Simple regression formulae

$$b_1 = \frac{\sum(X_i-\overline{X})(Y_i-\overline{Y})}{\sum(X_i-\overline{X})^2} \qquad b_0 = \overline{Y} - b_1\overline{X}$$

$$\mathrm{Var}(b_1) = \frac{\sigma^2}{\sum(X_i-\overline{X})^2} \qquad \mathrm{Var}(b_0) = \sigma^2\left(\frac{1}{n} + \frac{\overline{X}^2}{\sum(X_i-\overline{X})^2}\right)$$

$$\mathrm{Cov}(b_0, b_1) = -\frac{\sigma^2\overline{X}}{\sum(X_i-\overline{X})^2} \qquad \mathrm{SSTO} = \sum(Y_i - \overline{Y})^2$$

$$\mathrm{SSE} = \sum(Y_i - \hat{Y}_i)^2 \qquad \mathrm{SSR} = b_1^2\sum(X_i - \overline{X})^2 = \sum(\hat{Y}_i - \overline{Y})^2$$

$$\begin{aligned}\sigma^2\{\hat{Y}_h\} &= \mathrm{Var}(\hat{Y}_h) \\ &= \sigma^2\left(\frac{1}{n} + \frac{(X_h-\overline{X})^2}{\sum(X_i-\overline{X})^2}\right)\end{aligned} \qquad \begin{aligned}\sigma^2\{\mathrm{pred}\} &= \mathrm{Var}(Y_h - \hat{Y}_h) \\ &= \sigma^2\left(1 + \frac{1}{n} + \frac{(X_h-\overline{X})^2}{\sum(X_i-\overline{X})^2}\right)\end{aligned}$$

$\hat{X}_h \pm \frac{t_{n-2,1-\alpha/2}}{|b_1|} *$ appropriate s.e.
(valid approximation if $\frac{t^2 s^2}{b_1^2\sum(X_i-\overline{X})^2}$ is small)

Working-Hotelling coefficient:
$W = \sqrt{2F_{2,n-2;1-\alpha}}$

Regression in matrix terms

$$\begin{aligned}\mathrm{Cov}(\mathbf{X}) &= \mathrm{E}[(\mathbf{X} - \mathrm{E}\mathbf{X})(\mathbf{X} - \mathrm{E}\mathbf{X})'] \\ &= \mathrm{E}(\mathbf{X}\mathbf{X}') - (\mathrm{E}\mathbf{X})(\mathrm{E}\mathbf{X})'\end{aligned} \qquad \mathrm{Cov}(\mathbf{AX}) = \mathbf{A}\mathrm{Cov}(\mathbf{X})\mathbf{A}'$$

$$\mathbf{b} = (\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}'\mathbf{Y} \qquad \mathrm{Cov}(\mathbf{b}) = \sigma^2(\mathbf{X}'\mathbf{X})^{-1}$$

$$\hat{\mathbf{Y}} = \mathbf{Xb} = \mathbf{HY} \qquad \mathbf{e} = \mathbf{Y} - \hat{\mathbf{Y}} = (\mathbf{I} - \mathbf{H})\mathbf{Y}$$

$$\mathbf{H} = \mathbf{X}(\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}' \qquad \mathrm{SSR} = \mathbf{Y}'(\mathbf{H} - \tfrac{1}{n}\mathbf{J})\mathbf{Y}$$

$$\mathrm{SSE} = \mathbf{Y}'(\mathbf{I} - \mathbf{H})\mathbf{Y} \qquad \mathrm{SSTO} = \mathbf{Y}'(\mathbf{I} - \tfrac{1}{n}\mathbf{J})\mathbf{Y}$$

$$\begin{aligned}\sigma^2\{\hat{Y}_h\} &= \mathrm{Var}(\hat{Y}_h) \\ &= \sigma^2\mathbf{X}_h'(\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}_h\end{aligned} \qquad \begin{aligned}\sigma^2\{\mathrm{pred}\} &= \mathrm{Var}(Y_h - \hat{Y}_h) \\ &= \sigma^2(1 + \mathbf{X}_h'(\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}_h)\end{aligned}$$

$$R^2_{\mathrm{adj}} = 1 - (n-1)\frac{MSE}{SSTO}$$