Applied Economic Forecasting

Basics of Time Series & Forecasting

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Section 1

Introduction to Economic Forecasting

Outline

What is Economic Forecasting?

- Predicting future values based on
  - qualitative and/or qualitative judgement.

The appropriate forecasting methods depend largely on what data are available.

1. If there are no data available, or if the data available are not relevant to the forecasts, then **qualitative** forecasting methods must be used.

- require the use of well-developed judgemental forecast methods.

2. **Quantitative** forecasting can be applied when two conditions are satisfied:

i. numerical information about the past is available;
ii. it is reasonable to assume that some aspects of the past patterns will continue into the future.

What is Economic Forecasting?

Quantitative forecasts

Most quantitative prediction problems use either time series data or cross-sectional data (collected at a single point in time).

In this course, we are concerned with forecasting future data, and we will concentrate on the time series domain.

What is Economic Forecasting?

> *Often in forecasting, a key step is knowing when something can be forecast accurately, and when forecasts will be no better than tossing a coin. Good forecasts capture the genuine patterns and relationships which exist in the historical data, but do not replicate past events that will not occur again.* ~*Rob Hyndman*

A time series is a sequence of measurements over time, usually obtained at regular, equally spaced intervals

- Every minute
- Hourly
- Daily
- Weekly
- Monthly
- Quarterly
- Yearly

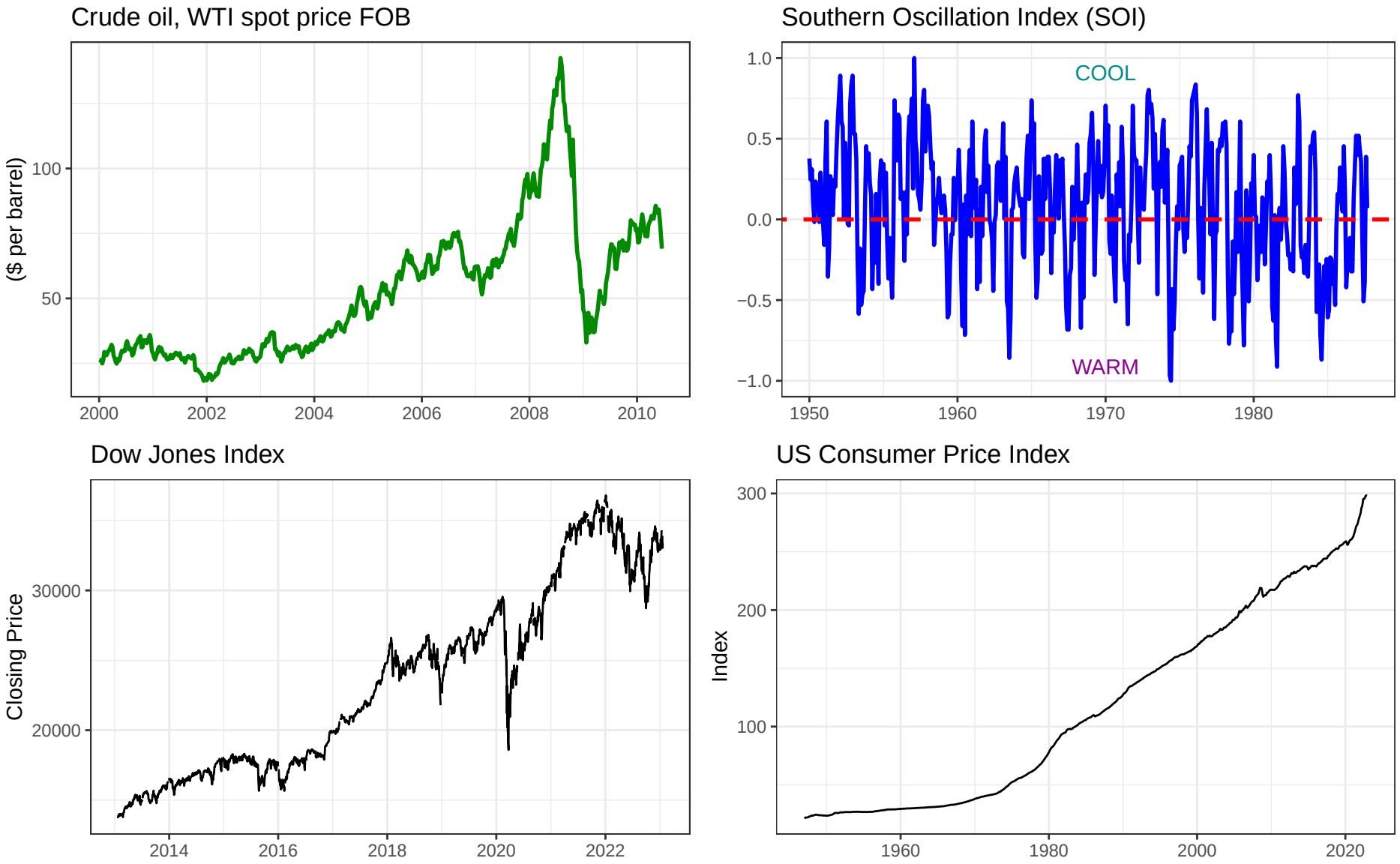


Figure 1: Examples of Time Series Data

Components of a Time Series

- **Trends** (exists when there is a longrun increase or decrease in the data.)
  - Linear
  - Nonlinear
- **Seasonality** (occurs when a time series is affected by seasonal factors such as the time of the year or the day of the week.)
  - Seasonality is **always of a fixed and known frequency**.
    - These patterns repeat themselves within a year.
    - The duration of these fluctuations is usually at least 2 years.
- **Cycles**
  - Rises and falls that are not of a fixed/predictable frequency
  - These fluctuations are usually due to economic conditions (not caused by seasonal effects) such as recessions and expansions. These are often related to the "business cycle".

(Linear) trend models

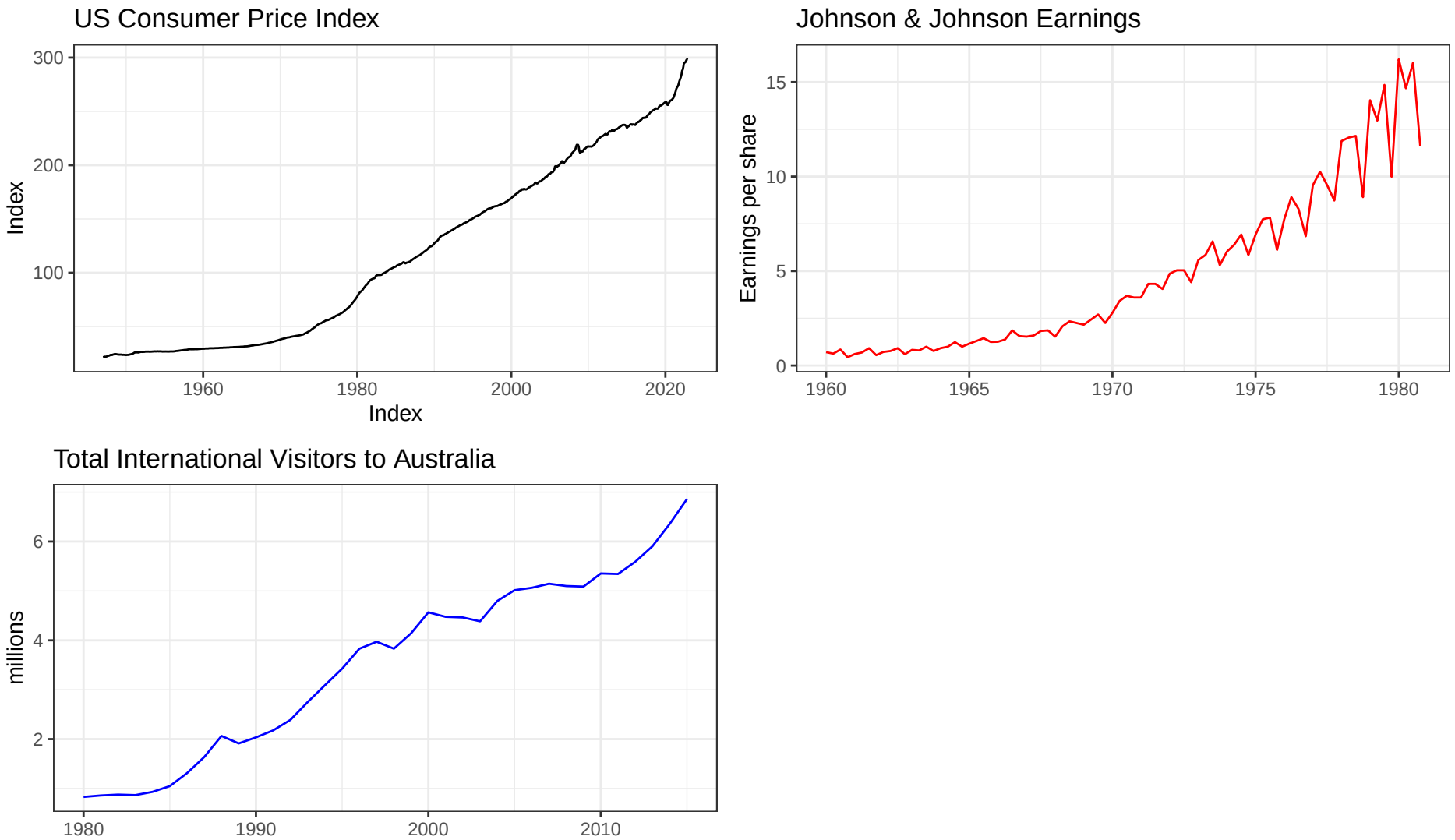
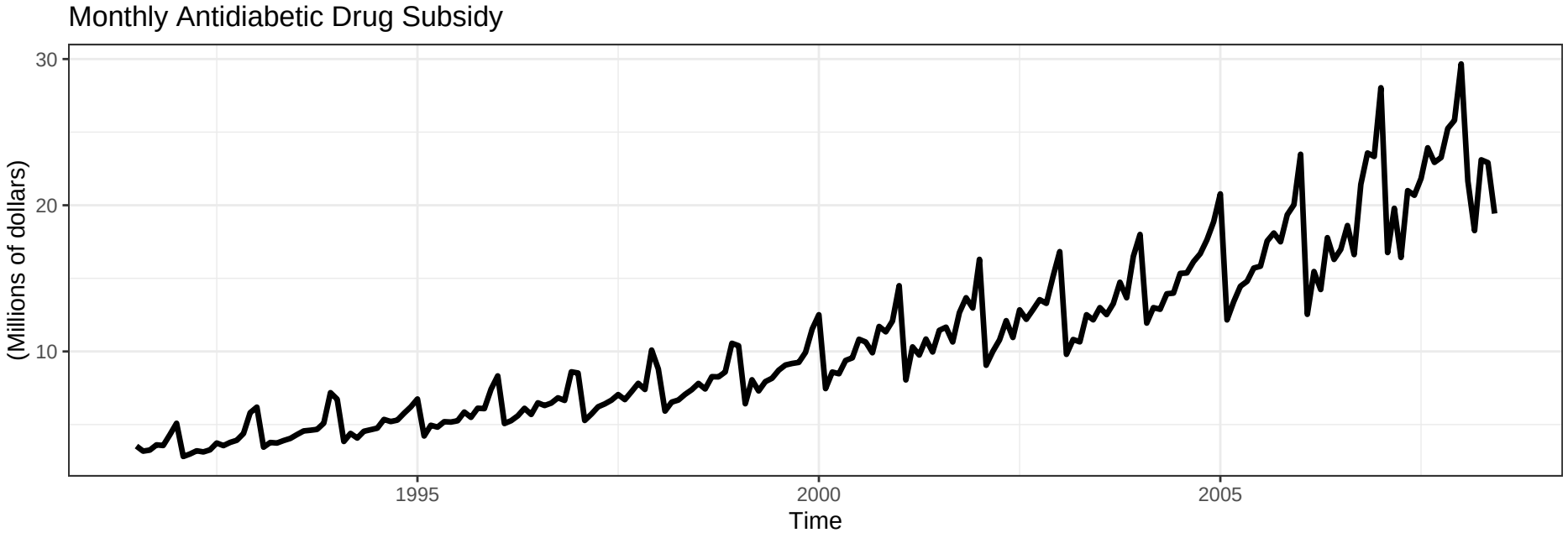
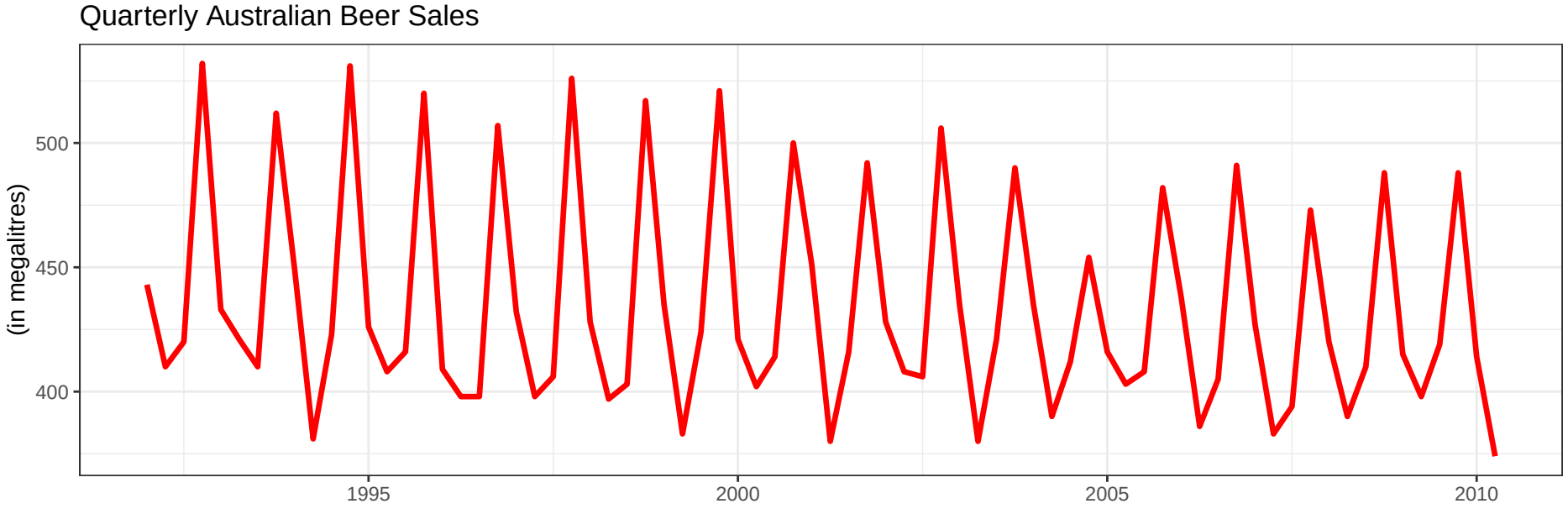


Figure 2: Examples of Data with Linear Trends

Trends and Seasonality?





Models with cycles

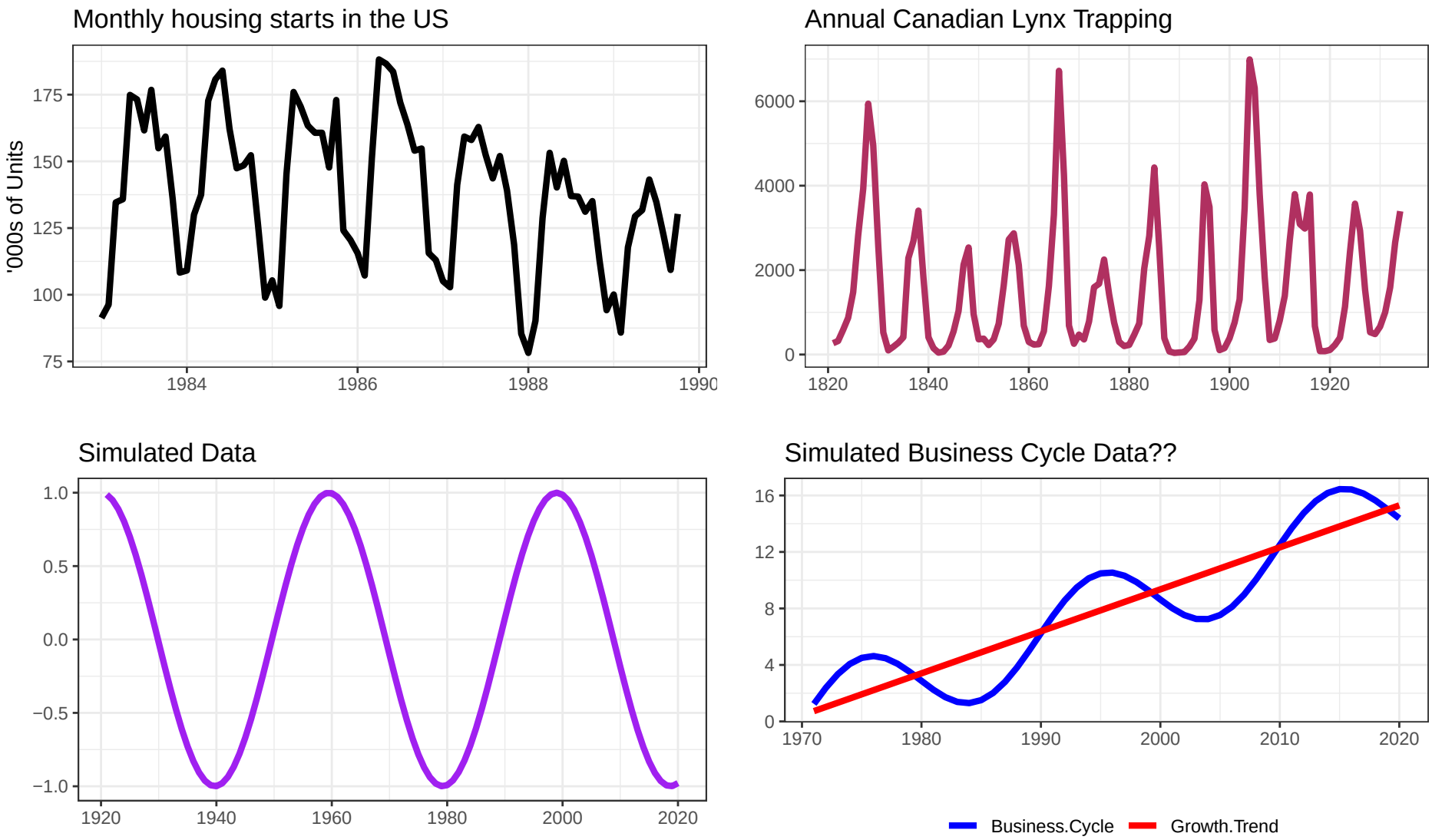
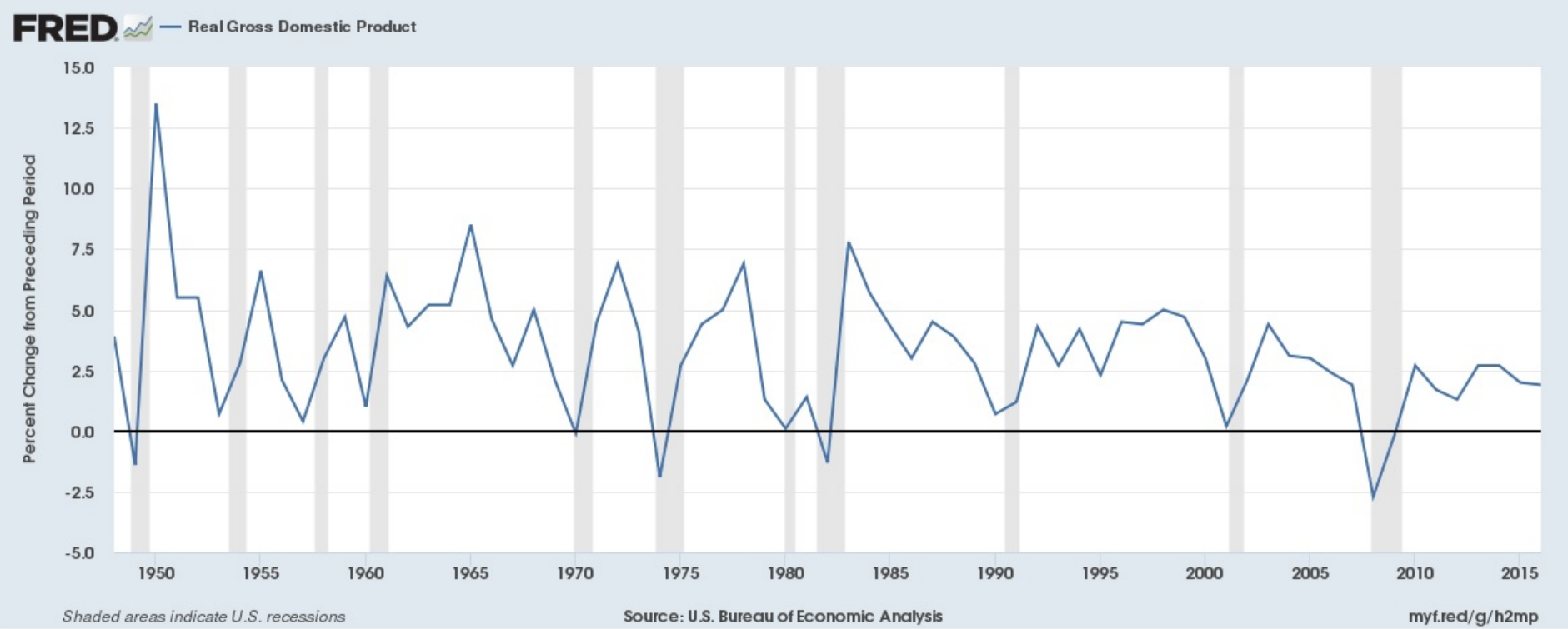


Figure 4: Example of Data with Cycles

Seasonal or cyclic?

Differences between seasonal and cyclic patterns:

- seasonal pattern have a constant length vs. cyclic pattern which have varying lengths
- average length of cycles are much longer than length of seasonal pattern
- the magnitude of cycles are more variable than magnitude of seasonal pattern
- Timing of peaks (highs) and troughs (lows) are predictable with seasonal data, but unpredictable in the long term with cyclic data.


FRED
Real Gross Domestic Product
Percent Change from Preceding Period
15.0
12.5
10.0
7.5
5.0
2.5
0.0
-2.5
-5.0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
Shaded areas indicate U.S. recessions
Source: U.S. Bureau of Economic Analysis
myf.red/g/h2mp

Forecasting Methods & Steps

1. Problem formulation
2. Data collection
3. Data manipulation and cleaning
4. Model building
5. Model evaluation
6. Model implementation (the actual forecast)
7. Forecast evaluation

Forecasting Methods & Steps

1. **Problem formulation**
   - Why is a forecast needed?
   - Who will use the forecast?
   - What are specific requirements on forecasting?
   - What level of detail or aggregation is required?
   - What is the proper time horizon?
   - What forecasting methods should be chosen?

2. **Data collection**

- Where to obtain data required by the forecasting problem?
- What are data frequencies, sample periods, sources?
- How much does data collection cost?
- What level of data is required?
- What is the data quality?

3. **Data manipulation and cleaning**
   - Missing values
   - Outliers
   - Different data sources
   - Different units
   - ...

Forecasting Methods & Steps

4. **Model building**

- This will depend on the characteristic of the data and the purpose for the forecast.
- See How to choose the right forecasting Technique

5. **Model evaluation**

- Is the chosen model best suited for data?
- Are the underlying assumptions of the model satisfied?
  - For example, assumptions for ordinary least square (OLS) regression:
    - A.1: zero error term mean
    - A.2: error terms are homoscedasticity
    - A.3: error terms have no autocorrelation
    - A.4: no multicollinearity
    - A.5: explanatory variables and error terms are uncorrelated.
    - ...

Forecasting Methods & Steps

6. **Model implementation for forecasting**
   - rolling window forecast
   - recursive/expanding window forecast
   - estimation period and forecasting period
   - parameter updating frequencies
   - ...

7. **Forecast Evaluation**

- Choice of loss functions:
  - Mean Absolute Deviations (MAD)

$$MAD = \frac{1}{T}\sum_{t=1}^{T}|y_t - \widehat{y}_t|$$

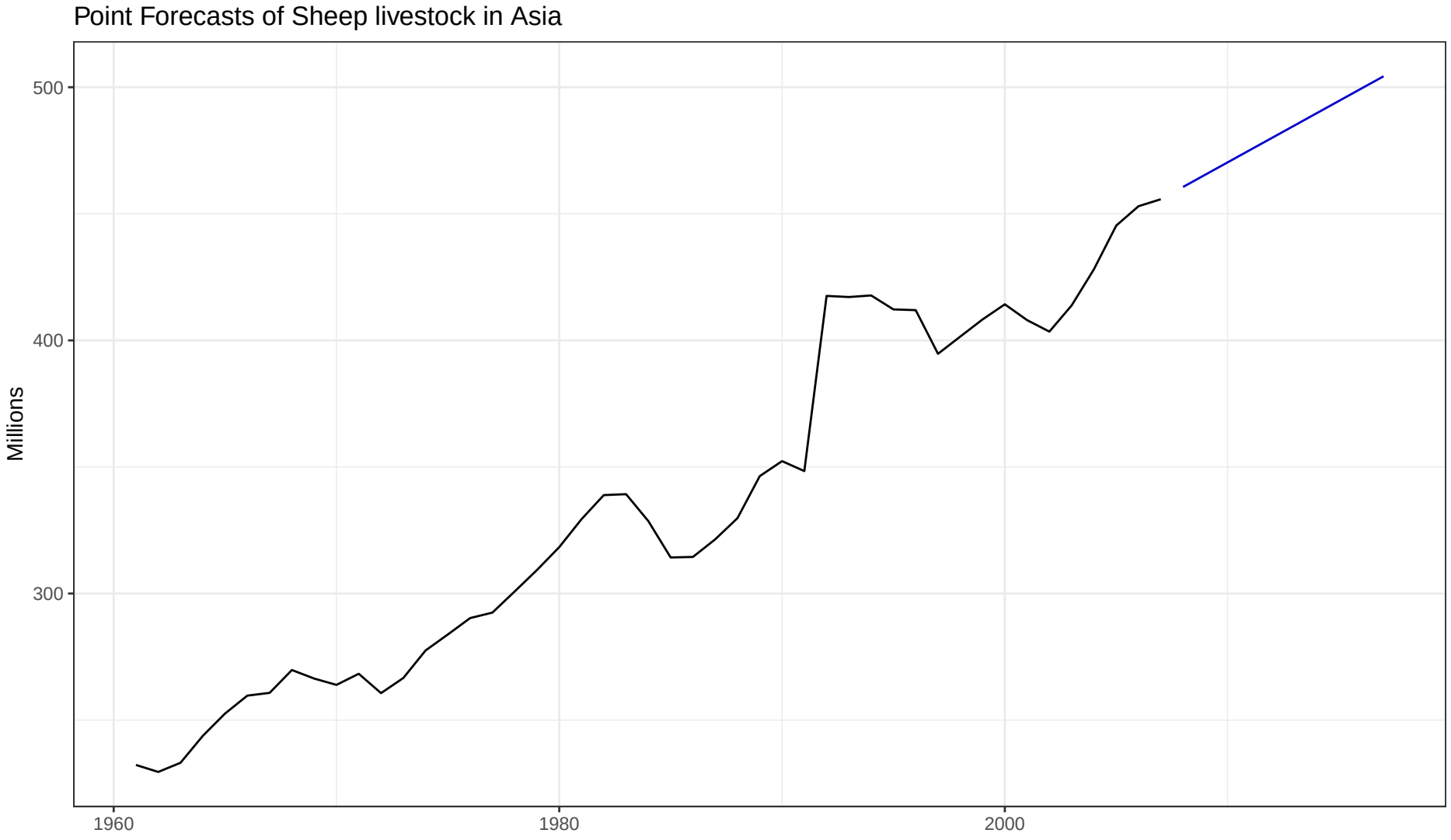
  - Mean Squared Error (MSE)

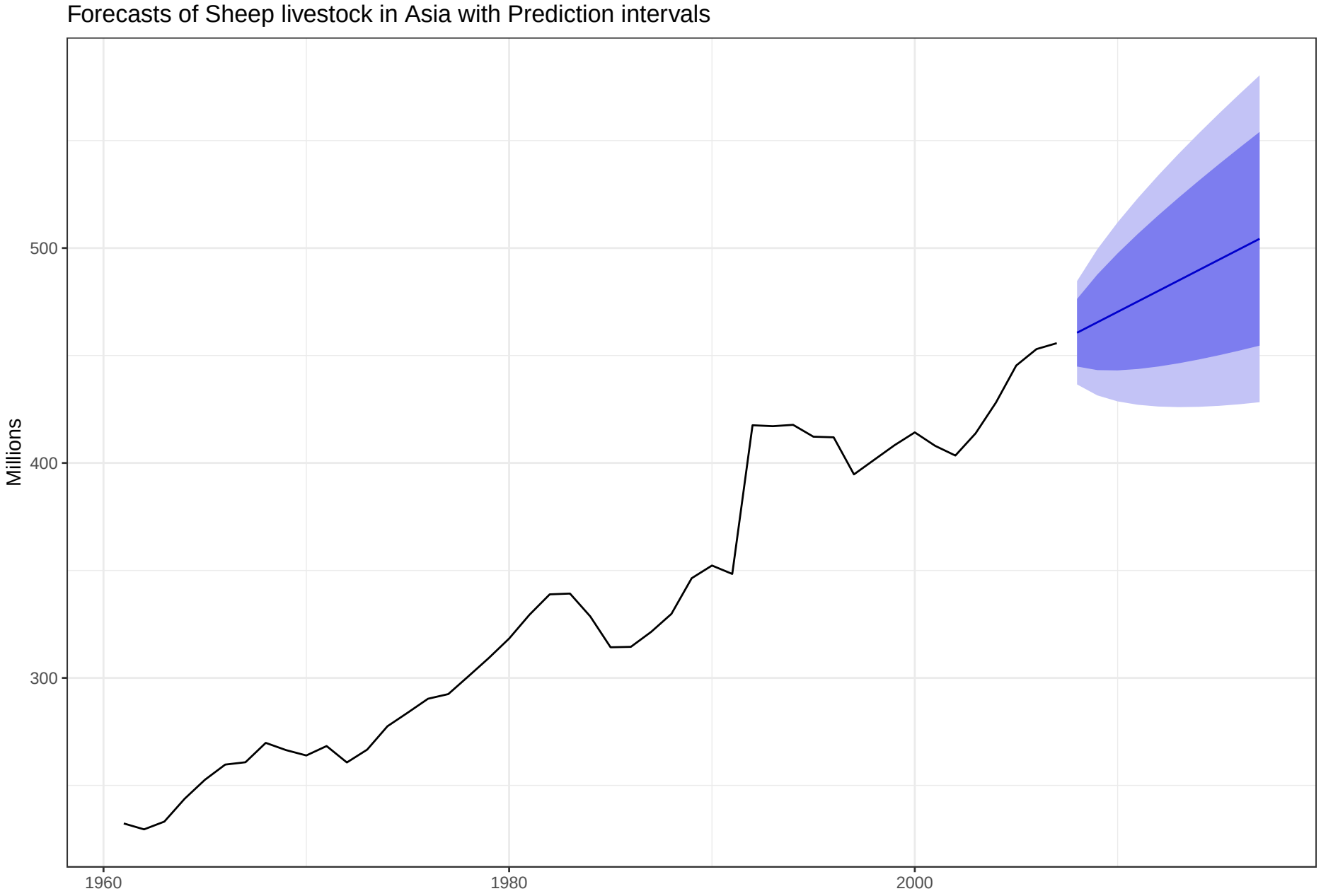
$$MSE = \frac{1}{T}\sum_{t=1}^{T}(y_t - \widehat{y}_t)^2$$

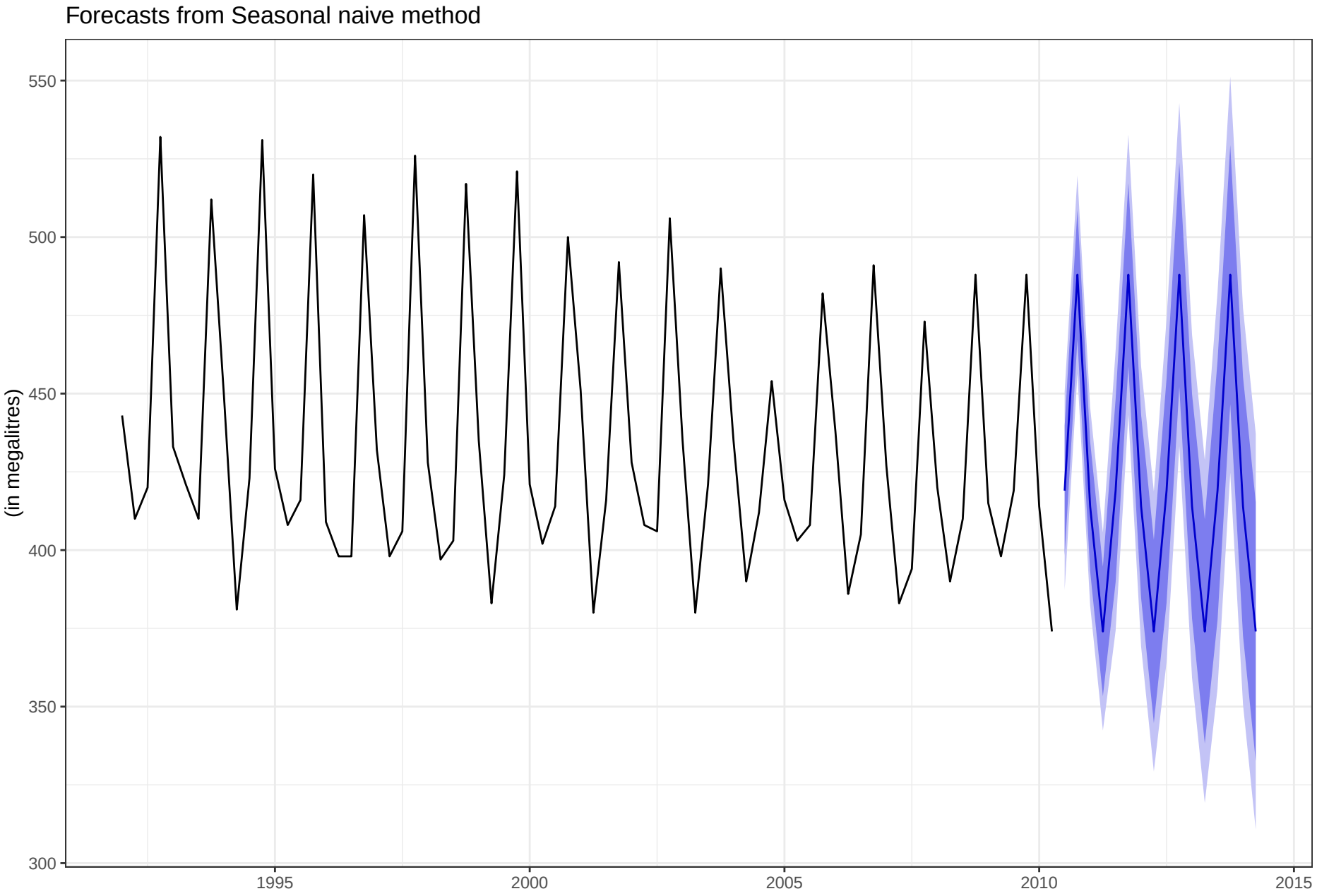
  - Root Mean Squared Error (RMSE)

$$RMSE = \sqrt{MSE} = \sqrt{\frac{1}{T}\sum_{t=1}^{T}(y_t - \widehat{y}_t)^2}$$

8 Types and Objectives of Forecasting




Forecasts of Sheep livestock in Asia with Prediction intervals
Millions
500
400
300
1960
1980
2000


Forecasts from Seasonal naive method
(in megalitres)
550
500
450
400
350
300
1995
2000
2005
2010
2015

Data Sources

- Federal Reserve Economic Data (https://fred.stlouisfed.org/)
- The World Bank (http://data.worldbank.org/)
- EuroStat (http://ec.europa.eu/Eurostat)
- U.S. Bureau of Economic Analysis (www.bea.gov)
- U.S. Bureau of Labor Statistics (www.bls.gov)
- U.S. Census Bureau (www.census.gov)
- OECD iLibrary (http://www.oecd-ilibrary.org/statistics)
- IMF Data (https://www.imf.org/en/Data)
- Financial Time Series (http://www.finance.yahoo.com)
- ...

Forecasting Software

- General statistical packages
  - Minitab
  - Excel
  - SPSS
  - EVIEWS
- General statistical programming software:
  - **R**
  - Matlab
  - Mathematica
  - SAS
  - Stata
  - C
  - Fortran
  - Python