

# Econometrics II TA Session #13

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## 1 Empirical Application of Time Series Model: Nikkei 225

### 1.1 Background and Data

The “Nikkei225” is a stock price index published by Nihon Keizai Shimbun (hereafter, NIKKEI). NIKKEI calculates this price index based on 225 high liquid brands listed with first section of the Tokyo Stock Exchange. We use daily data of the Nikkei 225 index taken from the yahoo finance (<https://stocks.finance.yahoo.co.jp/stocks/detail/?code=998407.O>). The time length is from January 4th 2020 to January 22 2021. We have 498 observations. We call a csv data which recodes the Nikkei 225 dairy index, using the `read.csv` function in R. Since R recognize a time variable (e.g., 2021/01/22) as a character string, we need to define a time variable, using `as.Date()` function. The data structure is as follows:

```
dt <- read.csv("data/nikkei225.csv", stringsAsFactor = FALSE)
dt$date <- as.Date(dt$date, format = "%Y/%m/%d")
head(dt)
```

##		date	open_price	high_price	low_price	close_price
## 1		2021-01-22	28580.20	28698.18	28527.16	28631.45
## 2		2021-01-21	28710.41	28846.15	28677.61	28756.86
## 3		2021-01-20	28798.74	28801.19	28402.11	28523.26
## 4		2021-01-19	28405.49	28720.91	28373.34	28633.46
## 5		2021-01-18	28238.68	28349.97	28111.54	28242.21
## 6		2021-01-15	28777.47	28820.50	28477.03	28519.18

There are five variables:

- `date`: date variable
- `open_price`: open price in day  $t$
- `high_price`: high price in day  $t$
- `low_price`: low price in day  $t$
- `close_price`: close price in day  $t$

Mainly, we use the `date` and `close_price`.

Figure 1 shows the time-series of close price of the Nikkei225. We summarize some features

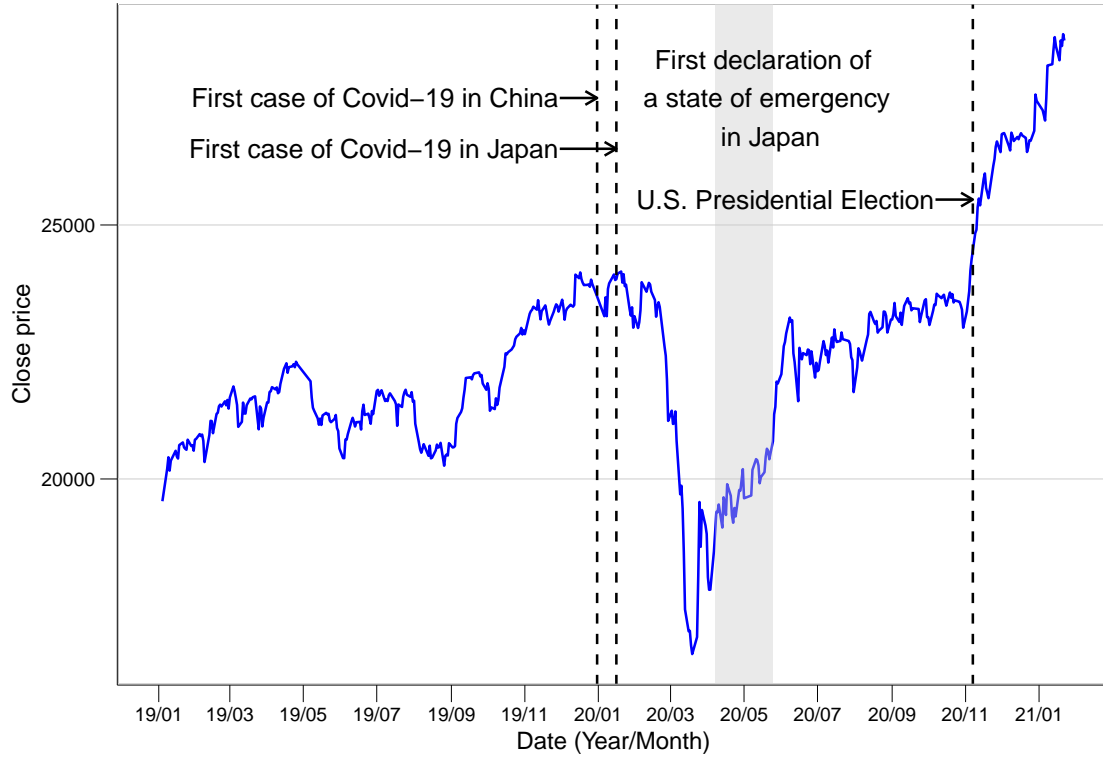


Figure 1: Time Series Data of Nikkei 225

of this data as follows:

- After the COVID-19 occurred in Japan and China, the Nikkei225 has drastically decreased.
- During the first declaration of a state of emergency in Japan, the Nikkei225's performance has been a V-shaped recovery.
- The Nikkei225 has sharply increased immediately before and after the U.S. presidential election.

Some may wonder if the negative shock of COVID-19 reflects the Nikkei225. To discuss it, we need to consider two potential concerns.

1. unlisted companies (such as restaurant business) suffers heavily from the negative shock of COVID-19.
2. the Nikkei225 does not represent a variation of price index of 225 brands. In principle, the Nikkei225 is a mathematical mean of stock price of 225 brands. The stock prices of top five brands which contribute to the Nikkei225 have increased at 70%. On the other hand, the stock price of other brands have decreased at 5%<sup>1</sup>.

Anyway, we estimate the time series model, using this dataset.

<sup>1</sup>See <https://news.yahoo.co.jp/articles/f63a4627b298857a62ac329b1ed41a88c2721bd4>.

## 1.2 Autoregressive of Order 1: AR(1) model

We want to know if the trend of Nikkei225 is a stationary process satisfying the AR(1) equation

$$X_t = \beta X_{t-1} + \epsilon_t$$

where  $X_t$  is the close price of Nikkei225 in day  $t$ , and  $(\epsilon_t) \sim BB(0, \sigma^2)$ .

```
ar1 <- ar(dt$close_price, method = "mle", order.max = 1)
sprintf(
  "The coefficient is %1.4f (s.e. = %1.4f)", ar1$ar, sqrt(ar1$asy.var.coef)
)
```

```
## [1] "The coefficient is 0.9968 (s.e. = 0.0059)"
```

```
library(tseries)
dftest <- adf.test(dt$close_price, k = 1)
sprintf(
  "The DF statistic is %1.4f (p-value = %1.4f)",
  dftest$statistic, dftest$p.value
)
```

```
## [1] "The DF statistic is -2.7638 (p-value = 0.2550)"
```