

# The Impact of Transmission Type on Fuel Efficiency

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## Executive Summary

This report summarizes the impact of transmission type on fuel efficiency. The author uses a data set that Motor Trend Magazine constructed in 1974, concerning the performance and attributes of 32 different models of vehicles across 11 variables. The study attempts to answer two questions as directed by Motor Trend Magazine: 1) is an automatic or manual transmission better for mpg and 2) what is the MPG difference between automatic and manual transmissions?

Using a linear model that measures the effect of the quantity of carburetors, the number of cylinders, and whether the automobile has an automatic or manual transmission against the estimated mpg of a vehicle, the author finds that 1) a manual transmission is better for gas mileage and 2) the difference between the two types of transmissions is 4.243 mpg.

All referenced figures are located in the appendix.

## Analysis

A cursory glance at the data shows that cars with manual transmissions get better gas mileage when compared to cars with automatic transmissions as illustrated by the box plot in figure 1.

A t-test can further illuminate this fact:

```
##           am    mpg
## 1 Automatic 17.15
## 2   Manual 24.39
```

## Regression Analysis

The initial linear model examines the interaction between transmission type and estimated mileage per gallon, where 'mpg' represents miles per gallon and am is a dummy variable where a 1 represents a manual transmission.

According to the summary (Figure 2) vehicles with manual transmissions get 7.24 more miles per gallon on average. The initial model can explain approximately 33.8 percent of the variation in mpg. This isn't a particularly helpful model. It is necessary to investigate other variables.

## Anova analysis:

An anova analysis is run to determine a model with a better fit.

The original model is compared against a model that contains all of the independent variables, as well as against one that examines carburetors, cylinders and transmission.

```
## Analysis of Variance Table
##
## Model 1: mpg ~ am
## Model 2: mpg ~ am + cyl + carb
```

```
## Model 3: mpg ~ cyl + disp + hp + drat + wt + qsec + vs + am + gear + carb
##   Res.Df RSS Df Sum of Sq    F Pr(>F)
## 1      30 721
## 2      28 212  2      508 36.19 1.6e-07 ***
## 3      21 147  7       65  1.32  0.29
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

The second model is chosen for its significance.

## Multivariate model:

The expanded model examines how carbeurators, cylinders and transmission can affect the estimated gas mileage of an automobile. As evident in Figure 3, this model explains approximately 80 percent of the variation in gas mileage. With the addition of cylinders and carbeurators as independent variables, the effect of transmission is significantly reduced; from 7 mpg to 4 mpg.

## Appendix

Figure 1

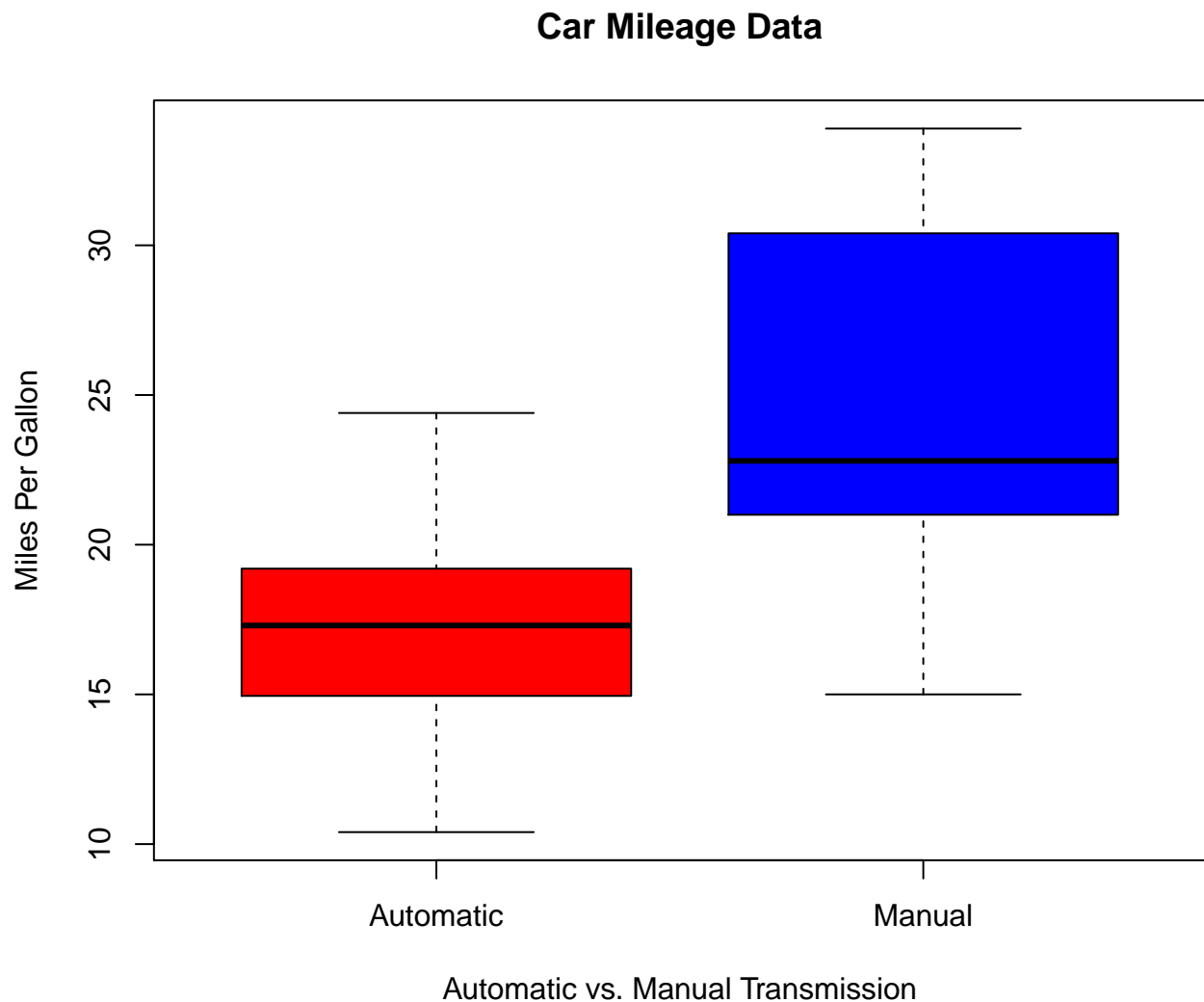


Figure 2

```
##
## Call:
## lm(formula = mpg ~ am, data = mtcars)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -9.392  -3.092  -0.297   3.244   9.508
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    17.15      1.12    15.25  1.1e-15 ***
## amManual         7.24      1.76     4.11  0.00029 ***
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.9 on 30 degrees of freedom
## Multiple R-squared:  0.36,    Adjusted R-squared:  0.338
## F-statistic: 16.9 on 1 and 30 DF,  p-value: 0.000285
```

### Figure 3

```
##
## Call:
## lm(formula = mpg ~ am + cyl + carb, data = mtcars)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -5.885 -1.158  0.265  1.488  5.484
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   32.173     2.491    12.91  2.6e-13 ***
## amManual       4.243     1.309     3.24  0.00307 **
## cyl          -1.717     0.430    -4.00  0.00042 ***
## carb          -1.130     0.406    -2.79  0.00948 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.75 on 28 degrees of freedom
## Multiple R-squared:  0.811,    Adjusted R-squared:  0.791
## F-statistic: 40.1 on 3 and 28 DF,  p-value: 2.85e-10
```

## Residual Analysis

