EC 12: Statistics II

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Spring 2021

Jindal School of Government and Public Policy
O.P. Jindal Global University

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1. Course Synopsis

This is the second part of the two part course on statistical methods for undergraduate economics students. It begins with a discussion on sampling techniques used to collect survey data. The course introduces the concept of sampling distributions that act as a linkage between statistical inference and probability theory. It then covers topics in inference which include point estimation, interval estimation and hypothesis testing. We end the course with a refresher of what we have learnt in statistics and how it gets connected to econometrics.

2. Course Goals

1. Understand scope and limitations of sampling techniques,
2. Understand and implement estimation techniques to obtain point estimates from a sample,
3. Apply sampling distributions to inform interval estimates,
4. Form intelligible hypothesis about population parameters and use sample to evaluate the confidence in a hypothesis,
5. Extend this understanding to two populations and examine the sample statistics related to two populations,
6. And be able to use Excel to conduct most of the inference required in the course using simplistic data.

3. Class Timing

Spring 2021
Monday 1:00 PM - 2:30 PM
Wednesday 3:00 PM - 4:30 PM

Pre-requisites: Statistics I, Math I

4. Instructors and Office Hours

Nikhil Damodaran
Personal webpage for course content and other interesting material related to the course.
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Office: Cabin 6, T4, Academic Block, OP Jindal Global University
Office hours online on zoom.

5. Readings

Required Text:

Anderson, D. R., Sweeney, D. J., Williams, T. A., Camm, J. D., Cochran, J. J. (2015). Statistics for business and economics (13th ed.). Delhi: Cengage Learning. [ASW]

Takahashi, S. (2014). The Manga Guide to Statistics. Manga Guide To. No Starch Press.

Additional References:

Lock, P., Lock, R., Lock, D., Morgan, K., and Lock, E. (2018). Statistics: Unlocking the Power of Data. Wiley, 2nd edition edition.

Griffiths, D. (2008). Head First Statistics. Head First. O'Reilly Media.

Advanced References:

Devore, J. and Berk, K. (2011). Modern Mathematical Statistics with Applications. Springer Texts in Statistics. Springer New York.

Mittelhammer, R. C. (2013). Mathematical Statistics for Economics and Business. Springer, 2nd edition edition.

Casella, G. and Berger, R. L. (2002). Statistical Inference. Duxbury Thomson Learning, 2nd edition edition.

Amemiya, T. (1994). Introduction to Statistics and Econometrics. Harvard University Press, 1st edition edition.

6. Assessment

Assessments include internal evaluations which account for 50% of your total grade and an external end term exam for the remaining 50%. The internal is divided into a maximum of:

6 Problem Sets for each chapter
2 Presentations
3 Quizzes

The weightage will be determined at the end of the classes depending on the class performance.

Missed excusable reasons: Require prior or immediate email communication with the instructor, cc-ed to the academic dean and the vice dean of the school. The percentage grade would be proxied with the percentage grade obtained in the remainder of the course, only to be assessed at the *end of the semester*.

7. Course Contents

This syllabus is intended to give the student guidance in what may be covered during the semester and will be followed as closely as possible. However, the instructor reserves the right to modify, supplement and make changes as the course needs arise.

Weekly Schedule:

Week 1: Sampling, Point Estimation basics (7.1-7.3)

Week 2: Sampling distributions and distribution of $\bar{x}$ (7.4-7.5)

Week 3: Sampling distribution of $\bar{p}$, properties of point estimators and other sampling methods (7.6-7.8) + 14th Edition (Big Data)†

Week 4: Interval Estimation for known and unknown population standard deviation σ (8.1-8.2)

Week 5: Interval estimation for unknown population σ, Optimal sample size and population proportion (8.2, 8.3, 8.4) + 14th Edition (Big Data)†

Week 6: Review

Week 7: Developing Null and Type I and Type II error (9.1-9.2)

Week 8: Hypotheses tests for population mean with known σ (9.3)

Week 9: Hypotheses tests for population mean with unknown σ (9.4)

Week 10: Proportion, Hypothesis test and decision making (9.5-9.6)

Week 11: Type II error and sample size (9.7-9.8), + 14th Edition (Big Data)†

Week 12: Two population means (10.1, 10.2)

Week 13: Matched samples and two population proportion (10.3,10.4)

Week 14: Inferences about population variance (11.1,11.2)

Week 15: Connecting statistics to econometrics

† If there is spare time.

7.1 Topics in Detail

Topic 1: Sampling and Sampling Distributions

ASW, Chapter 7: Sampling and Sampling Distributions

7.1 Introduction

- Example of Voter Patterns

7.2 Selecting a Sample

- Sampling from a Finite Population
- With and Without Replacement
- Sampling from an Infinite Population
- Example: McDonald's Randomization Efforts

7.3 Point Estimation

- Example: EAI Managers Problem
- Exercises

7.4 Introduction to Sampling Distributions

7.5 Sampling Distribution of Sample Averages, $\bar{x}$

- Expected value of $\bar{x}$
- Unbiased Estimator
- Standard Deviation of $\bar{x}$
- Form of the Sampling Distribution of $\bar{x}$
- Central Limit Theorem
- Example: Sampling Distribution of $\bar{x}$ for the EAI Problem
- Z-table look up
- Relationship between the sample size and the sampling distribution of $\bar{x}$

7.6 Sampling Distribution of $\bar{p}$

- Expected value, Standard Deviation of $\bar{p}$
- Form of the sampling distribution of $\bar{p}$
- Example: Sampling Distribution of $\bar{p}$ for the EAI Problem

7.7 Properties of Point Estimators

- Unbiasedness
- Efficiency
- Consistency

7.8 Other Sampling Methods

7.9 Maximum Likelihood Estimation

7.10 Method of Moments Estimation

Topic 2: Interval Estimation

Chapter 8 Interval Estimation, (ASW)

8.1 Intervals for population mean, μ under known population standard deviations, σ

Example: Lloyd's Departmental Store

Standard Normal Variable and Margin for Error

Confidence Intervals constructed using $z_{\alpha/2}$

8.2 Intervals for population mean, μ under unknown population standard deviations, σ

t-distribution and its degrees of freedom

Reading the t-table

Confidence Intervals constructed using $t_{\alpha/2}$

Example: Average Credit Card Debt

Using a Small sample

Example: Sheer Industries Automated Training Program

8.3 Determining the Sample size

Optimal Error and sample size

Example: Renting a Mid-Size

8.4 Population Proportion

Normal approximation of a binomial distribution

Example: Women's Tee Times and Discrimination in Golf

Determining the Sample Size

Planning Value

Example: Using planning value for Women's Tee Times

Topic 3: Introduction to Hypothesis Testing

AWS: Chapter 9: Hypothesis Tests

9.1 Developing Null and Alternative Hypothesis

Types of Null Hypothesis, One tailed and Two Tailed Tests

Exercises

9.2 Type I Error: reject H_0, when its true and Type II Errors: accept H_0 when its false

Example: Honda Jazz Mileage

Statement about 'Not Rejecting the null

Exercise

9.3 Population Mean with Known σ

Example: Hilltop Coffee and Federal Trade Commission

Step 1: Specifying a null hypothesis

Step 2: Deciding a level of significance, α

Step 3: Constructing a test statistic, z under population normality

Step 4: Compare p-value with α and reject/fail to reject null

Step 4A: Examine critical value of the test-statistic, and reject/fail to reject null

Example: Two Tailed Tests using Kookaboora cricket ball

p-Value

Critical Value approach

Interval estimation and Hypothesis testing

9.4 Population Mean with Un-Known σ

t-distribution to capture sample variability

Example: Skytrax Delhi Airport

Step 1: Specifying a null hypothesis

Step 2: Deciding a level of significance, α

em Step 3: Constructing a test statistic, t using $\bar{x}, s$ from sample

Step 4: Compare p-value with α and reject/fail to reject null

Step 4A: Examine critical value of the test-statistic, and reject/fail to reject null

Example: Two Tailed Tests using Holiday Toys

p-Value

Critical Value approach

9.5 Population proportion, p

Example: Proportion of female candidates in BPP party

tem p-Value

Critical Value approach

9.6 Hypothesis testing with both Type I and Type II error

Example: Introducing Lot acceptance sample

9.7 Calculating Type II error

Power of Test and the Power Curve

9.8 Determining the Sample Size for a Hypothesis Test About a Population Mean

Optimal sample size accounting for α and β

Relation between α, β and n

Topic 4: Inference about Means and Proportions with Two Populations 10.1 Inference about the Difference between Two Population Means

Example: Big Bazar in GK versus Badli

Interval estimation

Example: Training quality of Two GRE Coching Centers

Hypothesis Tests

10.2 Inferences About Difference between Means based on Unknown

Example: State Bank of India

Interval Estimates

Example: Matlab vs. Python

Hypothesis testing

10.3 Inference About The Difference Between Two Population Means: Matched Samples

Example: Uber and Matched Samples

Interval Estimates

10.4 Inference About Difference Between Two Population Proportions

Example: Jindal Tax Center

Interval Estimate

Hypothesis Testing

Pooled Point Estimates

Test Statistic and Standard Error under the Null

Topic 5: Population Variance Inference

AWS Chapter 11: Inferences about population variances

11.1 One estimator with one population

11.2 Estimating variances from two populations

Topic 6: Goodness of Fit

AWS Chapter 12: Comparing Multiple Proportions, Tests of Independence and Goodness of Fit

12.2 Testing independence

12.3 Goodness of Fit Test

Extra useful topics: Chapter 20 on Index Numbers, Chapter 13 ANNOVA