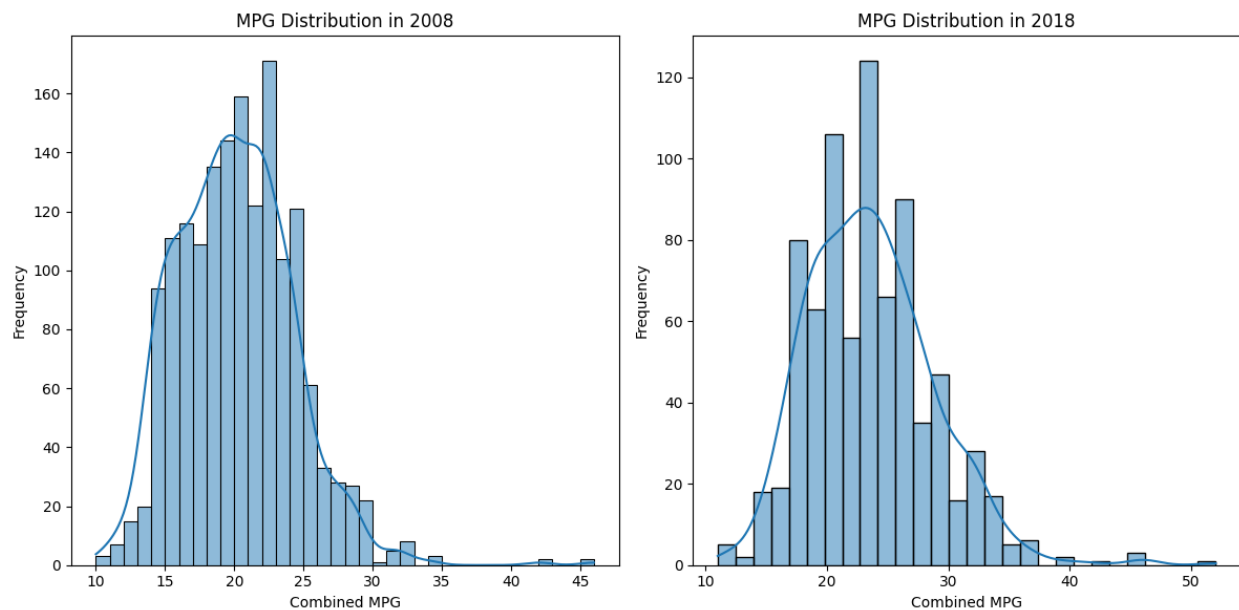
2.2. Shift in MPG Distribution

The distribution of fuel economy shifted towards higher values in 2018. Here's how:

- The *average* MPG increased, as noted above.
- The *middle* MPG (median) also increased, meaning that a typical car in 2018 was more efficient than a typical car in 2008.
- The percentage of vehicles with less than 20 MPG decreased, while the percentage of vehicles with more than 25 MPG increased.

This means that not only did the average MPG improve, but also a larger proportion of cars on the road became more fuel-efficient. This shift is visualized in the histograms below:

Distribution of MPG in 2008 and 2018



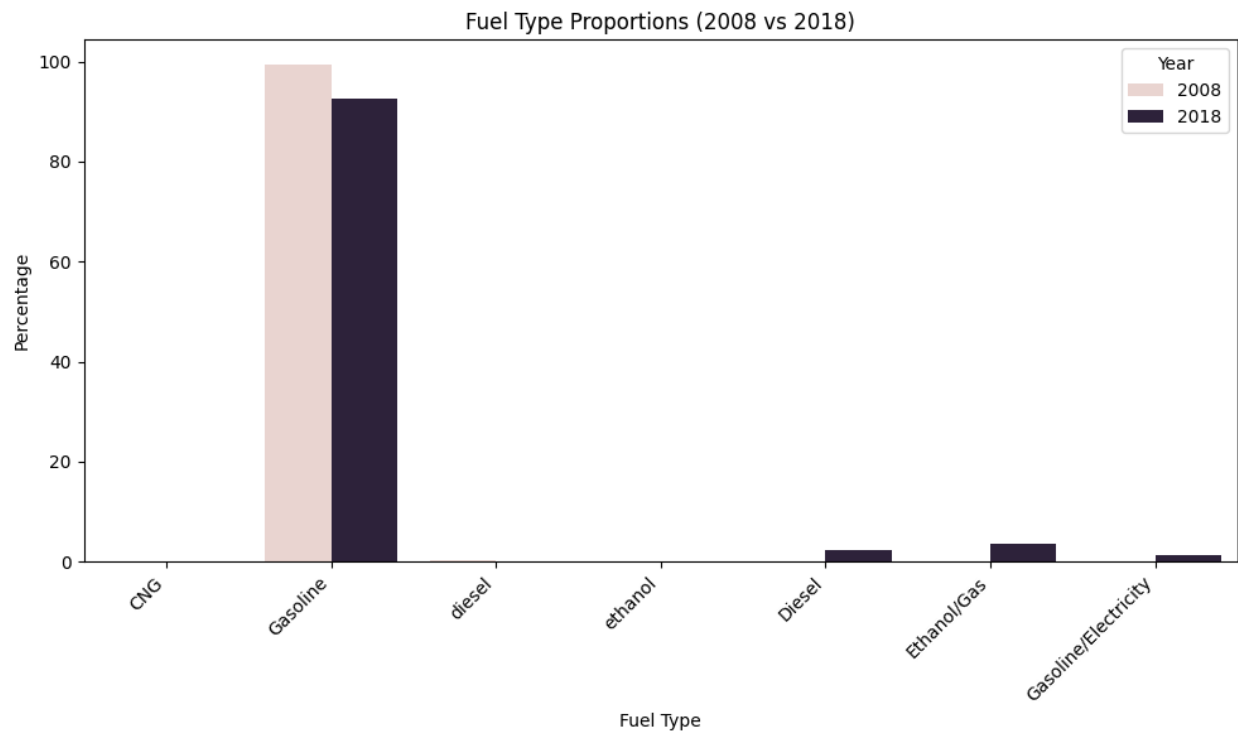
2.3. Changes in Fuel Type Proportions

Gasoline was the dominant fuel in both years. However, its share decreased from 99.38% in 2008 to 92.67% in 2018. At the same time, alternative fuels gained market share:

- Ethanol/gasoline blends increased to 3.61% of the market in 2018.
- Diesel increased to 2.28% in 2018.
- Hybrid gasoline/electric vehicles appeared, accounting for 1.44% of the market in 2018.

This trend is shown in the following bar chart:

Fuel Type Proportions (2008 and 2018)



2.4. Evolution of Vehicle Class Distribution

The types of vehicles people bought also changed:

- Small cars remained the most common type and increased slightly.
- Midsize cars became more popular.
- SUVs became more specialized, with "small SUV" and "standard SUV" categories emerging. These new SUV categories were significant portions of the market in 2018.
- Pickups and station wagons decreased slightly in popularity.
- Minivans declined substantially.

These shifts in vehicle preferences can also influence overall fuel economy. For example, the increased popularity of small cars can contribute to better average MPG.

2.5. Time-Based Trends within Specific Categories

Looking at specific vehicle classes, we see improvements across the board:

- Large cars, midsize cars, and station wagons showed substantial increases in average MPG.
- Pickups and small cars also became more efficient.
- Greenhouse gas emissions decreased for most vehicle classes.
- Air pollution scores also improved (meaning less pollution) for most classes.

This demonstrates that improvements in fuel economy and emissions were not limited to just one type of vehicle but rather occurred across the industry.

2.6. Impact of "SmartWay" Over Time

The proportion of SmartWay certified vehicles decreased from 35.37% in 2008 to 12.14% in 2018. However, the SmartWay vehicles in 2018 had better fuel economy (higher MPG) and lower emissions (higher greenhouse gas score) than those in 2008.

2.7. Correlation Changes Over Time

The relationship between some key factors also changed:

- The negative relationship between engine size and MPG weakened slightly. This suggests that improvements in engine technology have made larger engines somewhat more fuel-efficient.
- The positive relationship between MPG and greenhouse gas score strengthened. This means that more fuel-efficient cars were even more likely to have lower emissions in 2018 than in 2008.

Conclusion

The data shows a clear trend towards improved fuel economy in the automotive industry between 2008 and 2018. This improvement is driven by a combination of factors, including:

- Technological advancements in gasoline engines.
- The increasing availability and adoption of alternative fuels and hybrid technology.
- Improvements in fuel efficiency across various vehicle classes.

These changes have significant implications for reducing greenhouse gas emissions and potentially lowering fuel costs for consumers.

Limitations

This analysis is based on a specific dataset of vehicle information. While it provides valuable insights, it's important to acknowledge that it might not perfectly represent the entire US vehicle market.

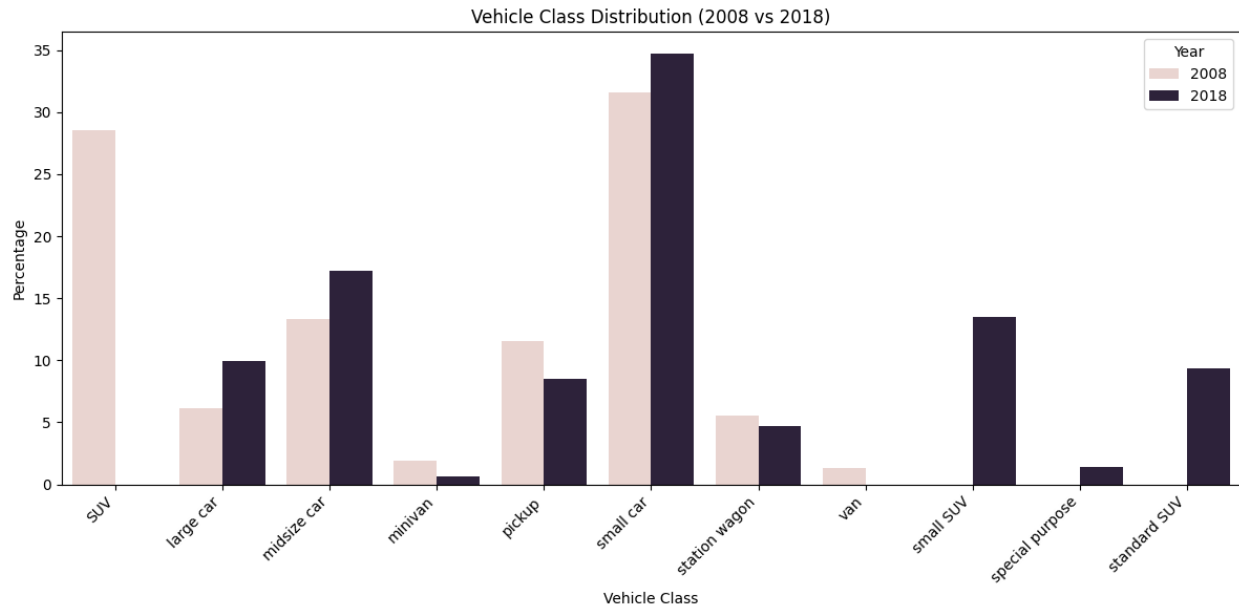
Further Research

Future research could explore the impact of specific technologies (e.g., turbocharging, direct injection) on fuel economy, analyze the economic factors influencing consumer vehicle choices, and investigate the effectiveness of government regulations in driving fuel efficiency improvements.

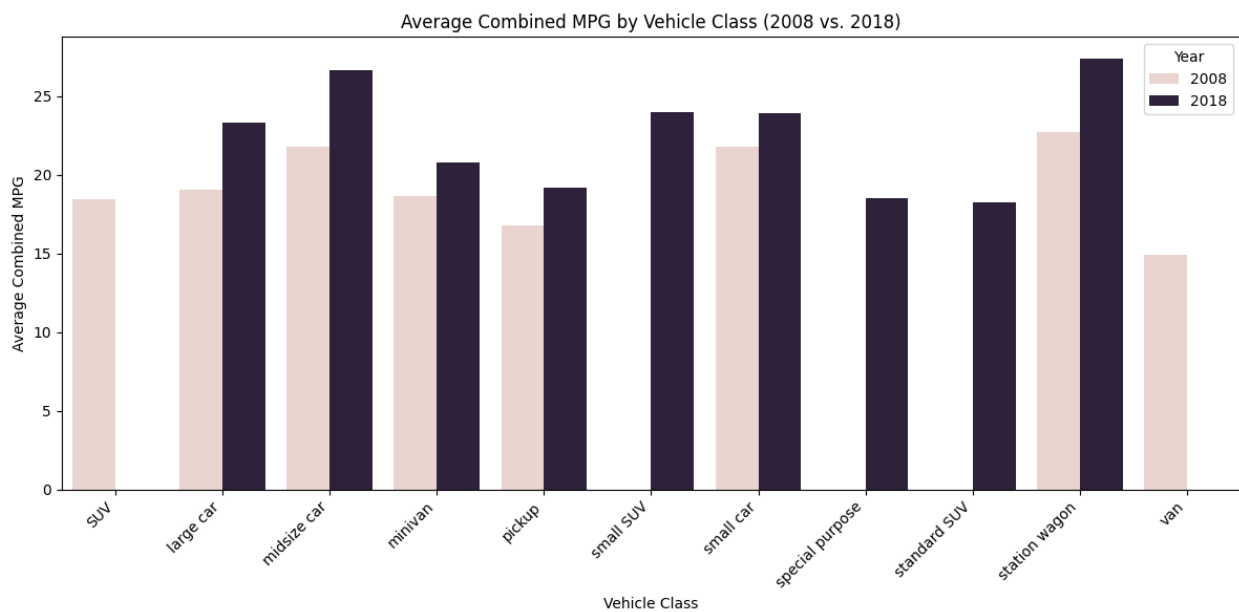
Appendix: Visualizations

This section includes the supplementary visualizations that support the analysis presented in this report.

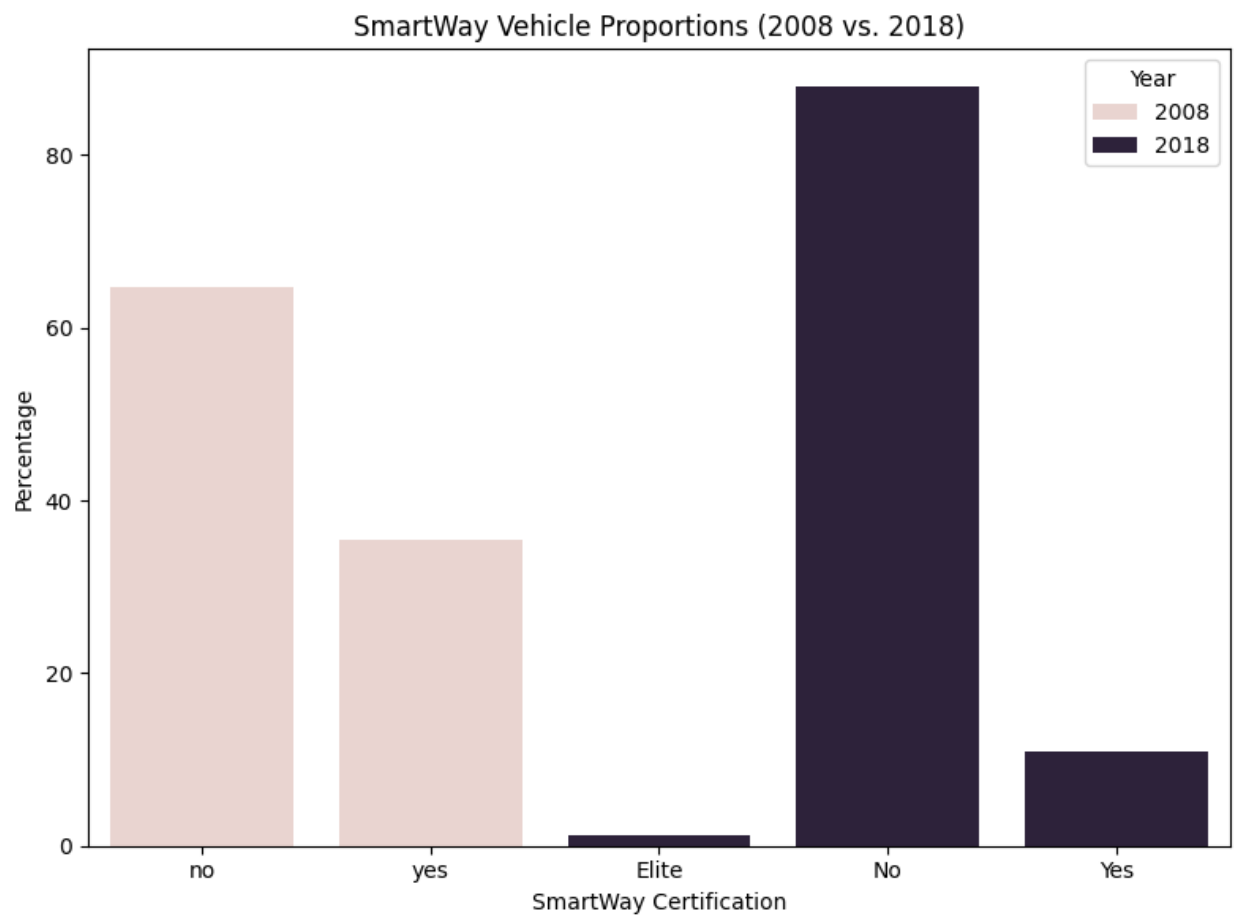
1. Vehicle Class Distribution (2008 and 2018)



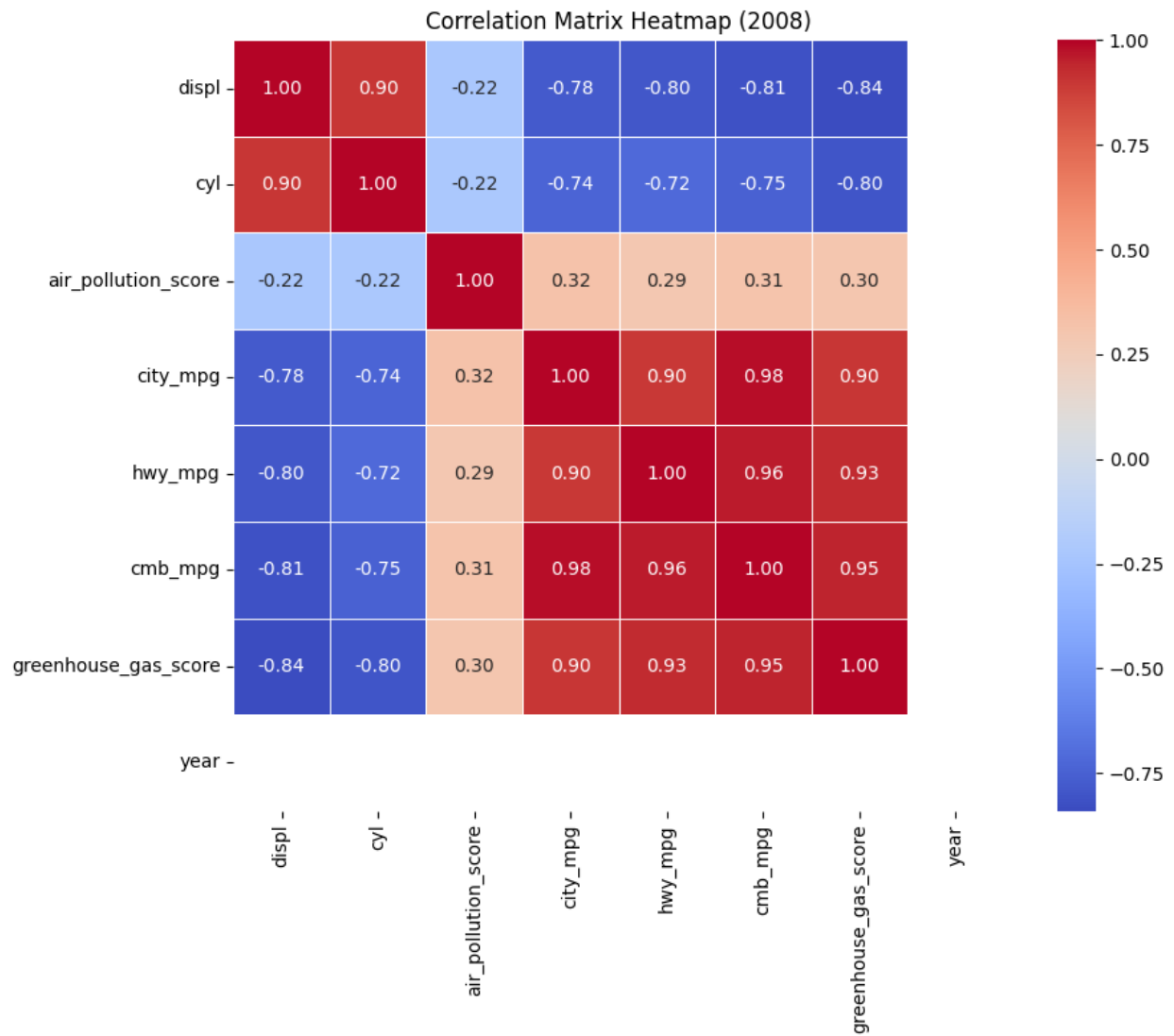
2. Average MPG by Vehicle Class (2008 vs. 2018)



3. SmartWay Vehicle Proportions (2008 and 2018)



4. Correlation Matrix (2008)



5. Correlation Matrix (2018)

