```
> ##  ========================================
> ##  Model : Y = b0 + b1 X1 + b2 X2  (X1 first)
> ##  ========================================
> LM3 = lm ( y ~ x1 + x2 )
> summary(LM3)

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -19.1742     8.3606  -2.293   0.0348 *
x1 | X2        0.2224     0.3034   0.733   0.4737
x2 | X1        0.6594     0.2912   2.265   0.0369 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.543 on 17 degrees of freedom
Multiple R-Squared: 0.7781,     Adjusted R-squared: 0.7519
F-statistic: 29.8 on 2 and 17 DF,  p-value: 2.774e-06

> anova(LM3)
Analysis of Variance Table

Response: y
          Df Sum Sq Mean Sq F value    Pr(>F)
x1         1 352.27  352.27 54.4661 1.075e-06 ***
x2 | X1    1  33.17   33.17  5.1284    0.0369 *
Residuals 17 109.95    6.47
---
```

$\hat{\beta}_k$ $SE[\hat{\beta}_k]$ → two-sided.

different from anova (X_1)

$T_1^2 = \left[\frac{\hat{\beta}_1}{SE(\hat{\beta}_1)}\right]^2 = \frac{SSR(X_1|X_2)/1}{MSE(X_1, X_2)}$

$T_2^2 = \left[\frac{\hat{\beta}_2}{SE(\hat{\beta}_2)}\right]^2 = \frac{SSR(X_2|X_1)/1}{MSE(X_1,X_2)} = \frac{33.17}{6.47} = 5.12$

$\sqrt{MSE}$

Overall F-test: $F = \frac{SSR(X_1,X_2)/2}{MSE} = \frac{385.44}{6.47} = 29.8$

$2.265^2 = 5.1284$

ANOVA(X_1, X_2)

same

$SSR(X_1, X_2) = SSR(X_1) + SSR(X_2|X_1)$
$= 352.27 + 33.17$
$= 385.44$

$MSE = 6.47$

$n - p$

$495.39 = SSTo$

$SSR(X_1) = 352.27$

$SSR(X_2|X_1) = 33.17$

Note: $[t\text{-value}]^2 = \text{partial-}F$.

```
> ##  ========================================
> ##  Model : Y = b0 + b1 X1 + b2 X2 (X2 first)
> ##  ========================================
> LM4 = lm ( y ~ x2 + x1 )
> summary(LM4)

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -19.1742     8.3606  -2.293   0.0348 *
x2 | X1        0.6594     0.2912   2.265   0.0369 *
x1 | X2        0.2224     0.3034   0.733   0.4737
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.543 on 17 degrees of freedom
Multiple R-Squared: 0.7781,     Adjusted R-squared: 0.7519
F-statistic: 29.8 on 2 and 17 DF,  p-value: 2.774e-06
```

↳ Overall F-test.

$T_1^2 = \left[\frac{\hat{\beta}_1}{SE(\hat{\beta}_1)}\right]^2 = \frac{SSR(X_1|X_2)/1}{MSE} = \frac{3.47}{6.47} = 0.537$

$0.733^2 = 0.537$

ANOVA(X_2, X_1)

```
> anova(LM4)
Analysis of Variance Table

Response: y
          Df Sum Sq Mean Sq F value    Pr(>F)
x2         1 381.97  381.97 59.057 6.281e-07 ***
x1 | X2    1   3.47    3.47  0.537    0.4737
Residuals 17 109.95    6.47
---
```

$SSR(X_1, X_2) = SSR(X_2) + SSR(X_1|X_2)$
$= 381.97 + 3.47 = 385.44$

MSE

$495.39 = SSTo$ (Same as the above)