Economics 140 – Spring 2021
Course Syllabus

January 19, 2021

Welcome to Economics 140! This course is meant to introduce you to the statistical analysis of economic data, also known as "Econometrics." You should have taken both microeconomics and macroeconomics (either the Economics 100A/B or 101A/B series, or equivalent). More importantly, you have completed an introductory statistics course, e.g., Statistics 2, 20, W21, or an equivalent. On occasion, when it helps to explain a concept, we will make use of calculus – which is not a pre-requisite for the course, but it is a requirement for the Economics major. Those looking for a more mathematical and theoretical treatment of the same topics covered in this course are encouraged to take Economics 141.

After reviewing essential concepts from probability and statistics, we turn to the heart of the course: regression analysis. You will learn not only the meaning and properties of both univariate and multivariate regression, but also how to test economic relationships using real datasets and an econometrics software package. We will develop techniques to handle common statistical problems that arise when working with economic data including endogeneity, selection bias, mis-specification, and measurement errors. We will expand the types of data we can analyze by exploring the topics of panel data, binary response, and quasi-experiments.

General Information

- *Instructor*: Stephen Bianchi, 675 Evans & Zoom
- *Class Meeting Times*: TTh 3:40-5pm, Zoom
- *Office Hours*: W 2-4pm, Zoom
- *Enrollment*: Please see the Economics Department Head GSI, John Wieselthier (548 Evans, headgsi@econ.berkeley.edu), for ALL questions regarding enrollment.
- *Email*: swbianchi@berkeley.edu
- *Email Policy*: When you email me, please put "[ECON140]" in the subject and ask me questions that can be answered in a few sentences. If I find that my response will require more than a few sentences, I will ask you to come see me during office hours. I will reply to course related emails within 48 hours.

- *Discussion Sections, UGSIs, and GSIs*:
  - Alexey Sinyashin (alexey_sinyashin@berkeley.edu)
    - Econ 140 Lead GSI
    - Section: Th 5-6:30pm, Zoom
  - Andrei Caprau (acaprau@berkeley.edu)
    - Sections: M 5-6:30pm, M 6:30-8pm, Zoom
  - Nick Gebbia (nickgebbia@berkeley.edu)
    - Sections: W 5-6:30pm, W 6:30-8pm, Zoom
  - Maximiliano Lauletta (maximiliano_lauletta@berkeley.edu)
    - Sections: Th 9:30-11am, Th 11am-12:30pm, Zoom
  - Alan Liang (alanliang@berkeley.edu)
    - Sections: Th 12:30-2pm, Th 2-3:30pm, Zoom
  - Runjiu Liu (runjiu_liu@berkeley.edu)
    - Sections: Tu 2-3:30pm, Tu 5-6:30pm , Zoom
  - Pedro Pires (pedropires@berkeley.edu)
    - Sections: Tu 8-9:30am, Tu 9:30-11am, Zoom
  - Murilo Ramos Rodrigues de Paula (murilo@berkeley.edu)
    - Sections: M 8-9:30am, W 8-9:30am, Zoom
  - Matthew Tauzer (mtauzer@berkeley.edu)
    - Sections: Tu 11am-12:30pm, Tu 12:30-2pm, Zoom

  Due to remote instruction, you need NOT attend your first section meeting in order to remain enrolled in the course. This is a change from past semesters with on-campus instruction.

  Each GSI is only responsible for students who are officially registered in one of their sections, so please do not email another GSI. However, you may go to any GSI's office hours. If you have a conflict, you may also attend your GSI's other regularly scheduled section – but before doing so, please discuss with your GSI.

- *Accomodations*: If you need disability-related accommodations in this class, if you have emergency medical information you wish to share with us, or if you need special arrangements in case the building must be evacuated, please inform John Wieselthier immediately. For disability-related accommodations, you must also obtain a Letter of Accommodation (LOA) from the Disabled Students' Program (`http://dsp.`

`berkeley.edu`), which they send electronically to me. Request for exam accommodation must be received and acknowledged by me or Alexey *at least two weeks before an exam*, which is DSP's own internal deadline for scheduling the proctoring of exams. Accommodations are not offered retroactively.

- *Academic Honesty*: In fairness to students who put in an honest effort, cheaters will be harshly treated. Any evidence of cheating will result in a score of zero on that assignment. Cheating on the midterm or the final exam results in an "F" for the course. Cheating includes but is not limited to bringing unauthorized written or electronic materials into an exam, using unauthorized written or electronic materials during an exam, copying off another person's exam or assignment, allowing someone to copy off of your exam or assignment, having someone take an exam or assignment for you, changing an exam answer after an exam is graded, and plagiarizing written or other materials. Incidences of cheating are reported to the Center for Student Conduct, which administers additional punishment. See also `http://sa.berkeley.edu/conduct/students/standards`.

- *Limits to Confidentiality*: As UC employees, all course instructors and tutors are Responsible Employees, and we are required to report incidents of sexual violence, sexual harassment or other conduct prohibited by university policy to the Title IX officer. We cannot keep reports of sexual harassment or sexual violence confidential, but the Title IX officer will consider requests for confidentiality. There are confidential resources available to you, including the CARE Advocate Office (`http://sa.berkeley.edu/dean/confidential-care-advocate`), which serves survivors of sexual violence and sexual harassment.

- *Honor Code*: We at UC Berkeley have adopted this Honor Code: "As a member of the UC Berkeley community, I act with honesty, integrity, and respect for others." Your Econ 140 instructors join you in pledging to adhere to this code.

Course Books

Required:

- (SW) James H. Stock and Mark W. Watson, *Introduction to Econometrics*, 3rd or 4th Edition.

Optional (but strongly encouraged):

- (MM) Joshua D. Angrist and Jörn-Steffen Pischke, *Mastering 'Metrics: The Path From Cause to Effect*, 1st Edition.

There is a companion website for the 4th edition of Stock & Watson at: `https://www.princeton.edu/~mwatson/Stock-Watson_4E/Stock-Watson-Resources-4e.html`. Many study resources are available on this site including answers to end-of-chapter questions, datasets for empirical exercises, replication files for empirical analyses reported in the textbook, and additional empirical exercises. There is also a companion website for the 3rd Edition at: `https://wps.pearsoned.com/aw_stock_ie_3/178/45691/11696965.cw/index.html`.

Course Software

The assignments in this course will be in Jupyter Notebooks using Python. Python is a general purpose open-source programming language utilized commonly by economists, data scientists, and programmers alike. We will primarily use the *statsmodels* library to carry out econometric analyses, in addition to *pandas* for data manipulation. All assignments will be distributed and completed in Jupyter Notebooks, an intuitive and interactive computing environment that contains both text and code.

Your notebooks will be hosted on DataHub, a free campus-wide cloud service that will provide the computing environment for your code. This means that you don't have to install anything on your computer; instead you can access all assignments through a browser (preferably Google Chrome). If you have taken Data 8 or other data science courses on campus, the format should be familiar to you.

Do not worry if you have never used Python before; the first (optional, but highly recommended) assignment in the class will help familiarize you with Python and the Jupyter environment. There are many other full-service econometrics packages (e.g., Stata, R, Matlab, SAS) but these will not be supported by your GSIs. Experience with Python can be helpful if you do other economic research (e.g., an honors thesis) and it looks good on your job resume.

Requirements

The course requirements include one midterm, a final, and five graded problem sets. The course grade will be determined as follows:

- Problem Sets (40%)
- Midterm (25%)
- Final (35%)

Problem sets: You are encouraged (but not required) to form study groups of **up to three students**. The group may submit a **single** answer sheet with the names of all of the study group members at the top of the first page. Everyone in the study group receives the same grade. We will use the usual 3-point "check" system of grading problem sets.

Answers to problem sets must be submitted via Gradescope by the specified time on the due date. No late work will be graded and, yes, that penalizes all members of the study group. Problem set 1 will be posted after the first lecture and is due Thursday, February 4th.

Exams: There will be a midterm exam on **Thursday, March 18th** and a final exam on **Wednesday, May 12th**. If you do relatively better (i.e., earn a higher standardized score) on the final than on the midterm, your final score will count for 60% of your overall class score.

Dates for exams will not change and make-up exams will not be given. If you fail to take the midterm (for *any* reason), your final exam will count for 60% of your overall class score. If you fail to take the final (again, for *any* reason), you must petition for an **incomplete**. But please note that incompletes will not be granted unless you meet the University standards and those have become increasingly demanding. If you do not take the final and do not petition for an incomplete you will receive an "NP" or an "F" for the course (depending on your grading option).

Course Outline

The following is *preliminary* schedule of the topics to be covered in this class – it is likely to change a fair amount as we progress. The corresponding readings are from Stock & Watson, 4th Edition (SW). Lectures will loosely follow the readings from Stock & Watson.

- **Classical Statistics & Simple Regression**
  - **Lecture 1 (January 19)**: introduction, data types, random variables
    Readings: (SW) Chapter 1, Sections 2.1, 2.2
  - **Lecture 2 (January 21)**: random variables, probability distributions, random sampling and sample average
    Readings: (SW) Sections 2.3, 2.4 (pp. 33-35), 2.5, Appendix 2.1
  - **Lecture 3 (January 26)**: convergence of random variables, law of large numbers, central limit theorem, hypothesis tests
    Readings: (SW) Sections 2.6, 3.1
  - **Lecture 4 (January 28)**: t-tests, p-values, confidence intervals, testing for difference in means, multiple random variables, joint probability distributions, conditional probability
    Readings: (SW) Section 3.2, 3.3, 3.4, 3.7, Appendix 3.2
  - **Lecture 5 (February 2)**: interpreting statistical evidence, conditional expectation, law of iterated expectations (LIE), economic relationships and the conditional expectation function (CEF)
    Readings: (SW) Section 3.5
  - **Lecture 6 (February 4)**: CEF decomposition property, CEF prediction property, bivariate linear regression and the CEF, bivariate linear regression (estimation), **problem set 1 due**
    Readings: (SW) Section 4.1, 4.2
  - **Lecture 7 (February 9)**: linear regression model, unbiasedness and asymptotic normality of OLSEs, goodness of fit
    Readings: (SW) Section 4.3, 4.4, 4.5
  - **Lecture 8 (February 11)**: goodness of fit, regression with binary independent variable and relation to difference in means testing
    Readings: (SW) Sections 5.1, 5.2, 5.3
  - **Lecture 9 (February 16)**: regression with binary independent variable, one-sided hypothesis tests, heteroskedasticity and homoskedasticity, nonlineariteis and simple linear regression
    Readings: (SW) Section 5.4

- **Multivariate Regression**
  - **Lecture 10 (February 18)**: Gauss-Markov Theorem, multiple linear regression, Frisch-Waugh Theorem
    Readings: (SW) Sections 5.4, 6,1, 6.2, Appendix 6.3
  - **Lecture 11 (February 23)**: comparisons of univariate and multivariate coefficent estimates, multicollinearity
    Readings: (SW) Sections 5.4, 6,1, 6.2
  - **Lecture 12 (February 25)**: irrelevant variables, omitted variables, goodness of fit in multiple linear regression, **problem set 2 due**
    Readings: (SW) Sections 6.3, 6.4, 6.5, 6.6, 6.7
  - **Lecture 13 (March 2)**: multivariate regression: Gauss-Markov Theorem, hypothesis testing
    Readings: (SW) Sections 7.1, 7.2, 7.3
  - **Lecture 14 (March 4)**: multivariate regression: hypothesis testing
    Readings: (SW) Sections 7.1, 7.2, 7.3
  - **Lecture 15 (March 9)**: specifying a multivariate regression model, multivariate regression: incorporating nonlinearities
    Readings: (SW) Section 7.5, 8.1, 8.2
  - **Lecture 16 (March 11)**: multivariate regression: single and mutliple binary independent variables, interaction terms
    Readings: (SW) Sections 8.2, 8.3
  - **Midterm Review (March 16)**: catch up and review, **problem set 3 due**
  - **Midterm (March 18)**: time TBD, no lecture
  - **Lecture 17 (March 30)**: internal and external validity
    Readings: (SW) Sections 9.1, 9.2
- **Binary Response, Instrumental Variables, Quasi-Experiments**
  - **Lecture 18 (April 1)**: panel data, entity fixed effects
    Readings: (SW) Sections 10.1, 10.2, 10.3, 10.4, 10.5
  - **Lecture 19 (April 6)**: panel data, time fixed effects
    Readings: (SW) Sections 10.1, 10.2, 10.3, 10.4, 10.5
  - **Lecture 20 (April 8)**: limited dependent variable models, linear probability model
    Readings: (SW) Section 11.1

- **Lecture 21 (April 13)**: logit and probit models, binary dependent variable models: goodness of fit, estimating partial effects

  Readings: (SW) Sections 11.2, 11.3

- **Lecture 22 (April 15)**: instrumental variables and two stage least squares, **problem set 4 due**

  Readings: (SW) Section 12.1

- **Lecture 23 (April 20)**: instrumental variables and two stage least squares

  Readings: (SW) Section 12.2

- **Lecture 24 (April 22)**: efficiency of OLS estimators versus IV estimators, testing overidentifying restrictions

  Readings: (SW) Section 12.3

- **Lecture 25 (April 27)**: potential outcomes, causal effects, differences-in-differences estimator

  Readings: (SW) Sections 13.1, 13.2, 13.3, 13.4

- **Final Review (April 29)**: catch up and review, **problem set 5 due May 4th**

- **Final Exam (May 12)**