TIME SERIES ANALYSIS LECTURE 1

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Basic Terminology of Time Series Analysis

An Introduction to Concepts of Time Series

We will discuss the following concepts used in time series analysis:

- Stochastic process
  - Continuous-time stochastic process
  - Discrete-time stochastic process
- Time series
- Note: As in any statistical modeling, we will have to capture only the essential features of the problem being studied. Specifically, we will put some structures around the process by assuming that it follow certain probabilistic laws and not necessarily assuming that it follows a deterministic model.

Notion of Time Series

- A **time series** is a set of observations generated sequentially in time.
- If the set is continuous, such as $[0, f\pi]$ where f is some frequency, the time series is said to be a *continuous* time series.
- If the set is discrete, the time series is said to be a *discrete* time series.
- In theory, a time series begins in the infinite past and continues into the infinite future. This notion plays an important role when deriving important properties of the time series models we will study in this course.
- In practice, we often encounter time series with a specific origin and end in a finite number of time periods.
- With a discrete time series, the time index can be denoted as $t_1, t_2, \cdots, t_N, \cdots$ and the observations of the series can be denoted as $z(t_1), z(t_2), \cdots, z(t_N), \cdots$.
- For time series observed in equidistant for N successive periods, we can simply express the series as $z_1, z_2, \cdots, z_N$.

Notion of Stochastic Processes (1)

- A **stochastic process** is a statistical phenomenon that evolves in time according to some probability laws.
- We will use the terms **stochastic processes** and **processes** interchangeably.
- A time series is a particular realization of an underlying stochastic process (or an underlying probability mechanism). Statisticians and econometricians often call this probability mechanism a "data generating process"
- A discrete time stochastic process is a sequence of random variables $\{\cdots, z_{-1}, z_0, z_1, \cdots\}$
- A finite subset of this realization, $\{z_1, z_2, \cdots, z_N\}$ of the process is called a **sample path**, which can be considered a collection of observations.

Notion of Stochastic Processes (2)

- This marks one of the biggest differences with the cross-section analysis in the first half of the course. A cross-section of observations is consider many "realizations" or "draws" from the underlying probability distribution. In practice, many time series (such as the unemployment rate in the U.S.) is considered only "one draw" or "one realization" in the context of time series analysis.

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