Automotive Analysis of Transmission vs MPG

July 15, 2015

Executive Summary

This report analyzes the relationship between mpg and type of transmission. It was found that manual transmissions achieve the highest mpg efficiency, even while considering both number of cylinders and automobile weight. The most optimal model is a 4-cylinder manual transmission, resulting in the highest mpg efficency.

Data Processing

The data source for the analysis is the "mtcars" data set, extracted from the 1974 Motor Trend US magazine.

The data set contains 11 columns, of which two are directly relevant for our analysis. They are "Miles Per Gallon" and "Transmission". As we'll later show, we'll also consider "Number of Cylinders" and "Weight" in our analysis.

Model Selection

For model selection, we analyze the direct relationship between miles-per-gallon and transmission type (automatic and manual).

An initial plot of the mpg vs transmission data displays automatic transmissions ranging from 15 to 18 with a mean of 17.15, while manual averages from 21 to 30 with a mean of 24.39. There is a visible difference between mpg for automatic versus manual, with manual transmissions achieving the upper range. See Figure 1.

We can obtain a more detailed view of the actual data points in the samples by plotting the points across the transmission type, and overlaying a linear model to highlight the trend. The predicted mpg for automatic is the mean of 17.15, while the predicted mpg for manual is its mean of 24.39.

Multiple Models and Exploratory Analysis

By analyzing the coefficients in the linear model, it can be found that the transmission type is statistically significant when compared with the mpg. The model shows that we expect an increase of 7.25 mpg for manual vs automatic.

However, there may be other important factors that impact mpg and transmission. We can determine which factors may be significant by creating a linear model of all regressors in the data set and checking their significance.

The resulting data indicates that the statistically significant regressors with regard to mpg include Number of Cylinders, Displacement, and Weight. We can compare residual plots to determine which combination offers the closest model for the data.

Residual Plots

The first residual plot displays a close correlation and non-random pattern between transmission type and mpg. After adding Number of Cylinders to the model, the correlation begins to appear more random. A final residual plot that includes mpg, transmission, cylinders, and weight displays a random pattern, indicating the linear model is an appropriate fit. See Figure 2.

After including transmission, cylinder, and weight in the model we note the following values. Manual transmission increases mpg by only 0.15, 6-cylinders decreases mpg by -4.26, while 8-cylinders decreases mpg by -6.08. Weight decreases mpg by -3.15. By including weight, transmission type is no longer statistically signficant and manual vs automatic makes little difference.

Since our focus is on transmission type, we can settle on a final model of transmission and cylinder count. Manual transmission increases mpg by 2.56. 6-cylinders decreases mpg by -6.16, while 8-cylinders decreases mpg by -10.07.

Is an automatic or manual transmission better for MPG?

As shown in Figure 3, we can determine that manual transmission is better for mpg. We can predict from our model of mpg vs transmission + cylinders the following results: A 4-cylinder automobile will achieve 24.80 and 27.36 mpg for automatic and manual respectively, while 6-cylinders will achieve 18.65 and 21.21 mpg, and 8-cylinders 14.73 and 17.29 mpg respectively.

What is the MPG difference between automatic and manual transmissions?

Based upon our initial model of mpg vs transmission, we can expect a 7.25 mpg increase in manual vs automatic transmission. When considering number of cylinders, we expect a 2.56 mpg increase for manual vs automatic, and upon including weight, we expect a 0.15 mpg increase for manual transmissions.

Conclusion

In this analysis, we've determined that there is an overall trend of manual transmission achieving higher mpg efficiency than automatic transmissions. This effect is less for higher cylinder and higher weight cars, but holds effect nonetheless. The most optimal combination is a 4-cycliner manual transmission.
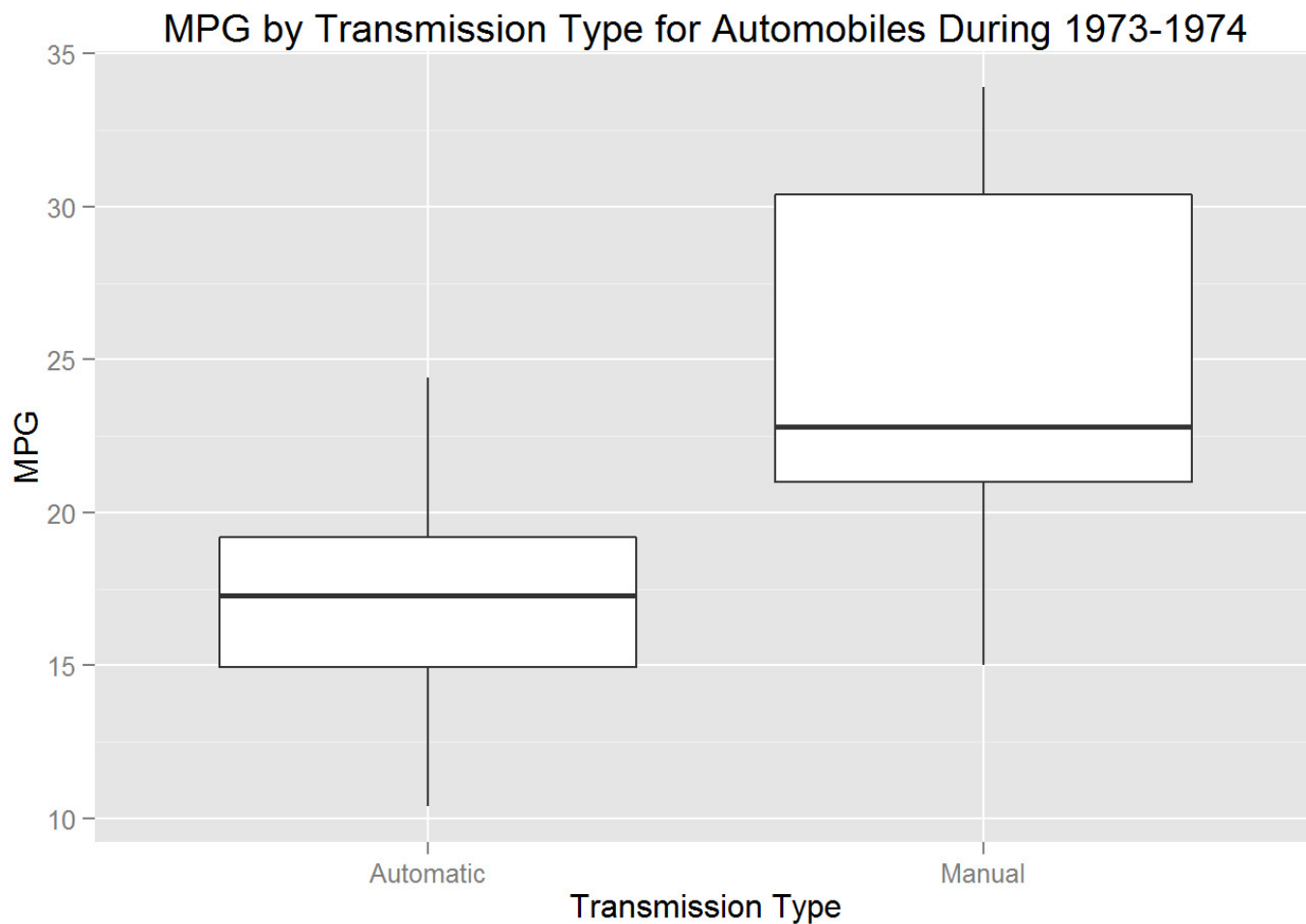
Appendix

Figure 1. This chart displays the difference in MPG by transmission type. Manual transmissions generally achieve higher values for MPG than automatic, with a clear separation around 23 MPG.
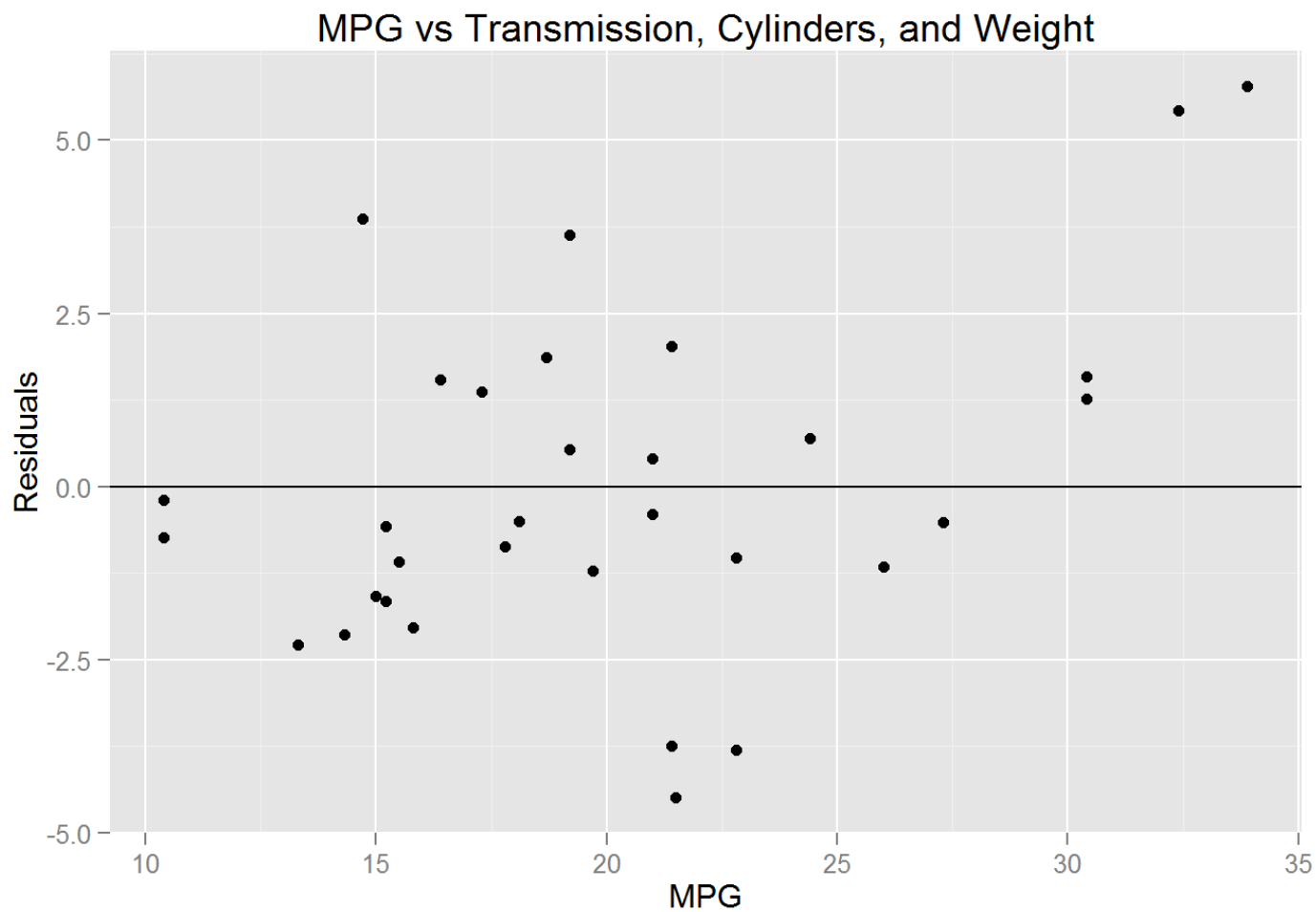
Figure 2. A residual plot of the linear model for mpg, transmission type, number of cylinders, and weight.
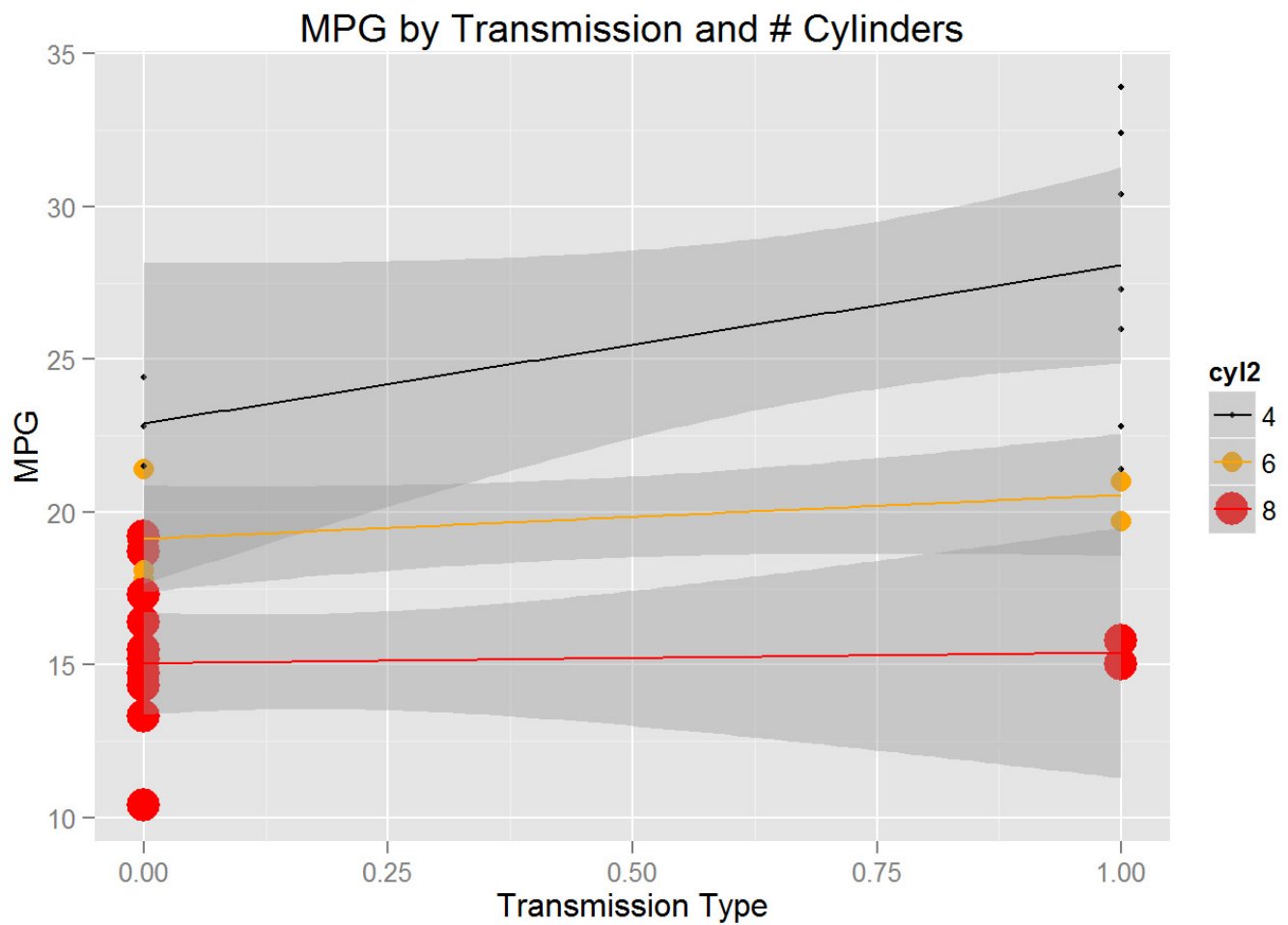
Figure 3. The linear model shows that the highest rates of MPG are achieved by 4-cylinder engines with manual transmissions.