

This report was prepared by Jay Cloyd for consumption by Edmunds.com in regards to NHTSA data concerning the Cash for Clunkers (CARS) [program](#). The following four questions were asked regarding the data:

1. Define one or more metrics that can be used to measure the success of the program. Identify the 10 most successful states and the 10 least successful states based on your metric(s), and show the performance in these 20 states.

The most obvious metrics to use are those stated by the NHTSA as the metrics by which they defined success for the CARS program, namely increased numbers of fuel-efficient vehicles on America's highways, where fuel-efficiency was measured both as a ratio of the mpg of vehicle purchased to vehicle traded in (ratio metric)--a measure of the relative success of the CARS program--and average mpg of vehicles purchased (average metric)--which helps measure the absolute effect of the CARS program. The NHTSA provided summary statistics indicates the average mpg of purchased vehicles was 24.9mpg, confirmed by my analysis with Python, with average mpg of trade-in vehicles of 15.8, though my analysis indicates average mpg of trade-in vehicles was 15.7, again using Python, as shown in Figure 1.

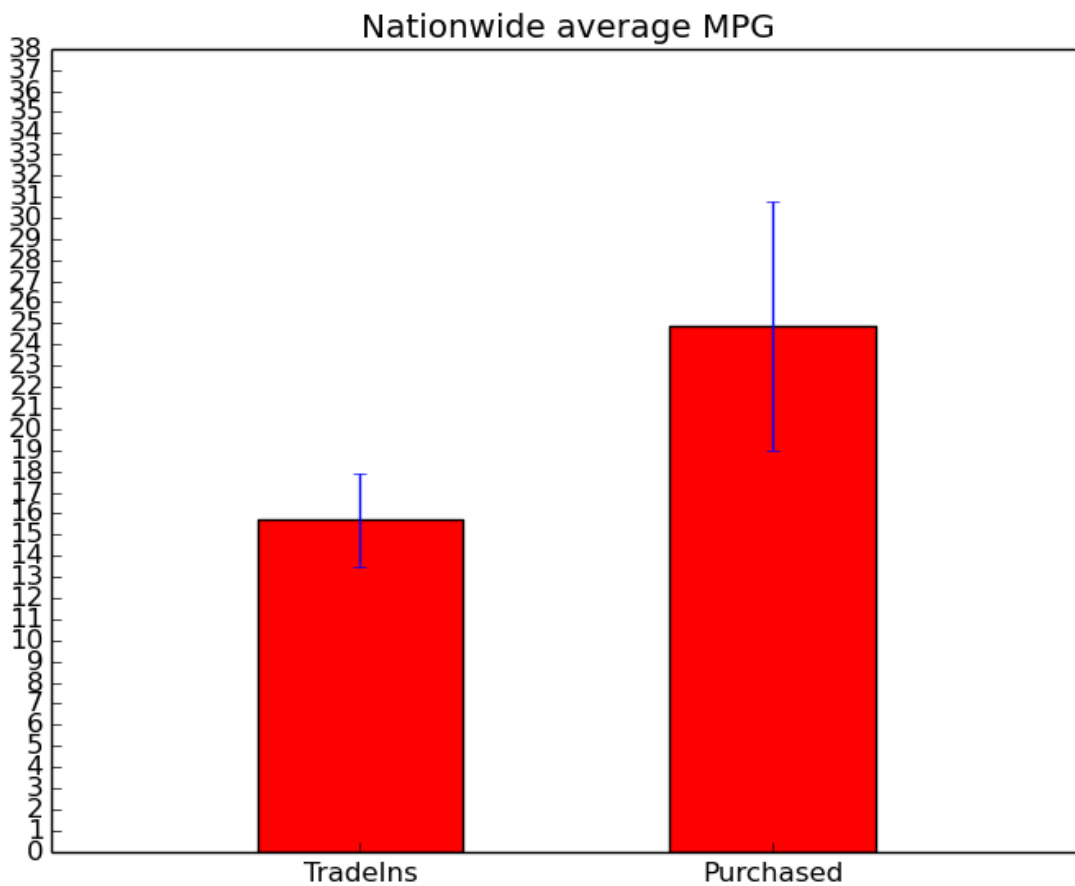


Figure 1: Nationwide average mpg of trade-in vehicles for CARS and average mpg of vehicles purchased in the CARS program. Error bars represent one STD.

By these two metrics we can sort the ten most successful and ten least successful states, which is visualized in Figures 2 and 3:

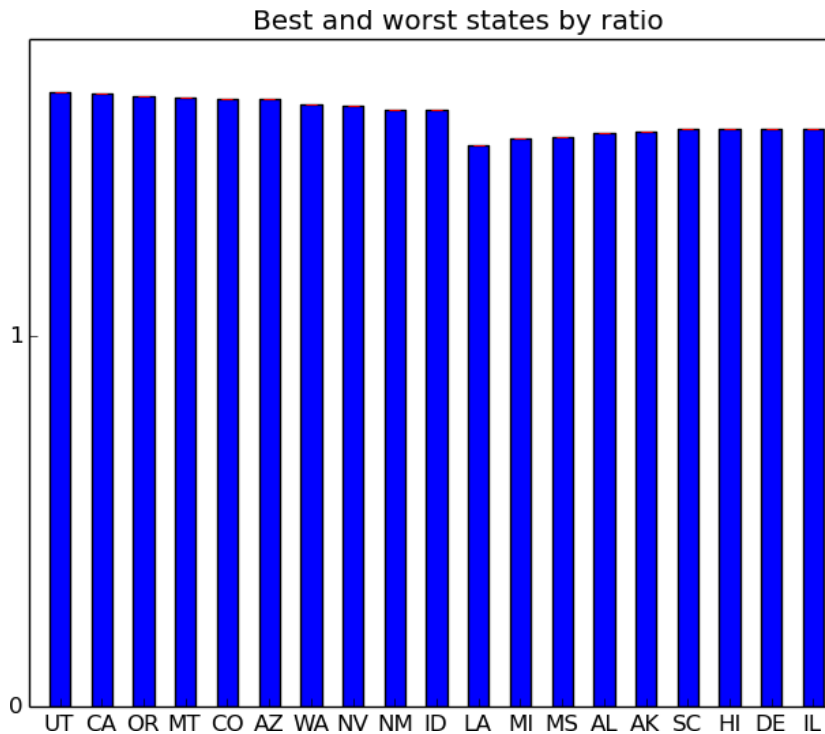


Figure 2: Top ten best and worst states by ratio metric

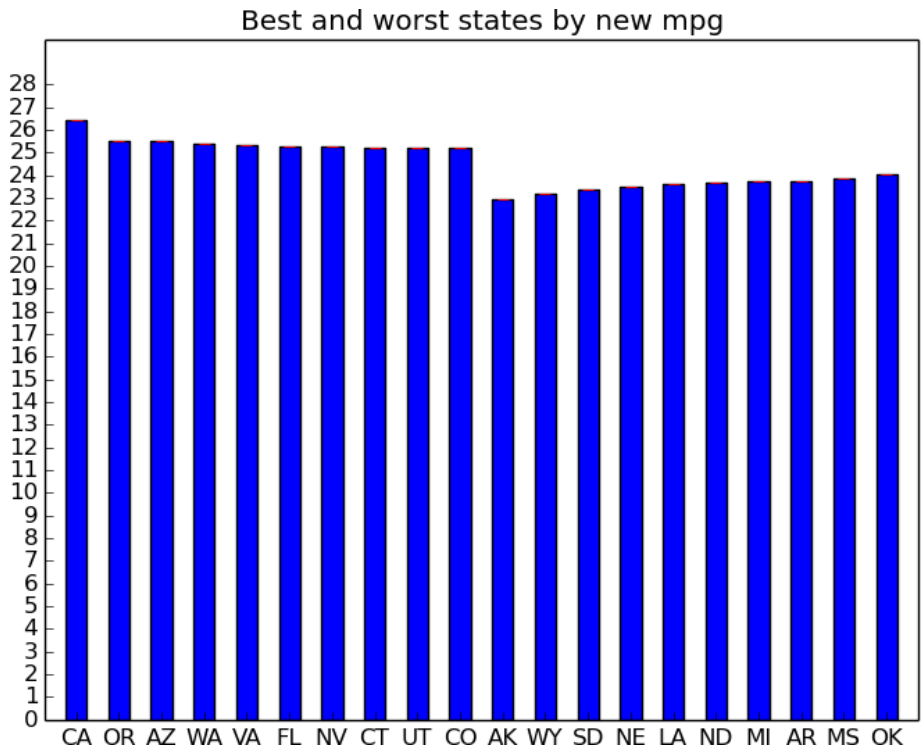


Figure 3: Top ten best and worst states by average metric

Of note, the NHSTA data contains several entries other than US states, which have been excluded from the above report (Virgin Islands, Guam, Washington D.C., and Northern Mariana Islands). Figure 2 shows there is not necessarily a very significant variation in ratio metric between various states.

2. Did West Coast consumers purchase more fuel efficient cars than consumers in other regions? Please support your answer with analysis and visualizations.

I used the definition of West, along with other designated regions, from the following [report](#) by the US Census Bureau. Figures 4 and 5 provide a visual demonstration that the CARS program was somewhat more successful in the West than in other regions, but not by a significant margin.

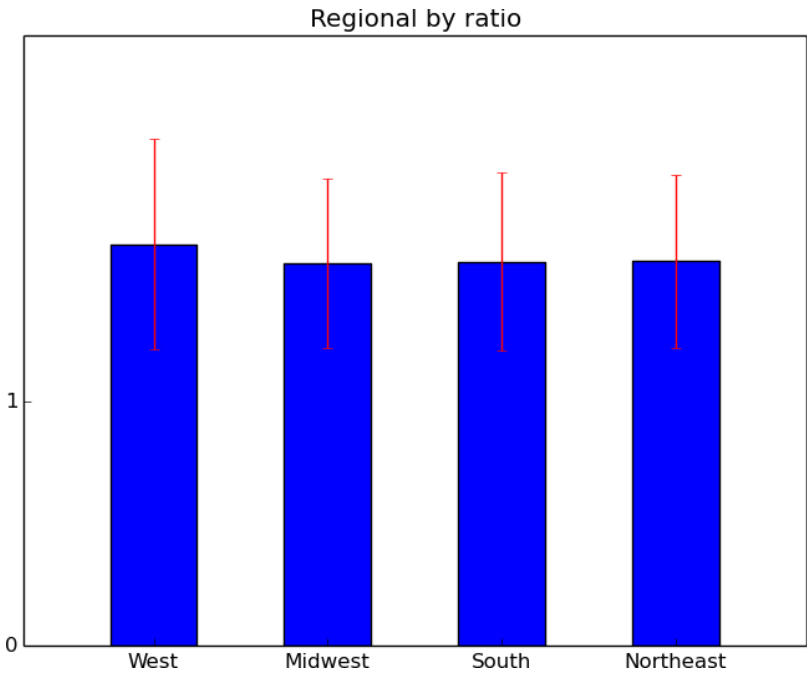


Figure 4: Ratio metric, along with STD, by region

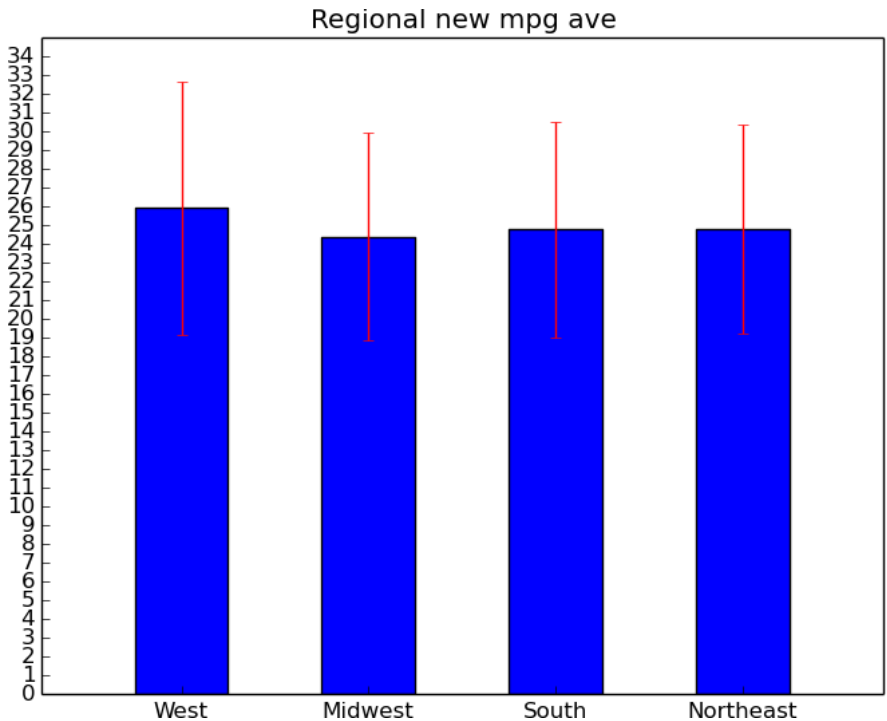
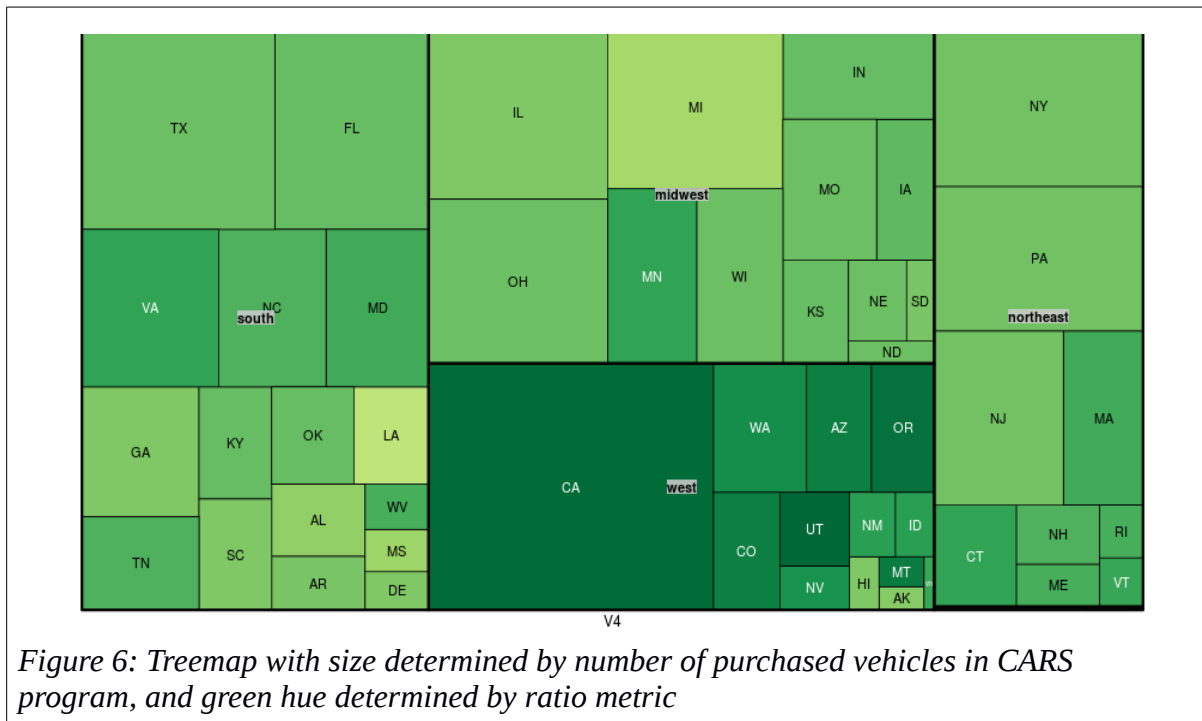


Figure 5: Average metric, along with STD, by region

Finally, Figure 6 provides a different visualization where area is determined by number of vehicles purchased in the CARS program with darkness of green color reflecting the ratio metric. This representation provides some visual evidence supporting the conclusion the CARS program was more successful in the West than in other regions of the nation.



3. From the data, can you find any behavioral patterns that help us understand how consumers buy new vehicles? Can the tendencies you found (if any) be applied to the general population? Support your answer with models / visualizations / analyses, as appropriate.

For this I direct you to the accompanying Tableau workbook. First, is [Dashboard1](#) which contains four sheets.

- Sheet1: Total MSRP of purchased vehicles by state. Light green is invoice amount of 3500, dark green invoice amount of 4500. Included is a filter for states by rank of total MSRP. This sheet can be used by car sellers to target states to maximize revenue.
- Sheet2: Number of cars sold for each state based off mpg. For example, by filtering on the right we can select only those vehicles whose mpg is ≥ 30 . This can be helpful for call sellers to target fuel-efficient vehicles to the appropriate state, as well as giving some insight into the relative success of CARS by state.
- Sheet3: Total MSRP by year of trade-in vehicle. Colors represent type of vehicle purchased. This chart can help car sellers in targeting customers more likely to purchase a new vehicle. The bottom graphic shows about half of all sales are done by car buyers who own a vehicle ≥ 15 years old.
- Sheet4: This chart shows there is not significant predictive power in how much a customer spends on their new vehicle based off the age of their trade-in vehicle

For [Dashboard2](#) we additionally have four sheets:

- Sheet5: The bottom chart shows average MSRP for new vehicle based off its drive train, but sorted by total MSRP for that drive train. This allows for visualization of the most important drive trains by revenue generated, nationwide.
- Sheet6: This chart demonstrates there is little predictive power in estimating average MSRP of purchased vehicle by make of trade-in vehicle
- Sheet7: This sheet demonstrates there is little predictive power in estimating average mpg of purchased vehicle by make of trade-in vehicle. Bottom shows relative weighting of trade-in make to filter top chart to most important trade-in makes
- Sheet8: This chart allows targeted selling of new vehicle type based off old vehicle type is possible. For example, if a person own a light truck(1), then roughly half the dollars they spend on their new vehicle is on a new light truck(1) with the other half on passenger vehicle. Peoples owning a category 2 truck purchased either a category 1 truck, category 2 truck, or passenger vehicle at roughly the same proportion. Owners of passenger vehicles tend to buy passenger vehicles, but there is a market for light truck purchases for this customer segment

Finally, I provide some analysis using R:

Correlation of new mpg to old mpg was 0.303, not especially high. There was a negative correlation of -0.432 between new mpg and MSRP of purchased vehicle, i.e. more expensive cars have, on average, worse mpg than less expensive cars.

A linear regression was done on new mpg v. old mpg resulting in: $\text{new_mpg} = 12.3 + 0.8(\text{old_mpg})$

A linear regression was done on new MSRP v. old mpg resulting in: $31821.7 - 596.8(\text{old_mpg})$, indicating people purchased more expensive cars if they previously owned a vehicle with lower fuel efficiency.

4. The program was declared “wildly successful” by the government. Is there sufficient data from NHTSA to support that conclusion? If not, what additional data will you need in order to determine if the government was right? Explain why this additional data is needed and what you would use it for. (You are not expected to actually go and find that extra data.) If you don’t need additional data, was the government right -- and why?

The most important information to evaluate how successful the CARS program would be to compare ratio metric, average metric, and the number of older vehicles traded in for newer vehicles during the CARS program v. a typical 30 day period, e.g. for other 30 day periods of 2010 and for the same 30 day period in past years, along with their respective ratio and average metrics. Without that information, it is difficult to provide a baseline from which to determine magnitude of success of the CARS program. The NHTSA provides a portion of this information in their summary-statistics, "cars purchased under the program are, on average, 19% above the average fuel economy of all new cars currently available," which may indicate purchasers were influenced by the program to pick more fuel efficient cars than they might otherwise have. This piece of information seems sufficient to offer support for some success of the CARS program, but it is impossible to validate the true impact without a baseline of comparison for other 30 day periods, as mentioned above.

The Survey of Consumer Response to CARS Initiative provides a proxy for such a desired baseline. Question 1 asks, "If you were not offered the CARS program trade-in incentive, would you still have traded in your current vehicle to purchase a new or used vehicle this month?" Question 2 asks, "If you were not offered the CARS program trade-in incentive, when you disposed of this vehicle, would you have purchased another vehicle?"

	category	values	percent
1	Trade-in without CARS:Yes	16801	0.12
2	Trade-in without CARS:No	127026	0.88
3	Trade-in within one year	52007	0.41
4	Trade-in >= 5 years	23964	0.19
5	Not purchase without incentive	16801	0.12
6	Purchase new vehicle	127026	0.88
7	Purchase used vehicle	50132	0.35

Figure 7: Results from the Survey of Consumer Response to CARS Initiative

Total respondents to this survey number 143,998. From Figure 7, 12% of these respondents would have traded in their vehicle, during the month of CARS, absent the CARS program, but 88% would not have for that month. However, 41% of those that would not have traded in their vehicle this month indicated they would have within one year. Additionally, 19% of those who would not have traded in their vehicle during the month of the CARS program indicated they would not have traded it in for at least five years or longer. Finally, independent of the CARS program 12% of total respondents indicated they would not have bought a new vehicle without the incentive provided from CARS upon disposing of their old vehicle, while 88% of respondents they would have purchased a new vehicle, and 35% (some respondents indicated both choices) would have purchased a used vehicle without the CARS incentive. This survey, while perhaps not as robust as the desired baseline data of actual trade-in and purchase rates from other previous 30-day periods, as there is a gap between what people indicate and their actual behavior, offers significant support for the NHSTA claim as to the significant success of the CARS program.