

Fuel Efficiency Analysis: Engine Displacement Impact On Average Miles Per Gallon

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Abstract

This paper uses R Studio dataset Tidyverse subsection mpg. The dataset goes over the miles per gallon of vehicles with various subsection categories. This analysis looks at two classes of vehicles, SUVs and compact cars, when comparing the engine displacement to the average miles per gallon when driven on a highway. Using linear regression on the data points for the two classes of vehicle it was found that, for compact cars in every liter in engine displacement, the average miles per gallon is decreased by 4.2692 gallons. For the SUV's vehicle regression line, it shows that for every liter in engine displacement, the average miles per gallon is decreased by 1.8249 gallons. The future analysis of this paper can include more factors such as, torque of vehicles, weight range of vehicles, and type of engine, which will help underline the effects of miles per gallon.

1 Background and Significance

A dataset which contains the data from the years 1999 and 2008 goes over the miles per gallon average return for cars. The cars have been categorized into multiple subsections. For this analysis paper the three categories that will be looked at are the class of vehicle being compact and SUV, the engine displacement in liters, and the miles per gallon on average when driven on the highway.

This dataset is a concise set found in R Studio package known as Tidyverse. This package allows the user to find and extrapolate specific sets from the package while visualizing it in 2D scatter plot with color classification.

The goal of this paper is finding a linear regression of the data points when comparing compact and SUV engine displacement in liters versus the average miles per gallon when driven on the highway.

The use of linear regression will allow one to interpret fuel efficiency.

2 Methods

2.1 Data

The data acquisition is done by using the R Studio software. The software is used to download a package known as Tidyverse, a form of CRAN (Comprehensive R Archive Network). The data set goes over vehicles fuel efficiency

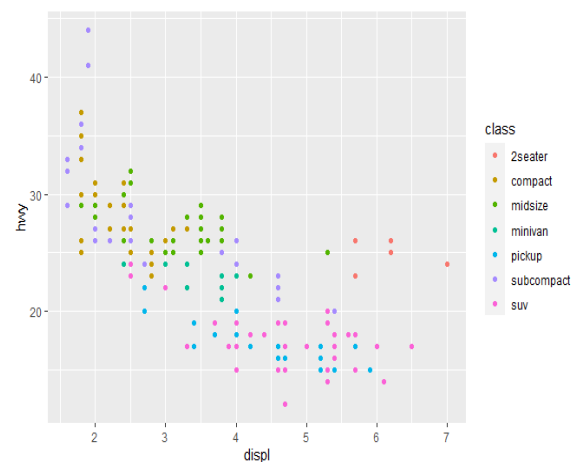
from 1999 and 2008. This lab will be focusing on two subcategory classes, SUVs and compact vehicles. Each class in this data set will have its own set which compares the values for engine displacement in liters and miles per gallon on the highway.

2.2 Calling Data Set

In order to extract the data set from the package, R Studio was used. The code will allow for a total dataset known as mpg to be referenced for further manipulation. This package will be called by using a subset called “ggplot2::mpg”.

2.3 Total Data Set Plot

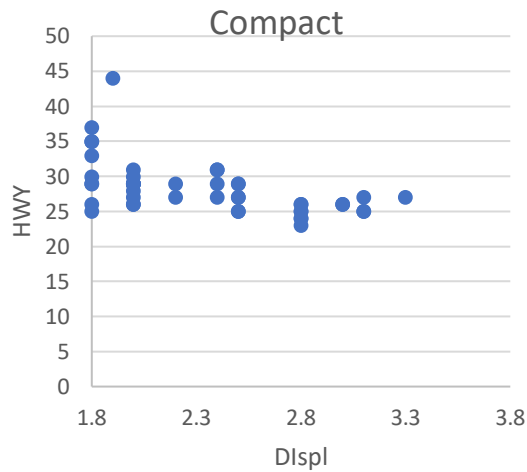
The data set, when extracted is then plotted using R Studio by three categories: classification of vehicle, mpg averaged on highway, and engine displacement.



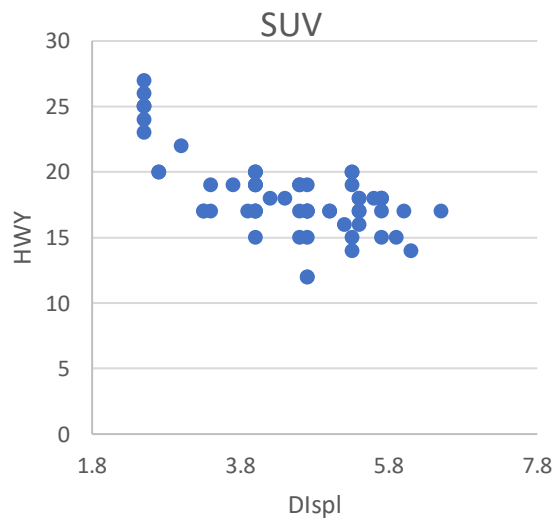
2.4 Compact and SUVs Plot

Extracting the data set's classes, compact and SUVs. This allows for the Compact class of

vehicles to be graphed from the original total data set plot.



As shown above this can also be applied to another class, SUVs. These graphs values are extracted from the total data set plot.



2.5 Linear Regression

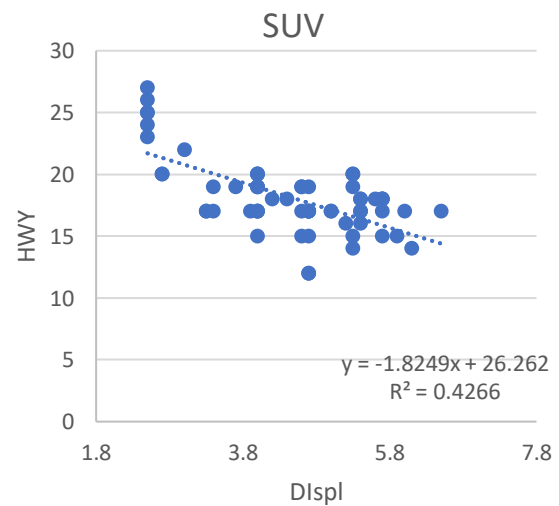
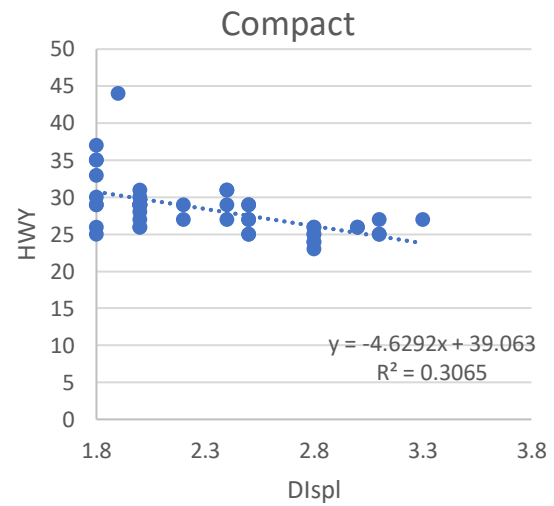
For this paper the linear regression that is used will be taking into account least squares regression line and coefficient of determination.

$$r^2 = 1 - \frac{SSE}{S_{yy}} \quad y = \hat{\beta}_0 + \hat{\beta}_1 x,$$

Where the value of y is the regression line and r^2 is the coefficient of determination [2].

3 Results

The results for the two plots for SUVs and compact vehicles with linear regression and coefficient of determination.



4 Discussion

The results show that the compact vehicles had a regression line of $y = -4.6292x + 39.063$ and a coefficient of determination of .03065. For SUVs the regression line $y = -1.8249x + 26.262$ and a coefficient of determination of .4266.

The regression line for the compact and SUV vehicles allow one to interpret the slope and find the relationship between engine displacement in liters and miles per gallon when driven on highways. The compact vehicle's regression line shows that for every liter in engine displacement, the average miles per gallon is decreased by 4.2692 gallons. For the SUV's vehicle regression line it shows that for every liter in engine displacement, the average miles per gallon is decreased by 1.8249 gallons.

4.1 Future Research

Upon looking at the results and the projection that was found for both classes of vehicles, one can then extrapolate this concept, of fuel efficiency, further towards why engine displacement effects miles per gallon. Engine displacement is when the combine movement of the cylinder pistons move the volume producing horsepower. Because engine displacement directly effects how much fuel is drawn it impact efficiency directly.

However, when comparing the two types of vehicle classes, one has to remember how each class has weight that impacts how effective

horsepower is. This concept comes when discussing torque of the vehicle.

In conclusion, the future analysis of this topic of fuel efficiency should also include other factors such as weight range among classes of vehicles along with the type of engine being used.

References

- [1] Leanse, Alex. "What Is Engine Displacement?" YourMechanic Advice, 1 Dec. 2015, www.yourmechanic.com/article/what-is-engine-displacement.
- [2] Archer, Kassie "Ch12Summary.pdf" 2020
- [3] Grolemund, Hadley Wickham and Garrelf. "R For Data Science." 3 *Data Visualisation* | *R for Data Science*, r4ds.had.co.nz/data-visualisation.html.

5 Appendix

5.1 Table For Section 3

manufactu	model	displ	year	cyl	trans	drv	cty	hwy	fl	class
audi	a4	1.8	1999	4	auto(l5)	f		18	29 p	compact
audi	a4	1.8	1999	4	manual(m5	f		21	29 p	compact
audi	a4	2	2008	4	manual(m5	f		21	30 p	compact
audi	a4	2.8	1999	6	auto(l5)	f		16	26 p	compact
audi	a4	2.8	1999	6	manual(m5	f		18	26 p	compact
audi	a4	3.1	2008	6	auto(av)	f		18	27 p	compact
audi	a4 quattro	1.8	1999	4	manual(m5	f	4	18	26 p	compact
audi	a4 quattro	1.8	1999	4	auto(l5)	f	4	16	25 p	compact
audi	a4 quattro	2	2008	4	manual(m5	f	4	20	28 p	compact
audi	a4 quattro	2	2008	4	auto(s6)	f	4	19	27 p	compact
audi	a4 quattro	2.8	1999	6	auto(l5)	f	4	15	25 p	compact
audi	a4 quattro	2.8	1999	6	manual(m5	f	4	17	25 p	compact
audi	a4 quattro	3.1	2008	6	auto(s6)	f	4	17	25 p	compact
audi	a4 quattro	3.1	2008	6	manual(m5	f	4	15	25 p	compact
nissan	altima	2.4	1999	4	manual(m5	f		21	29 r	compact
nissan	altima	2.4	1999	4	auto(l4)	f		19	27 r	compact
subaru	impreza av	2.5	2008	4	auto(s4)	f	4	20	25 p	compact
subaru	impreza av	2.5	2008	4	auto(s4)	f	4	20	27 r	compact
subaru	impreza av	2.5	2008	4	manual(m5	f		19	25 p	compact
subaru	impreza av	2.5	2008	4	manual(m5	f	4	20	27 r	compact
toyota	camry sola	2.2	1999	4	auto(l4)	f		21	27 r	compact
toyota	camry sola	2.2	1999	4	manual(m5	f		21	29 r	compact
toyota	camry sola	2.4	2008	4	manual(m5	f		21	31 r	compact
toyota	camry sola	2.4	2008	4	auto(s5)	f		22	31 r	compact
toyota	camry sola	3	1999	6	auto(l4)	f		18	26 r	compact
toyota	camry sola	3	1999	6	manual(m5	f		18	26 r	compact
toyota	camry sola	3.3	2008	6	auto(s5)	f		18	27 r	compact
toyota	corolla	1.8	1999	4	auto(l3)	f		24	30 r	compact
toyota	corolla	1.8	1999	4	auto(l4)	f		24	33 r	compact
toyota	corolla	1.8	1999	4	manual(m5	f		26	35 r	compact
toyota	corolla	1.8	2008	4	manual(m5	f		28	37 r	compact
toyota	corolla	1.8	2008	4	auto(l4)	f		26	35 r	compact
volkswage	gti	2	1999	4	manual(m5	f		21	29 r	compact
volkswage	gti	2	1999	4	auto(l4)	f		19	26 r	compact
volkswage	gti	2	2008	4	manual(m5	f		21	29 p	compact
volkswage	gti	2	2008	4	auto(s6)	f		22	29 p	compact
volkswage	gti	2.8	1999	6	manual(m5	f		17	24 r	compact
volkswage	jetta	1.9	1999	4	manual(m5	f		33	44 d	compact
volkswage	jetta	2	1999	4	manual(m5	f		21	29 r	compact
volkswage	jetta	2	1999	4	auto(l4)	f		19	26 r	compact
volkswage	jetta	2	2008	4	auto(s6)	f		22	29 p	compact
volkswage	jetta	2	2008	4	manual(m5	f		21	29 p	compact
volkswage	jetta	2.5	2008	5	auto(s6)	f		21	29 r	compact
volkswage	jetta	2.5	2008	5	manual(m5	f		21	29 r	compact
volkswage	jetta	2.8	1999	6	auto(l4)	f		16	23 r	compact
volkswage	jetta	2.8	1999	6	manual(m5	f		17	24 r	compact
chevrolet	c1500 subi	5.3	2008	8	auto(l4)	r		14	20 r	suv
chevrolet	c1500 subi	5.3	2008	8	auto(l4)	r		11	15 e	suv
chevrolet	c1500 subi	5.3	2008	8	auto(l4)	r		14	20 r	suv
chevrolet	c1500 subi	5.7	1999	8	auto(l4)	r		13	17 r	suv
chevrolet	c1500 subi	5.7	2008	8	auto(l4)	r		14	17 r	suv
chevrolet	k1500 tahc	5.3	2008	8	auto(l4)	r	4	14	19 r	suv
chevrolet	k1500 tahc	5.3	2008	8	auto(l4)	r	4	11	14 e	suv
chevrolet	k1500 tahc	5.7	1999	8	auto(l4)	r	4	11	15 r	suv
chevrolet	k1500 tahc	6.5	1999	8	auto(l4)	r	4	14	17 d	suv
dodge	durango 4x	3.9	1999	6	auto(l4)	r	4	13	17 r	suv
dodge	durango 4x	4.7	2008	8	auto(l5)	r	4	13	17 r	suv
dodge	durango 4x	4.7	2008	8	auto(l5)	r	4	9	12 e	suv
dodge	durango 4x	4.7	2008	8	auto(l5)	r	4	13	17 r	suv
dodge	durango 4x	5.2	1999	8	auto(l4)	r	4	11	16 r	suv
dodge	durango 4x	5.7	2008	8	auto(l5)	r	4	13	18 r	suv
dodge	durango 4x	5.9	1999	8	auto(l4)	r	4	11	15 r	suv
ford	expedition	4.6	1999	8	auto(l4)	r		11	17 r	suv
ford	expedition	5.4	1999	8	auto(l4)	r		11	17 r	suv
ford	expedition	5.4	2008	8	auto(l6)	r		12	18 r	suv
ford	explorer 4x	4	1999	6	auto(l5)	r	4	14	17 r	suv
ford	explorer 4x	4	1999	6	manual(m5	f	4	15	19 r	suv
ford	explorer 4x	4	1999	6	auto(l5)	r	4	15	17 r	suv
ford	explorer 4x	4	2008	6	auto(l5)	r	4	13	19 r	suv
ford	explorer 4x	4.6	2008	8	auto(l6)	r	4	13	19 r	suv
ford	explorer 4x	5	1999	8	auto(l4)	r	4	13	17 r	suv
jeep	grand cher	3	2008	6	auto(l5)	r	4	17	22 d	suv
jeep	grand cher	3.7	2008	6	auto(l5)	r	4	15	19 r	suv
jeep	grand cher	4	1999	6	auto(l4)	r	4	15	20 r	suv
jeep	grand cher	4.7	1999	8	auto(l4)	r	4	14	17 r	suv
jeep	grand cher	4.7	2008	8	auto(l5)	r	4	9	12 e	suv
jeep	grand cher	4.7	2008	8	auto(l5)	r	4	14	19 r	suv
jeep	grand cher	5.7	2008	8	auto(l5)	r	4	13	18 r	suv
jeep	grand cher	6.1	2008	8	auto(l5)	r	4	11	14 p	suv
land rover	range rove	4	1999	8	auto(l4)	r	4	11	15 p	suv
land rover	range rove	4.2	2008	8	auto(s6)	r	4	12	18 r	suv
land rover	range rove	4.4	2008	8	auto(s6)	r	4	12	18 r	suv
land rover	range rove	4.6	1999	8	auto(l4)	r	4	11	15 p	suv
lincoln	navigator	5.4	1999	8	auto(l4)	r		11	17 r	suv
lincoln	navigator	5.4	1999	8	auto(l4)	r		11	16 p	suv
lincoln	navigator	5.4	2008	8	auto(l6)	r		12	18 r	suv
mercury	mountaine	4	1999	6	auto(l5)	r	4	14	17 r	suv
mercury	mountaine	4	2008	6	auto(l5)	r	4	13	19 r	suv
mercury	mountaine	4.6	2008	8	auto(l6)	r	4	13	19 r	suv
mercury	mountaine	5	1999	8	auto(l4)	r	4	13	17 r	suv
nissan	pathfinder	3.3	1999	6	auto(l4)	r	4	15	17 r	suv
nissan	pathfinder	3.3	1999	6	manual(m5	f	4	15	17 r	suv
nissan	pathfinder	4	2008	6	auto(l5)	r	4	14	20 p	suv
nissan	pathfinder	5.6	2008	8	auto(s5)	r	4	12	18 p	suv
subaru	forester av	2.5	1999	4	manual(m5	f	4	18	25 r	suv
subaru	forester av	2.5	1999	4	auto(l4)	r	4	18	24 r	suv
subaru	forester av	2.5	2008	4	manual(m5	f	4	20	27 r	suv
subaru	forester av	2.5	2008	4	manual(m5	f	4	19	25 p	suv
subaru	forester av	2.5	2008	4	auto(l4)	r	4	20	27 r	suv
subaru	forester av	2.5	2008	4	auto(l4)	r	4	18	23 p	suv
toyota	4runner 4x	2.7	1999	4	manual(m5	f	4	15	20 r	suv
toyota	4runner 4x	2.7	1999	4	auto(l4)	r	4	16	20 r	suv
toyota	4runner 4x	3.4	1999	6	auto(l4)	r	4	15	19 r	suv
toyota	4runner 4x	3.4	1999	6	manual(m5	f	4	15	17 r	suv
toyota	4runner 4x	4	2008	6	auto(l5)	r	4	16	20 r	suv
toyota	4runner 4x	4.7	2008	8	auto(l5)	r	4	14	17 r	suv
toyota	4runner 4x	4.7	1999	8	auto(l5)	r	4	11	15 r	suv
toyota	land cruise	5.7	2008	8	auto(s6)	r	4	13	18 r	suv