AFRE 802
Statistical Methods for Agricultural, Food, & Resource Economists

Concluding remarks on linear models & estimation by least squares; course wrap-up

December 7, 2017

Nicole Mason
Michigan State University
Fall 2017

Final exam details

- Cumulative but with emphasis on material since midterm (Ch. 7-Ch. 11)
- Please bring paper, pencil, calculator, and cheat sheets (two 8.5x11" sheets, front and back). Please write last 4 digits of your PID on all sheets of paper in advance to save time.
- Exam is closed book/notes except for cheat sheets
- Exam is in this room from 12:45-2:45 PM (hard stop) on Thurs. (Dec. 14)

Review sessions: 4-5 PM tomorrow (Friday), and 3-5 PM on Tuesday (both in the basement of Cook Hall)

Approximate grading scale (use natural breaks)

4.0	92-100
3.5	85-91.9
3.0	80-84.9
2.5	75-79.9
2.0	70-74.9
1.5	65-69.9
1.0	60-64.9

1

MICHIGAN STATE UNIVERSITY

Reminder

- Thanks in advance for completing your SIRS!

Game plan for today

- Go over answers to additional practice problem, then review
- Review
- Answer your questions

2

Review: Simple linear regression assumptions & implications

SLR.1-SLR.4 → OLS estimators are **unbiased**

SLR.1. Linear in parameters:

SLR.2. Random sampling

****SLR.3. Zero conditional mean (exogeneity):** $\boxed{E(u\,|\,x) = E(u) = 0}$

SLR.4. Sample variation in x

SLR.5. Homoskedasticity (constant variance): $\boxed{V(u\,|\,x) = V(u) = \sigma^2}$

→ Formulas for variances of OLS estimators are:

$$\boxed{V(\hat{\beta}_1) = \frac{\sigma^2}{\sum_{i=1}^{N}(x_i - \bar{x})^2}} \qquad \boxed{V(\hat{\beta}_0) = \frac{\sigma^2 N^{-1}\sum_{i=1}^{N} x_i^2}{\sum_{i=1}^{N}(x_i - \bar{x})^2}}$$

→ SLR.1-SLR.5 → OLS is **BLUE** (Gauss-Markov Theorem)

SLR.6. Normality: The population error ***u* is independent of *x*** and is **normally distributed** with $E(u)=0$ and $V(u)=\sigma^2$, i.e.:

→ SLR.1-SLR.6 (Classical Linear Model assumptions) →

$$\boxed{\hat{\beta}_j \sim Normal\left(\beta_j,\ V(\hat{\beta}_j)\right)}$$

Review: Testing hypotheses about β_0 or β_1

$$y = \beta_0 + \beta_1 x + u$$

1. State the **null & alternative hypotheses**: $H_0 : \beta_j = \beta_{j,0}, H_1 : \beta_j \neq \beta_{j,0}$
2. Define an appropriate **test statistic**: $\hat{\beta}_j$
3. Determine the **distribution of the test statistic under the null** hypothesis $\hat{\beta}_j \sim Normal\left(\beta_{j,0},\ V(\hat{\beta}_j)\right)$
4. **Standardize the test statistic** to something with known/tabled probabilities for its sampling distribution (e.g., *Z, t, chi-square, F*)

$$Z = \frac{\hat{\beta}_j - \beta_{j,0}}{\sigma_{\hat{\beta}_j}} \sim Normal(0, 1) \qquad T = \frac{\hat{\beta}_j - \beta_{j,0}}{\hat{\sigma}_{\hat{\beta}_j}} \sim t \text{ with } N-2 \text{ d.f.}$$

5. Choose a **significance level** (*α*, the *P*(Type I error)=*P*(reject the null when it is true), typically 0.01, 0.05, or 0.10) & a **rejection region** **OR** compute the **p-value** for the test statistic.
6. **Reject the null hypothesis if** the standardized statistic lies **in the rejection region (or if p-value≤*α*)**; fail to reject otherwise

MICHIGAN STATE UNIVERSITY

Review: Confidence intervals for β_0 or β_1

$$\hat{\beta}_j \pm t_{\alpha/2}\hat{\sigma}_{\hat{\beta}_j}$$

$$(N-2 \text{ d.f. for } t_{\alpha/2})$$

5

Back to Day 1: The objectives of statistics

1. To make an **inference about a population based on info in a sample** from that population
   - ***Estimate and test hypotheses about population parameters***

2. To provide a **measure of the 'goodness'** of that inference
   - ***Unbiasedness, consistency, efficiency, probabilities of Type I and Type II error***

Answer your questions

Thank you for a fun semester and for all of your hard work! I've enjoyed working with you!