

## Partial $F$ Tests

Applied Regression and Other Multivariable Methods  
Sections 9-5 - 9-6

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## Strategies

- Will consider two strategies carried out by SAS
- Each strategy based on order of fit
  - Variables-added-in-order - Type I SS
  - Variables-added-last - Type III SS
- PROC REG default is Type III approach
- Type III approach is similar to giving equal importance to all variables : Is this variable important after all other variables have been fit in the model?
- Type I approach gives more importance to those fitted early in the model.

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## Variables-Added-in-Order

- The order is specified in the model statement
- For example, consider the following statements

```
proc reg;  
model y = x1 x2 x3;
```

- To assess the significance of  $x_1$  use

$$F = \frac{SS(x_1)}{MS \text{ Residual}(x_1)}$$

- To assess the significance of  $x_2$  use

$$F = \frac{SS(x_2|x_1)}{MS \text{ Residual}(x_1, x_2)}$$

- To assess the significance of  $x_3$  use

$$F = \frac{SS(x_3|x_1, x_2)}{MS \text{ Residual}(x_1, x_2, x_3)}$$

- Notice that the denominator is diff for each test
- Common to use  $MS \text{ Residual}(x_1, x_2, x_3)$  for all tests

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## Variables-Added-Last

- Each variable tested as if fitted last
- For example, consider the following statements

```
proc reg;  
model y = x1 x2 x3;
```

- To assess the significance of  $x_1$  use

$$F = \frac{SS(x_1|x_2, x_3)}{MS \text{ Residual}(x_1, x_2, x_3)}$$

- To assess the significance of  $x_2$  use

$$F = \frac{SS(x_2|x_1, x_3)}{MS \text{ Residual}(x_1, x_2, x_3)}$$

- To assess the significance of  $x_3$  use

$$F = \frac{SS(x_3|x_1, x_2)}{MS \text{ Residual}(x_1, x_2, x_3)}$$

- Here the denominator is the same for each test

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## Example

- SAS does not compute partial F tests directly
- Can use SS1 option to obtain partial SS
- Proc GLM (Anova) does F-tests directly
- File below available as topic11.sas

```
options nocenter;

data new;
  infile 'i:\www\datasets502\example8-1.dat';
  input child wgt hgt age;

proc reg;
  model wgt = hgt age / ss1;
  model wgt = age hgt / ss1;
run;

proc glm;
  model wgt = hgt age / ss1 ss3;
run;
```

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## Output

The REG Procedure

Dependent Variable: wgt

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	692.82261	346.41130	15.95	0.0011
Error	9	195.42739	21.71415		
Corrected Total	11	888.25000			

Root MSE	4.65984	R-Square	0.7800
Dependent Mean	62.75000	Adj R-Sq	0.7311
Coeff Var	7.42605		

Parameter Estimates						
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr >  t	Type I SS
Intercept	1	6.55305	10.94483	0.60	0.5641	47251.00000
hgt	1	0.72204	0.26081	2.77	0.0218	588.92252
age	1	2.05013	0.93723	2.19	0.0565	103.90008

Parameter Estimates						
Variable	DF	Parameter Estimate	Standard Error	t Value	Pr >  t	Type I SS
Intercept	1	6.55305	10.94483	0.60	0.5641	47251.00000
age	1	2.05013	0.93723	2.19	0.0565	526.39286
hgt	1	0.72204	0.26081	2.77	0.0218	166.42975

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## Output

The GLM Procedure

Dependent Variable: wgt

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	692.8226065	346.4113033	15.95	0.0011
Error	9	195.4273935	21.7141548		
Corrected Total	11	888.2500000			

R-Square	Coeff Var	Root MSE	wgt Mean
0.779986	7.426048	4.659845	62.75000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
hgt	1	588.9225232	588.9225232	27.12	0.0006
age	1	103.9000834	103.9000834	4.78	0.0565

Source	DF	Type III SS	Mean Square	F Value	Pr > F
hgt	1	166.4297494	166.4297494	7.66	0.0218
age	1	103.9000834	103.9000834	4.78	0.0565

Parameter	Estimate	Standard Error	t Value	Pr >  t
Intercept	6.553048251	10.94482708	0.60	0.5641
hgt	0.722037958	0.26080506	2.77	0.0218
age	2.050126352	0.93722561	2.19	0.0565

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## Comparison

- From Regression Output

$$SS(\text{hgt}) = 588.92 \quad \text{and} \quad SS(\text{age}) = 526.39$$

$$SS(\text{age}|\text{hgt}) = 103.90 \quad \text{and} \quad SS(\text{hgt}|\text{age}) = 166.43$$

Type I SS always add up to SS(model)

$$SS(\text{hgt}) + SS(\text{age}|\text{hgt}) = SS(\text{age}) + SS(\text{hgt}|\text{age})$$

- From GLM Output

Both Type I and III SS performed

Type I only done for hgt fitted first

Uses constant MS Residual approach

Notice Type III tests similar to t-test of parameters

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