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Mathematics, Statistics and Computational Brush-up Courses for the Competition and Market Regulation and the Economics of Public Policy Master Programs

Instructors

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Manuel V. Montesinos - Computation

Course Objective

The aim of this courses is to refresh your memory of the tools in Mathematics and Statistics, which you are going to use in the courses throughout the master.

Schedule

The review classes are going to take place between Sept. 4 and Sept. 21, 2020.

References

For those of you who would like to prepare before the classes start, here there are some useful references. Anyway, the material we are going to cover is standard. If you have used some other book in your undergraduate studies, most likely it will work as well.

Mathematics Review

References and details about how to prepare the material for this review course are included in the summer readings file.

Computation

There are many books that cover similar material. For example:

Cameron, A. Colin and Pravin K. Trivedi (2010), “Microeconometrics Using Stata”, Stata Press, Revised

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Edition.

Mitchell, Michael N. (2020), “Data Management Using Stata: A Practical Handbook”, Stata Press, Second Edition.

There are also many freely available resources to learn Stata, such as:

Julian Reif, *Stata Coding Guide*: <https://reifjulian.github.io/guide/>.

Oscar Torres-Reyna, *Getting Started in Data Analysis using Stata and R*.
<https://dss.princeton.edu/training/>.

SDAS Stata Graphics Tips: <https://www.surveymdesign.com.au/tipsgraphs.html>.

StataCorp LLC Video Tutorials: <https://www.youtube.com/user/statacorp/featured>.

StataCorp, *Stata User’s Guide. Release 13*: <https://www.stata.com/manuals13/u.pdf>.

StataList – The Stata Forum: <https://www.statalist.org/>.

The Stata Blog: <https://blog.stata.com/>.

UCLA Institute for Digital Research & Education, Stata Learning Modules:
<https://stats.idre.ucla.edu/stata/modules/>.

Probability and Statistics Review

There are many books that cover similar material. For example:

Robert B. Ash (1972), *Real Analysis and Probability*, Academic Press.

Bierens, Herman J. (2004), *Introduction to the Mathematical and Statistical Foundations of Econometrics*, Cambridge University Press.

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De Groot, Morris H. and Mark J. Schreivish (2012), *Probability and Statistics*, Addison-Wesley.

Goldberger, Arthur S. (1991), *A Course in Econometrics*, Harvard University Press.

Greene, William E. (2003), *Econometric Analysis*, Prentice-Hall, Fifth Edition.

Hogg, Robert V. and Joseph W. McKean (2013), *Introduction to Mathematical Statistics*, Pearson.

Lindgren, Bernard W. (1993), *Statistical Theory*, Chapman & Hall.

Mood, Alexander M., Franklin A. Graybill, and Duane C. Boes (1974), *Introduction to the Theory of Statistics*, McGraw-Hill, Third Edition.

Rice, John A. (1995), *Mathematical Statistics and Data Analysis*, Duxbury Press.

Stock, James H. and Mark W. Watson (2015), *Introduction to Econometrics*, Pearson Education Limited, Third Update, Global Edition.

Tanis, Elliot A. and Robert V. Hogg (2008), *A Brief Course in Mathematical Statistics*, Prentice Hall.

The following are some excellent freely available sources:

Hansen, Bruce E., *Introduction to Econometrics*, June 2020 update, <https://www.ssc.wisc.edu/~bhansen/probability/>.

Hanck, Christoph, Martin Arnold, Alexander Gerber and Martin Schmelzer, *Introduction to Econometrics with R*, 30th August 2019 update. <https://www.econometrics-with-r.org/index.html>. License: Creative Commons BY-NC-SA.

Orloff, Jeremy and Jonathan Bloom, *18.05 Introduction to Probability and Statistics*, Spring 2014. Massachusetts Institute of Technology: MIT OpenCourseWare, <https://ocw.mit.edu>. License: Creative Commons BY-NC-SA.

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Course Outline

1. MATHEMATICS (18h)

1.1. Basic Concepts.

- Sets.
- Basic Algebra.
- Mathematical Notation.
- Functions
- Elements of Linear Algebra.
- Matrix Operations.

1.2. Calculus

- Limits and Continuity
- Differentiation
- Taylor's Rule
- Integration
- Partial derivatives
- Implicit Function Theorem
- Concave and Convex Functions

1.3. Optimization

- Unconstrained Maximization
- Necessary Conditions for an Interior Extrema
- Sufficient Conditions for a Local Extrema
- Equality Constraints and Lagrange Multiplier Method
- Envelope Theorem
- Inequality Constraints and Kuhn-Tucker Method

2. COMPUTATION (10h)

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2.1. Introduction to Stata

- Working with Stata: Menu, Command Line and Do-Files
- Help Files
- Creating Empty Datasets and Copy/Pasting Data
- Data Import, Use and Export
- Describing the Data
 - Describe
 - List
 - Summarize
 - Tabulate

2.2. Data Sources

- Importing Data from Main Public Data Sources (e.g. Eurostat, Federal Reserve, World Bank)
- Missing Values

2.3. Data Manipulation

- Generating New Variables: “generate” vs. “egen”
- Keeping and Dropping variables
- Sorting
- Recode and Group
- Labeling Variables and Values
- Logical Expressions

2.4. Programming in Do-Files

- If Condition
- Loops
- Commenting

2.5. Graphing

- Line Plot
- Scatter plot
- Graph Customization
- Combining Graphs
- Histogram

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- Kernel Density
- Step Function for CDF

2.6. Presenting Results

3. STATISTICS (18h)

3.1. Review of Probability (6h)

- Random Variables and Probability Distributions
- Expected Values, Mean and Variance
- Two Random Variables
 - Joint and Marginal Distributions
 - Conditional Distributions
 - Bayes' Theorem
 - The Law of Iterated Expectations
 - Independence
 - Covariance and Correlation
 - The Mean and Variance of Sums of Random Variables
- The Normal, Chi-squared, Student t and F Distributions
- Random Sampling
- Large-Sample Approximations
 - Convergence in Probability and Convergence in Distribution
 - Law of Large Numbers
 - Central Limit Theorem

3.2. Review of Statistics (6h)

- Descriptive Statistics
- Properties of Estimators
 - Unbiasedness, Consistency and Efficiency
- Hypothesis Testing
- The t-statistic and the p-value
- Confidence Intervals

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- Linear Regression

3.3. Statistics with Stata (6h)

- Basis Statistical Routines
 - Summary Statistics
 - T-test on Mean Difference
 - Cross-tabulation of Two Binary Variables and Tests (Pearson)
 - Cross-tabulation of Two Discrete Variables and Tests (Pearson)
 - Linear Regression
 - Internal Variables: “_coef”, “_se”
 - Additional Stored Information: “ereturn list”, “matrix list e(vce)”
 - Postestimation Commands
- Panel data
 - Data Structure (Wide vs. Long) and the “reshape” Command
 - The “xtset” Command
 - The “xtdes” Command
- Time Series Data
 - The “tsset” Command
 - Time Series Operators

Exam

At the end of the courses, there will be a short exam.