1 Simple regression

Formula for $\hat{\beta}_1$

$$\hat{\beta}_1 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^{n}(x_i - \bar{x})^2}$$

Sum of squares

$$\begin{aligned} SST &= \sum_{i=1}^{n}(y_i - \bar{y})^2 \\ SSE &= \sum_{i=1}^{n}(\hat{y}_i - \bar{y})^2 \\ SSR &= \sum_{i=1}^{n}\hat{u}_i^2 \end{aligned}$$

Standard error of $\hat{\beta}_1$

$$se(\hat{\beta}_1) = \frac{\hat{\sigma}}{\sqrt{SST_x}}$$

where

$$\hat{\sigma}^2 = SSR/(n-2)$$

2 Multiple regression

Standard error of slopes

$$se(\hat{\beta}_j) = \frac{\hat{\sigma}}{\sqrt{SST_j(1-R_j^2)}},\ j = 1, 2, ..., k$$

where

$$\hat{\sigma}^2 = (n-k-1)^{-1}\sum_{i=1}^{n}\hat{u}_i^2$$

t statistic

$$\frac{\hat{\beta}_j - \beta_j}{se(\hat{\beta}_j)} \sim t_{n-k-1} = t_{df}$$

F statistic

$$F = \frac{(SSR_r - SSR_{ur})/q}{SSR_{ur}/(n-k-1)}$$

or

$$F = \frac{(R_{ur}^2 - R_r^2)/q}{(1-R_{ur}^2)/(n-k-1)}$$

Quadratic models

$$y = \beta_0 + \beta_1 x + \beta_2 x^2 + u$$

$$\frac{\Delta y}{\Delta x} = \beta_1 + 2\beta_2 x$$

Turning point in quadratic models

$$x^* = \left|\frac{\hat{\beta}_1}{2\hat{\beta}_2}\right|$$

Interaction terms

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_1 \centerdot x_2 + u$$

$$\frac{\Delta y}{\Delta x_1} = \beta_1 + \beta_3 x_2$$