

## Approximate F-tests for MANOVA Models

$N \equiv$  Overall sample size (number of experimental/sampling units)

$p \equiv$  Number of response variables

$q \equiv$  Degrees of freedom for factor being tested

$g \equiv$  Number of Treatment groups

$$r = (N - g) - \frac{p - q + 1}{2}$$

$$u = \frac{pq - 2}{4}$$

$$d = \begin{cases} \sqrt{\frac{p^2 q^2 - 4}{p^2 + q^2 - 5}} & \text{if } p^2 + q^2 - 5 > 0 \\ 1 & \text{otherwise} \end{cases}$$

$$df_1 = pq \quad df_2 = rd - 2u$$

$$\text{Test Statistic: } F^* = \frac{1 - (\Lambda^*)^{1/d}}{(\Lambda^*)^{1/d}} \left( \frac{df_2}{df_1} \right) \quad \text{Rejection Region: } F^* \geq F_{df_1, df_2}(\alpha) \quad \text{P-value: } P(F_{df_1, df_2} \geq F^*)$$