

ECON 1190: Econometrics 2:
Class 1: Intro and Stats Review Blitz

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Syllabus and course logistics

Course description

- ▶ hands-on skills in applied econometric research methods
- ▶ focus on research design and approaches to establish empirical relationships of cause and effect
- ▶ advanced methods in regression analysis

Topics covered include:

- ▶ omitted variable bias, fixed effects, instrumental variables, randomized control trials, difference-and-differences, and regression discontinuities.
- ▶ learning the basic tools of programming and coding in R (no prior knowledge is required)
- ▶ learn to present results in nice formatted tables and figures

Is this course right for me?

- ▶ I am interested in how economists do research with data
- ▶ I am interested in developing my (highly marketable!) data analysis skills
- ▶ I have taken a class such as ECON 1150: Applied Econometrics 1 (or STAT 1221, IF 1071) and am comfortable with:
 - ▶ basic probability and statistics
 - ▶ basic linear regressions
- ▶ to use other classes as prerequisites, check with Katherine Wolfe (kwolfeATpitt.edu)
- ▶ I am ready to work hard!

Contact

Email: ced87-at-pitt.edu

Office hours: Mondays after class: 4:30-5:30

Personal advising/discussion: Sign up at
<https://sites.google.com/view/claireduquennes/teaching>

Required materials

- ▶ Rstudio Cloud Student Account:
 - ▶ Purchase a Student account (\$5/month for duration of term).
- ▶ Homework article readings:
 - ▶ 5 academic journal articles that we will replicate
 - ▶ available on canvas to be read by the dates indicated in the course schedule
- ▶ Lecture notes and slides available on course github page:
<https://github.com/clairedug/econ1190>
- ▶ Reference texts as needed:
 - ▶ Nick Huntington-Klein The Effect (Available online).
 - ▶ Cunningham, Scott. Causal Inference: The Mixtape (Available online)
 - ▶ Wooldridge, Jeffery. Introductory Econometrics: A modern Approach. (Any edition).
 - ▶ Angrist, Joshua D and Pischke, J. Mostly Harmless Econometrics. Princeton University Press, 2008.

Grades

- ▶ Homework assignments 50%: 6 assignments, best 4 count for 10% each, lowest 2 for 5% each)
- ▶ 2 Exams 40%: Your best performance is worth 25% your lowest 15%
- ▶ 24 daily top hat 'Tiny Quizzes' 10%:
 - ▶ Participation 6%: Each of 19 for 0.32% (5 lowest are dropped)
 - ▶ Accuracy 4%: let score be the number of correct answers on tiny quizzes
 - ▶ if $7 < \text{score} \leq 10$: 1%
 - ▶ if $10 < \text{score} \leq 13$: 2%
 - ▶ if $13 < \text{score} \leq 16$: 3%
 - ▶ if $16 < \text{score}$: 4%

Homework assignments

- ▶ To deepen your understanding, practice coding in R, and see how real research is done in empirical applied economics
- ▶ To be done in R markdown via R Studio Cloud, submitted as PDF's on Gradescope
- ▶ You can help each other but submitted assignments cannot be identical (0 grade).
- ▶ Due as indicated on canvas (usually Tuesdays at 10 pm)
 - ▶ No assignments accepted more than 1 week late
 - ▶ each student has a quota of 90 late **hours** to use as needed
 - ▶ beyond this each extra hour costs 0.01 points off of final grade.
 - ▶ Save these for EMERGENCIES!
- ▶ Regrade request to be done within a week of getting graded assignment. Avoid regrade requests for minor point changes.

Exams

- ▶ will be written, timed, traditional pen and paper exams
- ▶ you will not be asked to code but will be asked to interpret code
- ▶ you will be allowed 1 page of handwritten notes
- ▶ see posted old exams to get an idea of what to expect

Other first day stuff

- ▶ Introduce yourself!

Send me an email and let me know if there is anything I need to know or you would like to share about yourself (eg. unique interests, pronouns, preferred names, special accommodations, anticipated absences on exams. . .) reach out and keep in touch!

Review Blitz: Probability, Statistics and regressions

Review: Probability

The probability of event A ($P(A)$) is a number between 0 and 1:

$$0 \leq P(A) \leq 1$$

Conditional Probability

The probability of an event might change when additional information becomes available

$$P(A|B) = \text{probability of A given that B occurred}$$

Statistical Independence

Two events are statistically independent if the information that one of them has happened does not change the probability of the other

$$\text{A and B are independent if } P(A|B) = P(A)$$

Stats Review: Random Variables

Random variables:

a variable whose value depends on random events

For a given outcome x we may be interested in the probability that the variable X achieves that outcome

$$P(X = x) = ?$$

These outcomes could be discrete or continuous

Stats Review: Discreet random variables

Discreet random variables take a finite number of values

There is a probability associated with each of it's possible values

$$\sum_{all x} P(X = x) = 1$$

Stats Review: Continuous random variables

Continuous random variables take an infinite number of possible values

The density function gives the probability that a random variable is smaller than some value so that

$$P(X \leq a) = \int_{-\infty}^a f(x)dx$$

with

$$\int_{-\infty}^{\infty} f(x)dx = 1$$

A cumulative density function maps out

$$F(a) = P(X \leq a)$$

Stats Review: Summarizing random variables

Measures of location:

► mean:

$$\text{Discreet: } E[X] = \mu_X = \sum_{\text{all } x} xP(X = x)$$

$$\text{Continuous: } E[X] = \mu_X = \int_{-\infty}^{\infty} xf(x)dx$$

► Also median, percentiles (ex: quartiles) ...

Stats Review: Summarizing random variables

Measures of dispersion:

- Variance

$$\text{Discreet: } \text{Var}(X) = \sigma_X^2 = \sum_{\text{all } x} (x - \mu_X)^2 P(X = x)$$

$$\text{Continuous: } \text{Var}(X) = \sigma_X^2 = \int_{-\infty}^{\infty} (x - \mu_X)^2 f(x) dx$$

- Standard deviation:

$$\text{Std.Dev.}(X) = \sigma_X = \sqrt{\sigma_X^2}$$

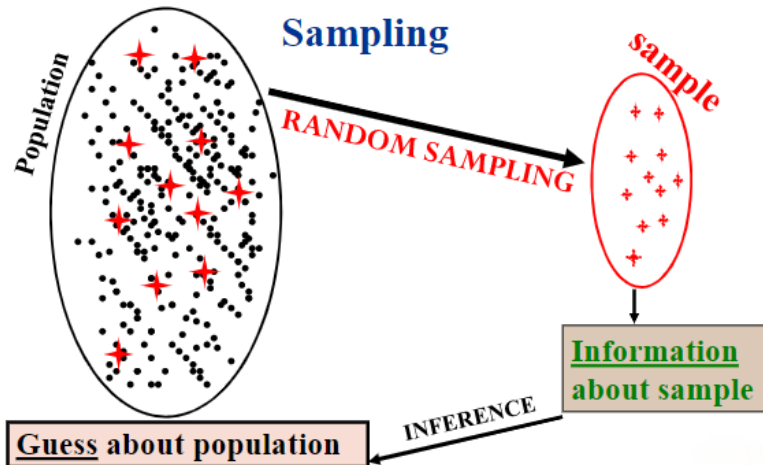
Stats Review: Important distributions

Uniform: the same probability to all values of the random variable

Normal: Important mainly because of the central limit theorem

Standard normal: A normal with mean 0 and standard deviation 1

Stats Review: Sampling, estimation and inference



Stats Review: Sampling, estimation and inference

What information do we get from the sample?

Get the sample mean

$$\bar{X} = \frac{\sum_{i=1}^n X_i}{n}$$

If you collected a new random sample, your sample mean will be different:

$$\bar{X}_1 \neq \bar{X}_2 \neq \bar{X}_3 \neq \bar{X}_4 \dots$$

So what can we learn from the SAMPLE mean about the POPULATION mean μ (what we really care about)?

Stats Review: The Central Limit Theorem

Consider a random sample of n observations taken from a population X with expected value μ_X and standard deviation σ_X . The following are always true of the sample mean \bar{X} .

- ▶ The probability distribution of \bar{X} approaches a normal distribution as n increases (i.e. with bigger sample size, the distribution of possible \bar{X}_i 's looks like a bell curve)
- ▶ The expected value of \bar{X} equal μ_X (i.e this bell curve is centered on the population mean)
- ▶ The standard deviation of \bar{X} (aka the **standard error**) equals $\frac{\sigma_X}{\sqrt{n}}$ (i.e. the bell curve is tighter as the sample size increases)

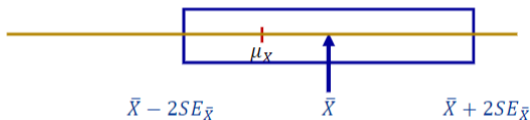
Stats Review: Standard errors and confidence intervals

So given our sample, our best guess of the population mean is the sample mean

$$E[\mu_X] = \bar{X}$$

How good is this guess? How far away from the population mean from the sample mean?

- ▶ We build confidence intervals around \bar{X} with its standard error $SE_{\bar{X}}$
- ▶ To do this we use a critical value, often $1.96 (\approx 2)$, that reflects how certain we want to be that the confidence interval includes the population mean.



Stats Review: Hypothesis testing

Using these confidence intervals, we can REJECT or FAIL TO REJECT a Null Hypothesis.

- ▶ Reject the Null Hypothesis if there is “enough” evidence against it

p-value: The largest probability of observing sample data as extreme as your draw given that the Null is true

Upcoming

Next class:

- ▶ Intro to R Studio Cloud and R Markdown
- ▶ (consider bringing your laptops)
- ▶ To do before class: Sign up for a student account (\$5 / month) and accept my invitation to the class workspace

After that:

- ▶ More review: Regressions and regressions in R