

Semester VII Economics (H)

6.19 Quantitative Methods

| Course title | Credits | Duration (per week) | | | Eligibility Criteria | Prerequisite |
|---|----------|---------------------|----------|-----------|----------------------|--------------|
| | | Lecture | Tutorial | Practical | | |
| Quantitative Methods ECON019 | 4 | 3 | 0 | 1 | Class 12th | NIL |

Learning Objectives

- This course will equip students with the necessary tools to conduct quantitative research, with a strong emphasis on causal inference, regression techniques, time-series analysis and big data applications.
- Students will also gain hands-on experience with empirical datasets related to India and learn how to analyse them using accessible software such as R, Python, STATA etc.

Learning outcomes

- Students will be able to analyse data patterns and answer questions about causality in observed data correlations.
- Students will get a foundation for independent research using the tools taught in the course.

Syllabus

UNIT I: Methods of Causal Inference (15 hours)

Causality vs. Correlation, Potential Outcomes Framework, Randomized Control Trials (RCTs), Instrumental Variables (IV), Regression Discontinuity Design (RDD), Difference-in-Differences (DiD), Matching Methods (Propensity Score Matching, Synthetic Controls), Case Studies and Applications

UNIT II: Regression with Panel Data and Binary Dependent Variables (11 hours)

Pooled OLS vs Panel Data Models, Fixed Effects vs Random Effects Models, Linear Probability Model (LPM) and its Limitations, Logit and Probit Models, High-dimensional and high frequency data and its applications in economic research.

UNIT III: Analysis of Time-Series Data (10 hours)

Stationarity and Unit Roots, Autoregressive (AR) and Moving Average (MA) Models, ARIMA Models and Forecasting, Vector Autoregression (VAR) and Impulse Response Functions, Cointegration and Error Correction Models, Structural Breaks and Policy Impact Analysis

UNIT IV: Data Collection, Textual Data, Network Data and Spatial Data (9 hours)

Primary vs. Secondary Data, Survey Design and Sampling, Understanding Economic and Social Datasets, Introduction to Unstructured Data, Text as Data: Sentiment Analysis, Topic Modeling, Network Analysis in Economics, Spatial Data and Geographic Information Systems (GIS), Applications in Development Economics and Political Economy.

Practical & Lab Sessions: Introduction to a software like R/Python etc (Data Wrangling, Visualization, Regression Analysis), Working with Large Datasets (Census, NSS, NFHS, Satellite Data, etc.), Empirical Project: Analyzing a Research Question Using Real Data, Replication of Empirical Papers Using Indian Data Sources

Recommended Readings:

- Angrist, J. D., & Pischke, J. S, Mastering Metrics (2014)
- Angrist, J. D., & Pischke, J. S. Mostly Harmless Econometrics, Princeton University Press. (2014)
- Athey & Imbens : Machine Learning Methods that Economists Should Know About (2019)
- Census of India, NSS, NFHS Data
- Chernozhukov, Hansen, Kallus, Splindler and Syrgkanis: Applied Causal Inference Powered by ML and AI (2025)
- Cunningham, S. Causal inference: The Mixtape (2018)
- Donaldson & Storeygard: The View from Above: Applications of Satellite Data in Economics (2016)
- Gelman, Hill & Vehtari: Regression and Other Stories (2021)
- Glennerster & Takavarasha: Running Randomized Evaluations (2014)
- Huntington-Klein, N. The effect: An introduction to research design and causality. Chapman and Hall/CRC (2021)
- Irizarry: Introduction to Data Science with R (2024)
- RBI, IMF, and World Bank Datasets
- Remote Sensing and Satellite Data for Economic Research
- Sargent & Stachurski, A First Course in Quantitative Economics with Python
- Stock & Watson: Introduction to Econometrics (2020)
- Wooldridge: Introductory Econometrics (2019)