Applied Econometrics and Data Analysis

ECON 121

People

- Me: Tom Vogl
  - User, not developer, of econometrics
  - Researcher of health and population in developing countries
  - Have been teaching variants of this course for over a decade
  - Teaching is very important to me
- TA: Regina Calles-Martínez
  - Will hold biweekly problem set labs, super useful

Roadmap for the Quarter

1. **Estimation**
   - "Review" of OLS
   - Departures from i.i.d.
   - Maximum likelihood
   - Limited dependent variables
   - Panel data
2. **Causality**
   - Difference-in-differences designs
   - Potential outcomes
   - Randomized experiments
   - Instrumental variables
   - Regression discontinuity designs

Prerequisites

- Option 1: ECON 120C
  - Targets Econ, Math/Econ majors after full 120 series
- Option 2: ECON 5 & ECON 120B
  - Targets BusEcon majors, who must take 5 but not 120C
- Either is solid
  - Students w/ 120C will have seen many 121 topics before
  - Students w/ 5 will have more experience with statistical computing

Course Structure

- Text
  - No textbook, will rely on course notes
- Participation
  - This is an in-person class, and I will sometimes take attendance
  - Beyond attendance, participation can take many forms
- Deliverables
  - Problem sets (5): R-based, can code in groups (max 4 people) but must write own answers, lowest score dropped
  - Academic articles (4): Multiple choice quizzes before discussions, lowest score dropped
- Final Exam
  - Open book, R-based, basically an extra problem set

Lectures and Assignments

- Lectures:
  - If people behind you will see material not related to the course on your laptop, please sit toward the back of the class
  - I will post written notes by the night before each lecture, so you can print them or put them on your tablet for notetaking
  - I will post whiteboards and new code afterward

- Problem sets:
  - Work in groups; let us know if you need help finding partners
  - Late problem sets not accepted
    - Lowest score dropped
    - If you are late, you should do it anyway

Grading

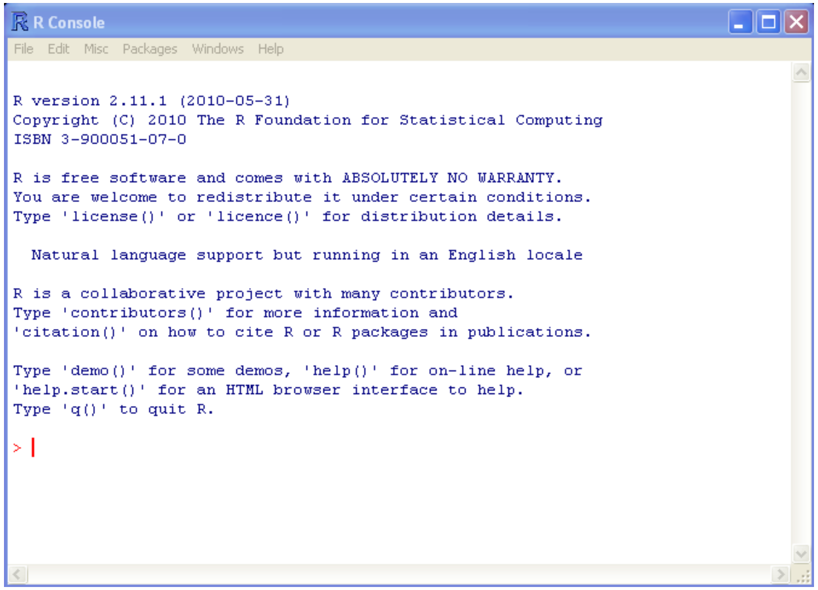
- I care about your learning, not about your grades
- I would love to teach you without giving you grades
- But both students and UCSD expect me to give grades, so I try to do it fairly and generously
- I assign letter grades based on your final course score:
  - 35% final exam
  - 40% problem sets
  - 15% quizzes
  - 10% participation (including attendance)
- Grades are curved to typical upper division ECON distribution, but the curve **helps** you, never hurts you
- If you fall behind, e-mail me – I am happy to offer a path to get back on track, but you will have to work for it

Statistical Computing

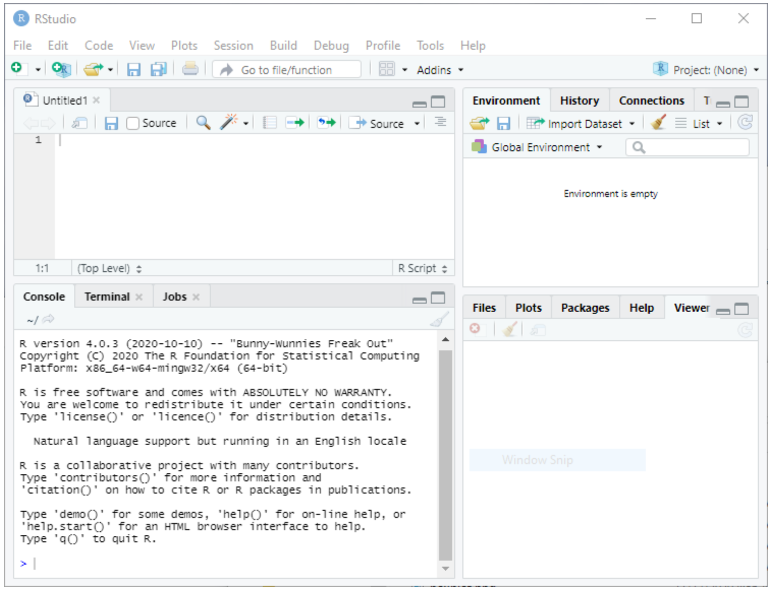
- Course used to use Stata
  - Easier implementation of methods we study
  - Used in ECON 120 series
  - Less common outside academia ($$$)
- Switched to R a couple years ago
  - Free, more common in industry, more similar to Python
  - Avoided in the past because of the package zoo, but I figured out we can do all topics using three packages
  - You may use base R and these three packages, **but no others**
- Stuck on R?
  - Refer to my examples from class (on GitHub)
  - Use help files / Stack Exchange / Google / ChatGPT / Claude

Background on R and RStudio

- R: programming language for statistical computing
  - Like my first kitchen: only basic tools, every task requires work
- RStudio: integrated development environment for R
  - Like Chancellor Khosla's kitchen: lots of appliances, easy cooking
- Download both: https://posit.co/download/rstudio-desktop/



```
R version 2.11.1 (2010-05-31)
Copyright (C) 2010 The R Foundation for Statistical Computing
ISBN 3-900051-07-0

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

  Natural language support but running in an English locale

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> 
```



```
R version 4.0.3 (2020-10-10) -- "Bunny-Wunnies Freak Out"
Copyright (C) 2020 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

  Natural language support but running in an English locale

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> 
```

Packages

- Of **many** user-written packages that extend base R’s capabilities, we will use three:
  - `tidyverse` (a suite of packages) for basic tasks and graphing
  - `fixest` for regression estimation
  - `marginaleffects` for post-estimation tools
- To download a package, type:
  - `install.packages(‘packageName’)`
- To load the package, type:
  - `library(packageName)`
- You only need to install each package once, but you must load it every time you open R or RStudio

Operators

- Operators perform operations on variables and values
- Arithmetic operators: `+` `-` `*` `/` `^`
- Comparison operators: `==` `!=` `>` `<` `>=` `<=`
- Logical operators: `&` `|`
- Assignment operators: `<-` `=`
  - Assign values to objects
  - They are the same, don’t be confused when used interchangeably
- Pipe operators: `%>%` `|>`
  - String together sequences of operations: ‘and then’
  - Original is `%>%` from `tidyverse`, `|>` is new addition to base R
  - Very similar, but we will mostly use `|>`

Data Frames and Variables

- Unlike Stata, R has always been able to store multiple datasets ("data frames") in memory simultaneously
- You need to specify the data frame when you ask R to perform calculations on a variable (or set of variables)
- The $ operator is the standard way
  - `mean(census$educ)` estimates the mean of the variable `educ` from the data frame `census`
- For `tidyverse` functions, pipes or the 1st argument do it
  - `census |> summarize(mean(educ))` or `summarize(census, mean(educ))`
- Missing values? Change to `mean(educ, na.rm=TRUE)`

Tidyverse Functions

- We will use `tidyverse` functions to ‘wrangle’ data
- A few that we will use often:
  - Modifying data:

    `arrange()` orders observations by the variable(s) inside the parentheses

    `filter()` subsets the data to observations that satisfy the statement inside the parentheses

    `mutate()` creates, modifies, or deletes variables

    `select()` keeps the variables inside the parentheses
  - Grouping data:

    `group_by()` groups the data by the variable(s) inside the parentheses

    `summarize()` summarizes the data in a group → useful w/ `mean()`, `sd()`, `sum()`

    `n()` gives the number of observations in a group
  - Evaluating conditional statements:

    `if_else()` evaluates truth of statement in parentheses → useful to create binary variables

    `case_when()` is like `if_else()` but with multiple categories

Guidelines for Programming in R

- I will do most programming instruction by writing R scripts in class, but here are a few basic principles:

1. Write code in a script (*.R) or Markdown (*.Rmd) file
   - R scripts are just code, do not automatically save output
   - R Markdown files save code, prose, and output to html or PDF
2. Keep track of your working directory
   - If you are using or saving files locally, set a working directory
   - `getwd()` tells the current directory, `setwd()` sets a new one
3. Annotate, annotate, annotate
   - Write comments to explain each step of your code
   - The # symbol starts a comment