Tread Wear Quadratic Model

![Graph showing the quadratic fit of tread wear depth by mileage.](image)

- Lecture Notes before Annotations
- Lecture Notes after Annotations
Residuals for Quadratic Model

The Fit Y by X platform was used to get these plots.

Left plot can also be obtained using the Plot Residuals option.

\[ y = \hat{b}_0 + \hat{b}_1 x + \hat{b}_2 x^2 \]

\[ \hat{y}_g = \hat{b}_0 + \hat{b}_1 x + \hat{b}_2 (x - \bar{x})^2 \]

\[ \bar{x} = 1.6 \]
Tread Wear Quadratic Model

R² was .95261 for model linear in x

\[ R^2 = 1 - \frac{S^2_e}{S^2_e} \]

\[ \sigma^2 = \sigma^2 \]

\[ \sigma^2 \]
Checking for Constant Variance: Plot of Predicted vs. Residual

If assumption is incorrect, often $\text{Var}(Y)$ is some function of $E(Y) = \mu$

Figure 10.7 Plots of Residuals $e$ vs. $\hat{x}$, Corresponding to Different Functional Relationships Between $\text{Var}(Y)$ and $E(Y)$: (a) Constant variance; (b) Variance proportional to $x^2$; (c) Variance proportional to $x$.

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Unit 10 - Stat 571 - Ramón V. León
Other Model Diagnostics Based on Residuals

- **Checking for normality of errors**: Do a normal plot of the residuals
- **Warning**: Don’t plot the response $y$ on a normal plot
  - This plot has no meaning when one has regressors
  - Don’t transform the data on the basis of this plot
  - Many students make this mistake in their project. Don’t be one of them.
Other Model Diagnostics Based on Residuals

Fit Model Platform:

- **Checking for independence of errors:** Plot the residual in time order. The order of data collection should be always recorded. Use Durbin-Watson statistic to test for autocorrelation.
Other Model Diagnostics Based on Residuals

- **Checking for outliers**: See if any standardized (Studentized) residual exceeds 2 (standard deviations) in absolute value.

\[
\hat{e}_i = \frac{e_i}{SE(e_i)} = \frac{e_i}{s \sqrt{1 - \frac{1}{n} \frac{(x_i - \bar{x})^2}{S_{xx}}} \cdot \frac{e_i}{s}, \quad i = 1, 2, \ldots, n.\
\]

Also do a box plot of residuals to check for outliers.
Standardized (Studentized) Residuals in JMP 4

Using the Fit Model JMP platform with linear model

Should we omit the first observation and refit the model?

Possible outlier

The model fitted here is the one linear in x, not the quadratic model