Lisbon School of Economics & Management
Universidade de Lisboa

Master in Applied Econometrics and Forecasting

Time Series Analysis and Forecasting

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Class Assignments and Topics

Class 1 (14/9): Introduction to Time Series and Their Empirical Features. Chapter 1 (p. 1-12)
Class 2 (21/9): Time Series Decomposition and Transformations. Chapter 2 (p. 13-30)
Class 3 (28/9): Stationarity, Autocorrelation and Partial Autocorrelation. Chapter 3 (p. 31-34)
Class 4 (12/10): White Noise and Autoregressive (AR) Models. Chapter 3 (p. 35-43)
Class 5 (19/10): Moving Average (MA) and ARMA Models. Chapter 3 (p. 36-43)
Class 6 (26/10): Model Identification, Estimation, Testing and Selection. Chapter 3 (p. 43-56)
Class 7 (2/11): ARIMA Models for Nonstationary Time Series. Chapter 4 (p. 57-69)
Class 8 (9/11): Unit Root, Trend and Difference Stationarity. Chapter 5 (p. 71-83)
Class 9 (16/11): Forecasting. Chapter 7 (p. 121-130)
Class 10 (23/11): Seasonal Time Series Models. Chapter 9 (p. 153-160)
Class 11 (30/11): Exponential Smoothing. Chapter 9 (p. 153-160)
Class 12 (7/12): Topics for Further Research: Prophet

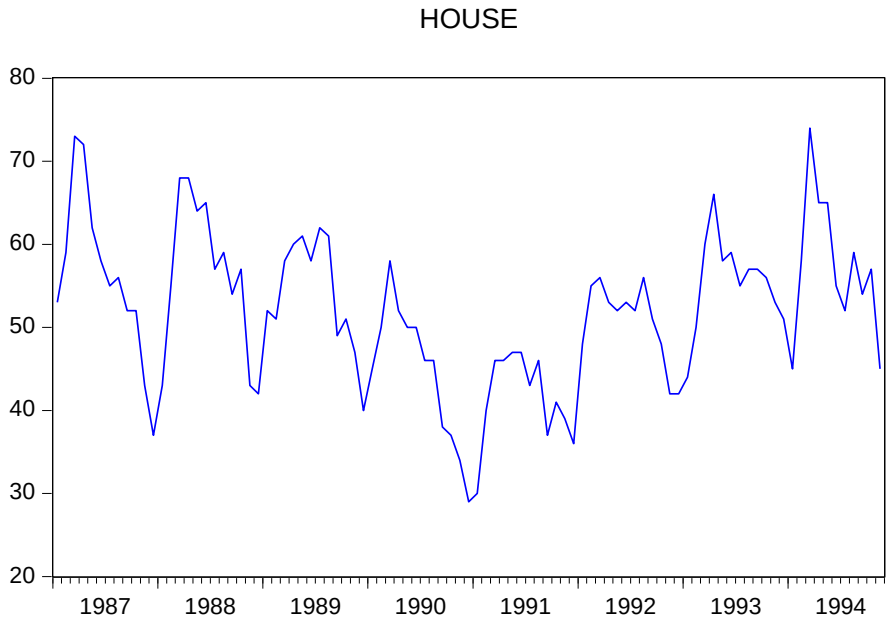
Textbook

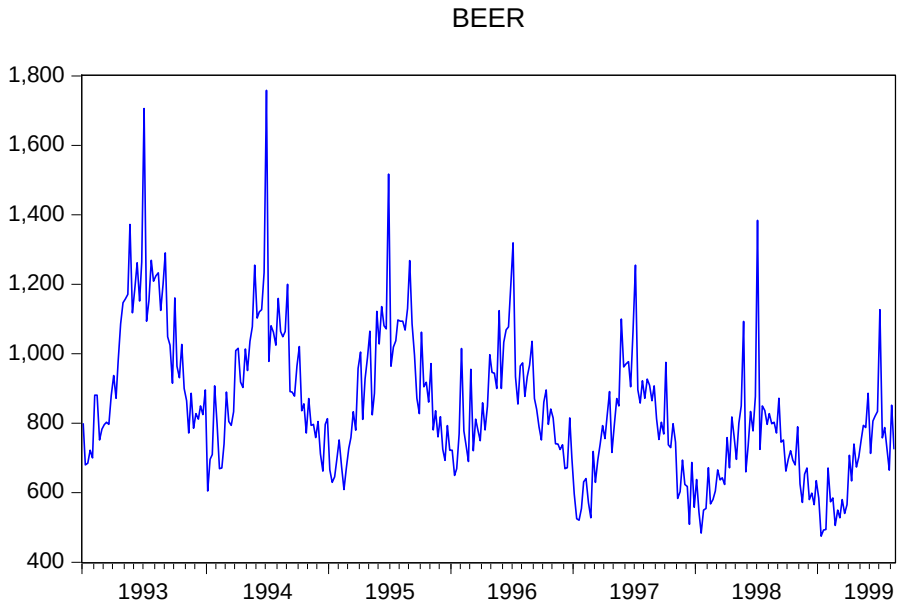
Mills, Terence (2019). *Applied Time Series Analysis: A Practical Guide to Modeling and Forecasting*, Academic Press, Elsevier, London.

Introduction to Time Series and Their Empirical Features

Definition of a Time Series

A **time series** is a sequence of observations over time, $X_t, t = 1, \ldots, T$. For example: monthly sales of new one-family houses; weekly beer consumption; daily stock indices; daily average temperature; annual electricity production.





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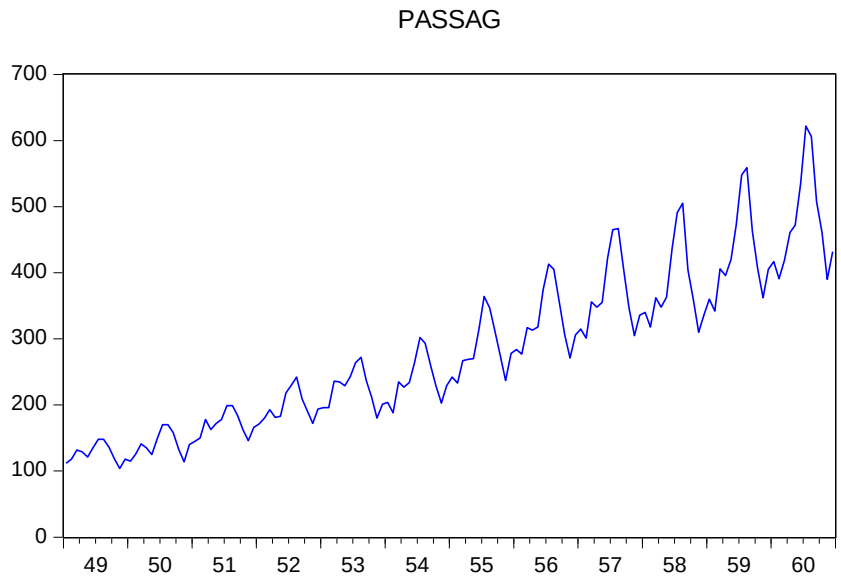

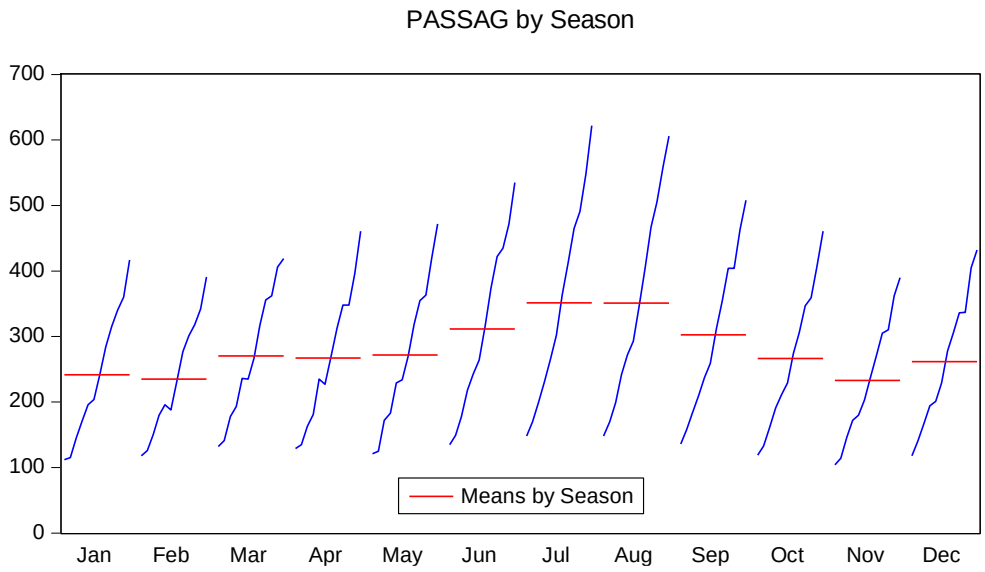

Time series patterns:

- Trend
- Cycle movements
- Seasonality
- Volatility
- Noise
- Autocorrelation
- Stationarity
- Nonstationarity
- Common features

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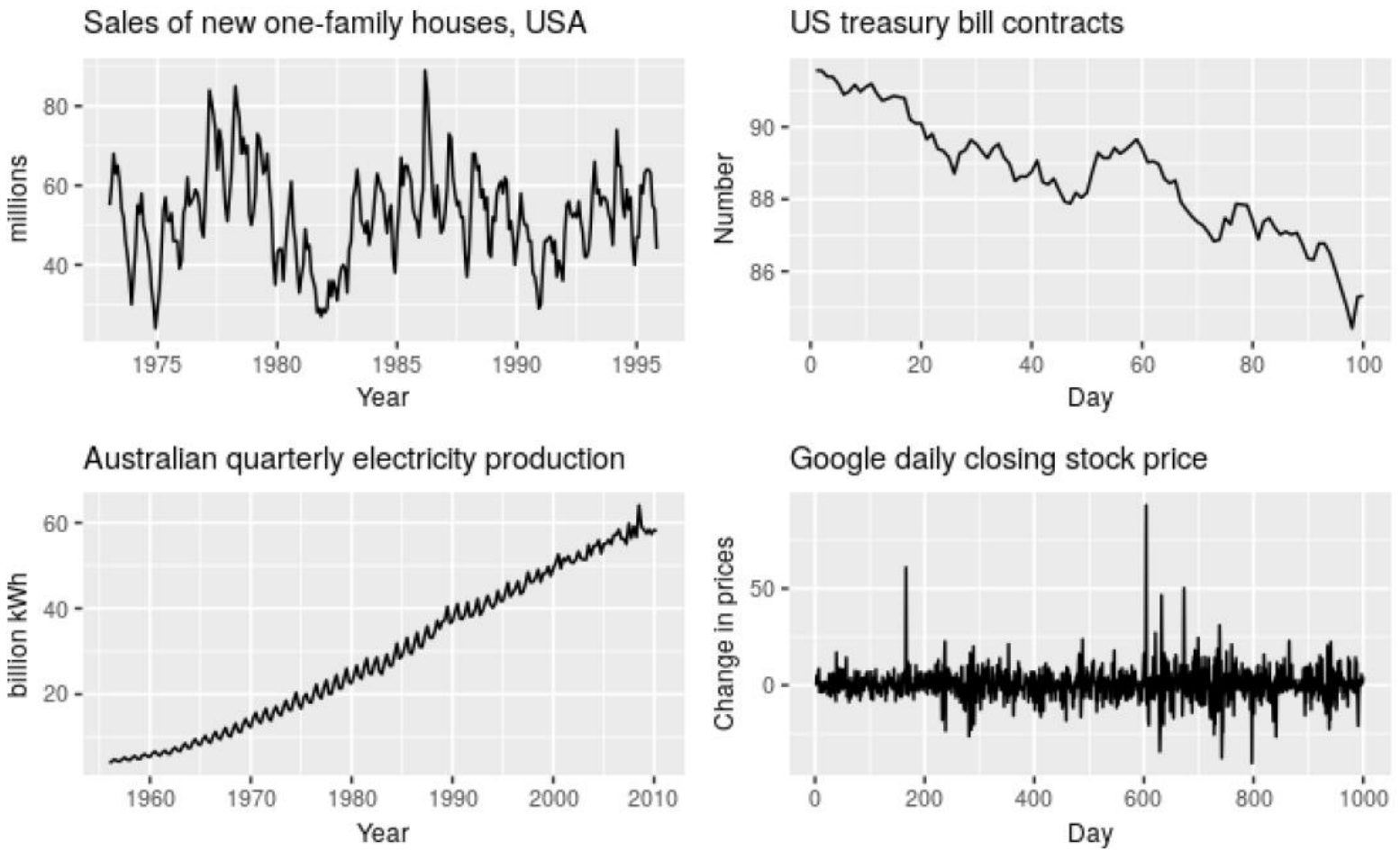
What features are presented in the time series below?



Source: Hyndman, R. e Athanasopoulos, G. (2018)

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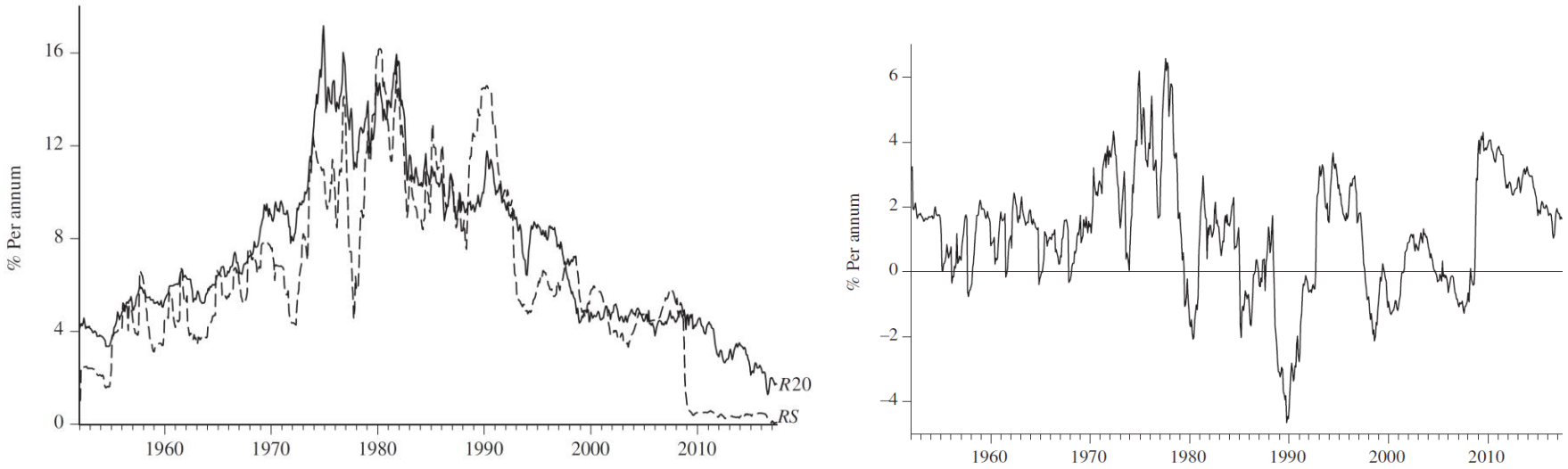
Two time series with common features: Cointegration?



Long (R20) and short (RS) UK interest rates (left) and their spread S=R20-RS (right)

Source: Mills, Terence (2019)

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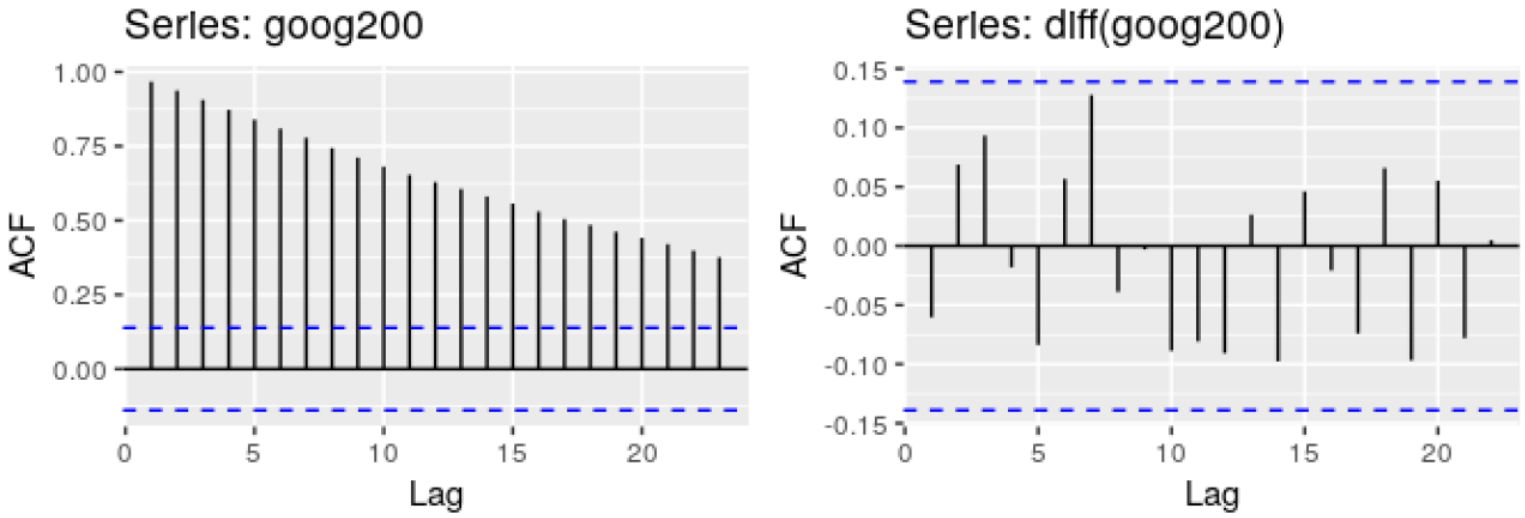
Autocorrelation

The sample **autocovariance function (SACOVF) and sample autocorrelation function (SACF)** represent the covariance and correlation between X_t and X_{t-k}, from the same process X separated only by k time lags:

$$s_k = \sum_{t=k+1}^{T}(X_t - \bar{X})(X_{t-k} - \bar{X}) \text{ (SACOVF) and } r_k = \frac{\sum_{t=k+1}^{T}(X_t-\bar{X})(X_{t-k}-\bar{X})}{Ts^2} \text{ (SACF)}$$

where $\bar{X}$ is the sample mean and s^2 is the sample variance of X_t.



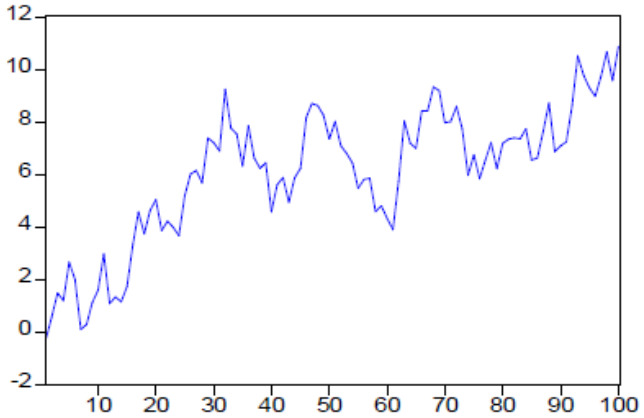
SACFs of Google stock prices and their daily changes. **Source:** Hyndman and Athanasopoulos (2018)

Introduction to Time Series and Their Empirical Features

Stationarity A process $X_t, t = 1, \dots, T$ is said to be **weakly stationary** if it has constant mean, constant variance, and the correlation between X_t and $X_{t-k}, k = 1,2, \dots$ depend only on time difference *k*.

Which are stationary?

A



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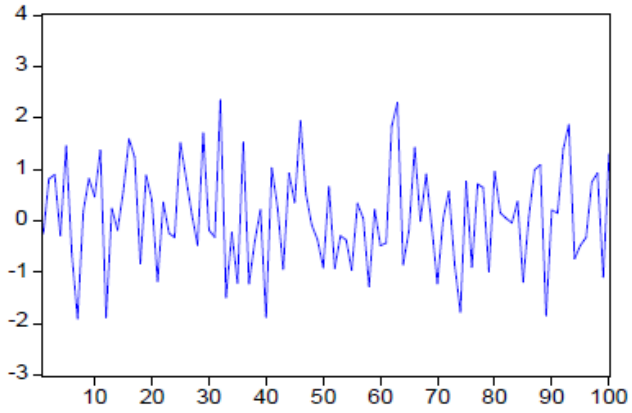

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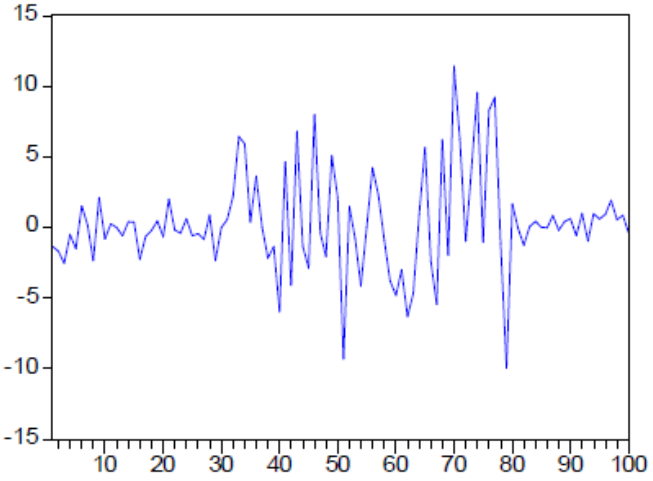

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