ISA 444: Business Forecasting

13 - Autocorrelation and Partial Autocorrelation

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Spring 2021

Outline

What we Covered Last Class

Main Learning Outcomes

☑ **Define the population mean, and variance of a random variable.**

☑ **Define the population covariance, and correlation between two random variables.**

☑ **Define the population autocovariance and autocorrelation of a random variable.**

☑ **Use sample estimates of the population mean, variance, covariance, and correlation.**

☑ **Explain the properties of the large sample distribution of the sample ACF.**

☑ **Use the large sample distribution of the sample ACF to identify significant autocorrelation in a time series.**

Recap: ACF Definitions

We defined **autocorrelation as the correlation between a time-series and its past values.**

The **ACF was defined as a function that captures the correlations between pairs of values at a certain lag**. For example:

- Lag-1 autocorrelation captures the correlation between y_t and y_{t-1}.
- Lag-2 autocorrelation captures the correlation between y_t and y_{t-2}.

Recap: The ACF of Advance Retail Sales [RSCCAS]

Build on the example below and plot the ACF for:

- The RSCCAS series, which is stored in the `retail` df.
- The first differences of the RSCCAS series.

```
pacman::p_load(tidyverse, magrittr, fpp2, tidyquant, scales, ggpubr)
retail = read.csv("http://tiny.cc/megahed")
retail$DATE %<>% ymd()
```

Based on both plots, answer the following two questions:

- Are the limits for both ACF plots the same? Why? Why not?
- Comment on how their ACF plots are different.

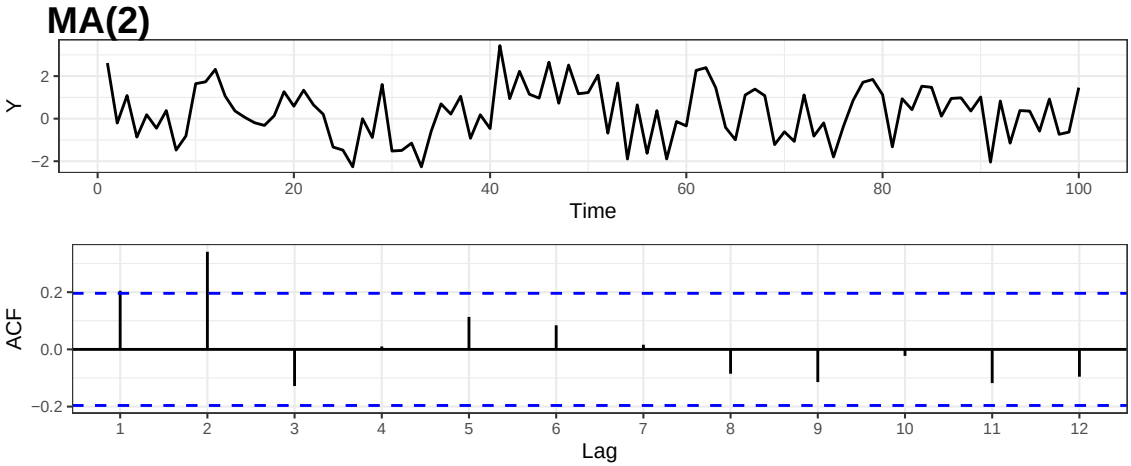
Learning Objectives for Today's Class

Main Learning Outcomes

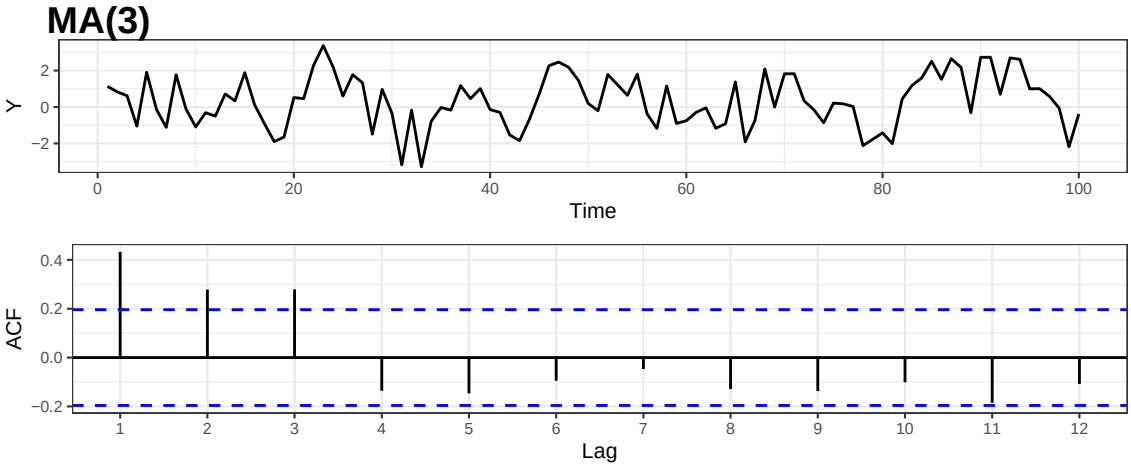
- **Determine if a sample ACF plot "cuts off" or "dies down".**
- **Explain how sample partial autocorrelation is calculated.**

Outline

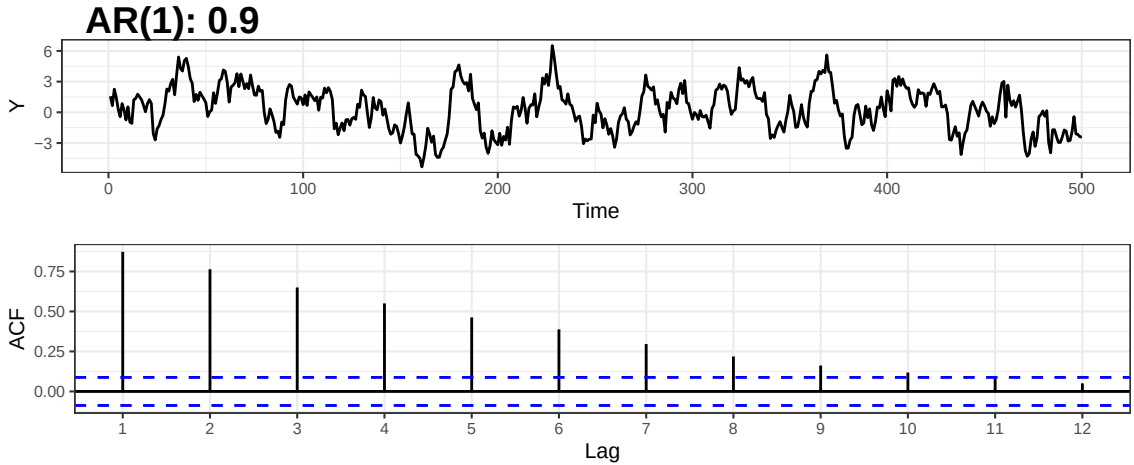
Some Time Series and their ACF Plots [1]



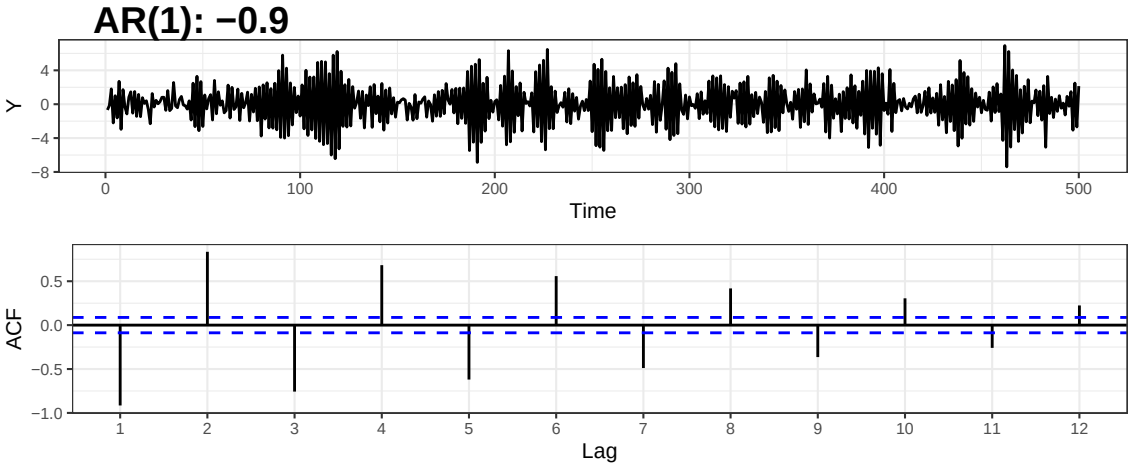
Some Time Series and their ACF Plots [2]



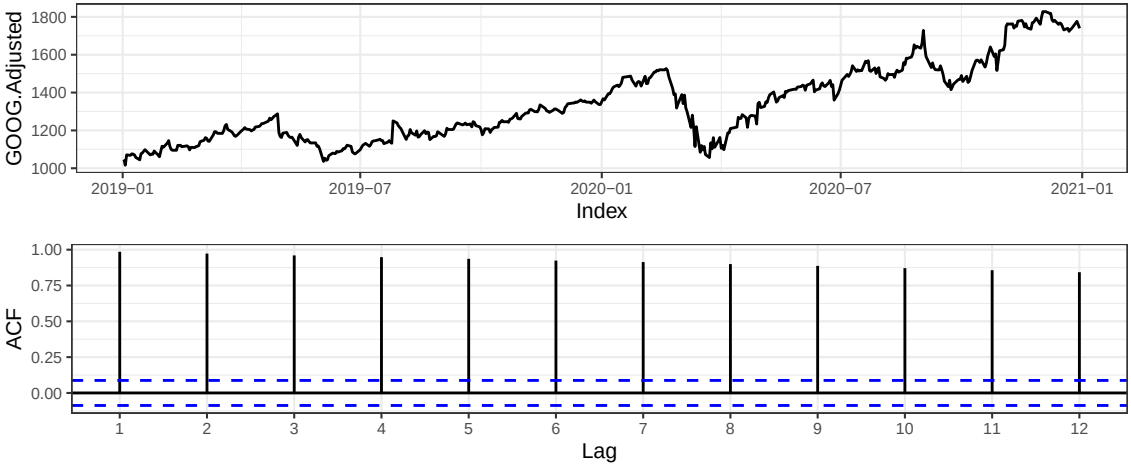
Some Time Series and their ACF Plots [3]



Some Time Series and their ACF Plots [4]



Some Time Series and their ACF Plots [5]



Outline

Definition: General

Statistical Definition: Let us say that we have three variables, X, Y, and Z, all correlated, and we want to know how X and Y are correlated after we remove the effects of Z on each.

Computation Approach:

$$\hat{X} = a_1 + b_1 Z; \qquad X^* = X - \hat{X}$$

$$\hat{Y} = a_2 + b_2 Z; \qquad Y^* = Y - \hat{Y}$$

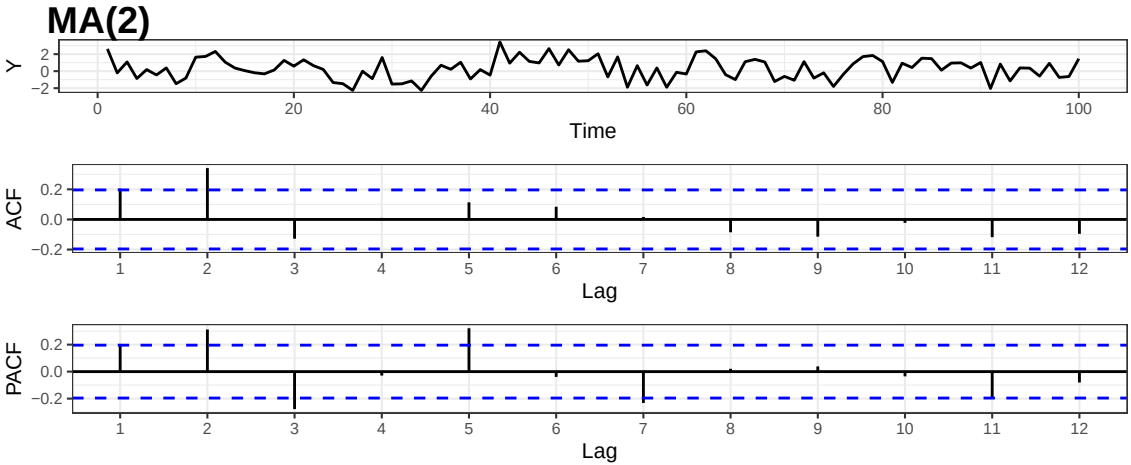
$Corr(X^*, Y^*)$ is the partial correlation between X and Y. It is the correlation that remains after we remove the effect of Z.

PACF in the Context of Time-Series Analysis

The Partial Autocorrelation between Y_t and Y_{t+k} is the correlation between Y_t and Y_{t+k} after removing the effects of Y_{t+1}, Y_{t+2}, Y_{t+3}, $\ldots$, Y_{t+k-1}.

- We plot the partial autocorrelation over multiple lags just like the autocorrelation function (ACF).
- We refer to the plotted partial autocorrelations as the PACF.

Some Time Series and their PACF Plots [1]



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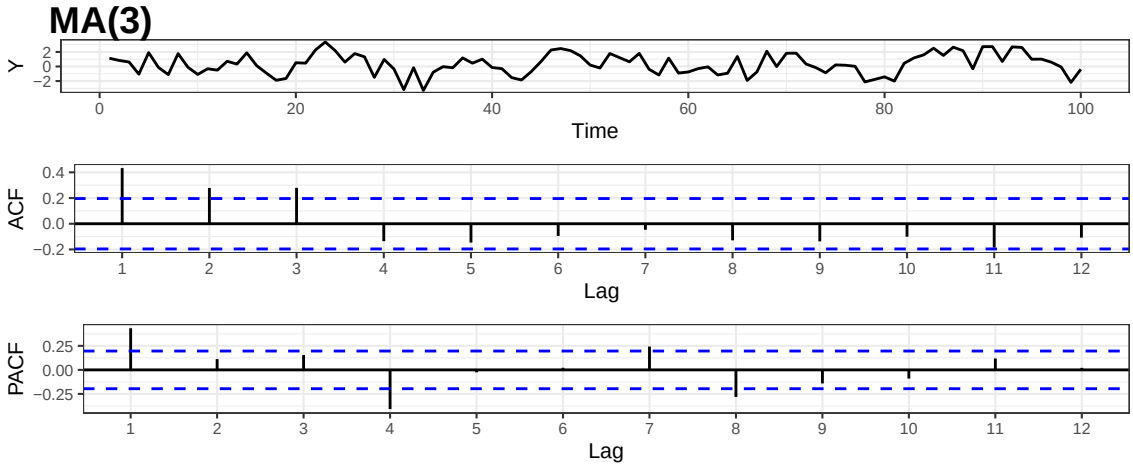

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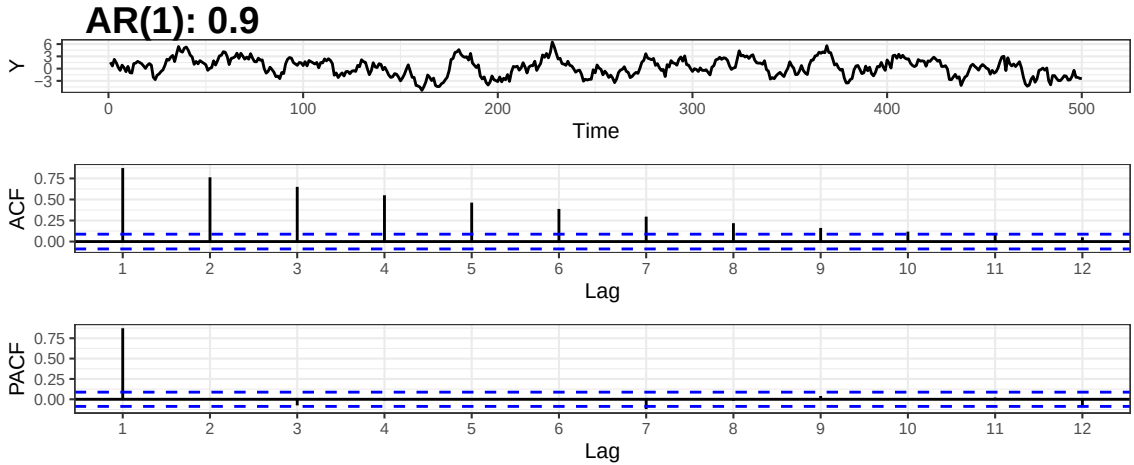

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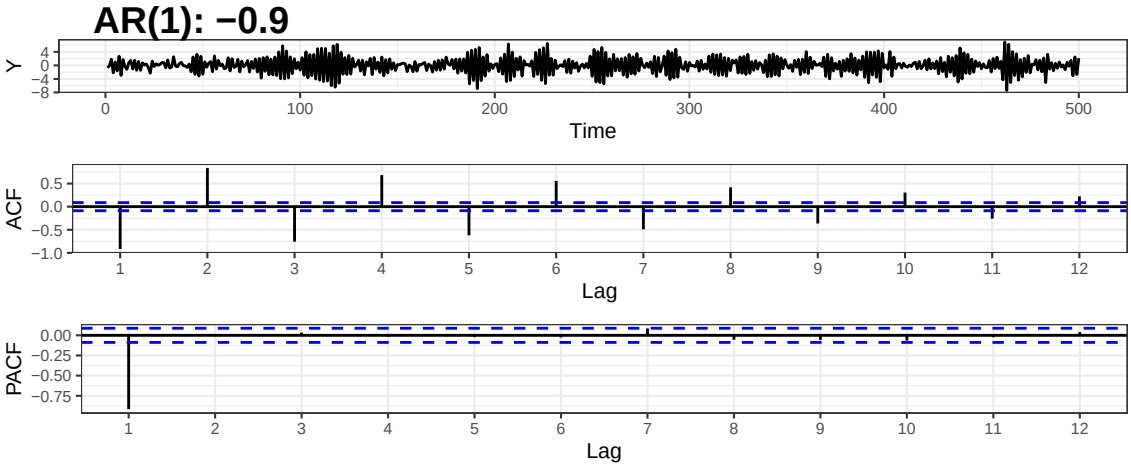

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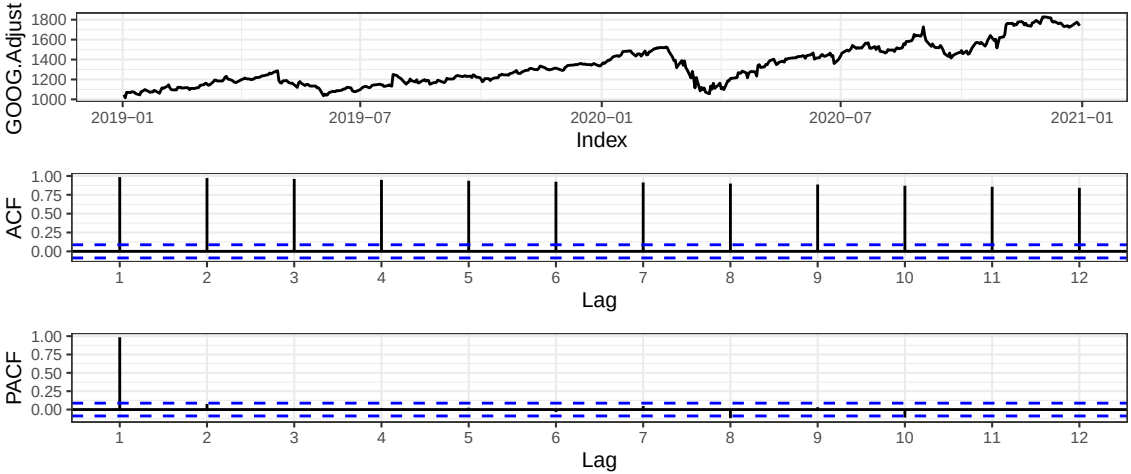
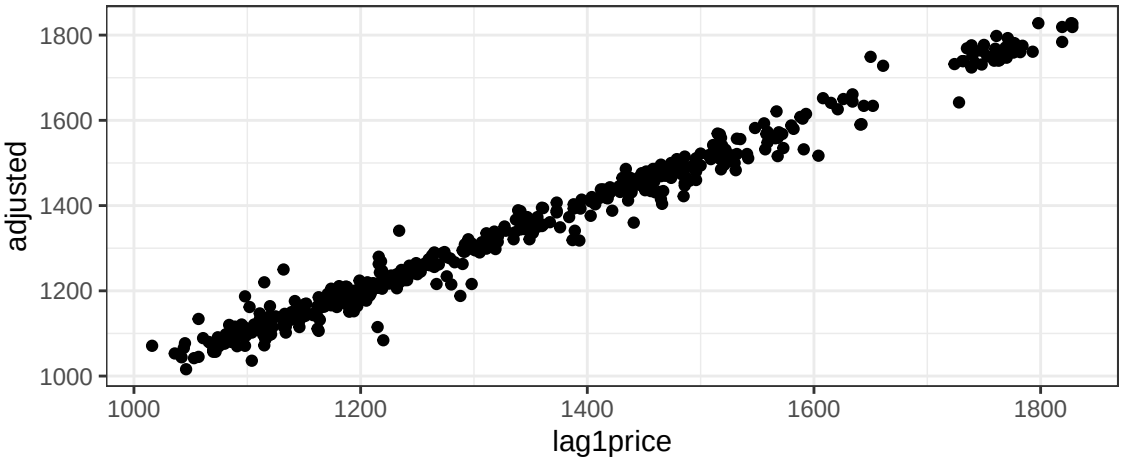


What we have learned from the GOOG Example [1]



What we have learned from the GOOG Example [2]

	Dependent variable:
	adjusted
lag1price	0.993***
	(0.006)
Constant	10.224
	(7.924)
Observations	503
R^2	0.983
Adjusted R^2	0.983
Residual Std. Error	26.271 (df = 501)
F Statistic	28,570.970*** (df = 1; 501)
Note:	*p<0.1; **p<0.05; ***p<0.01

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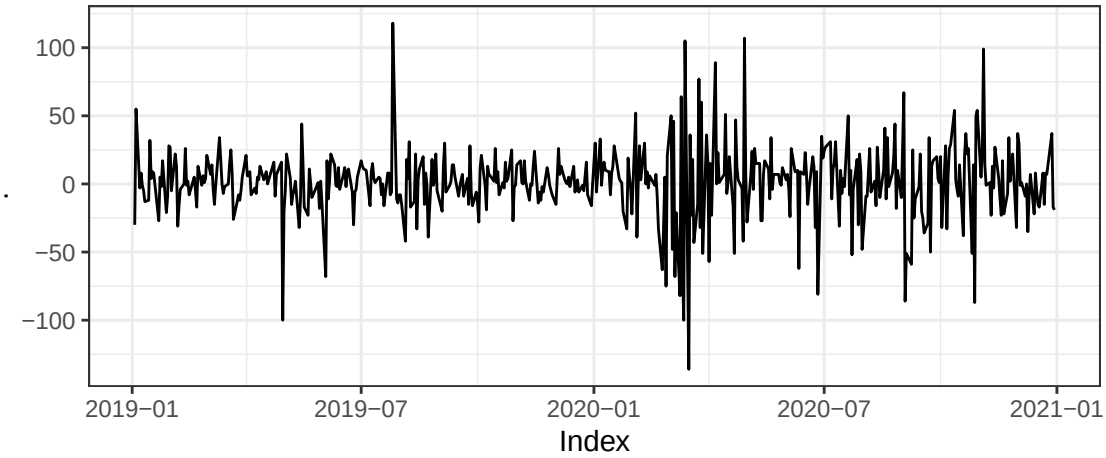

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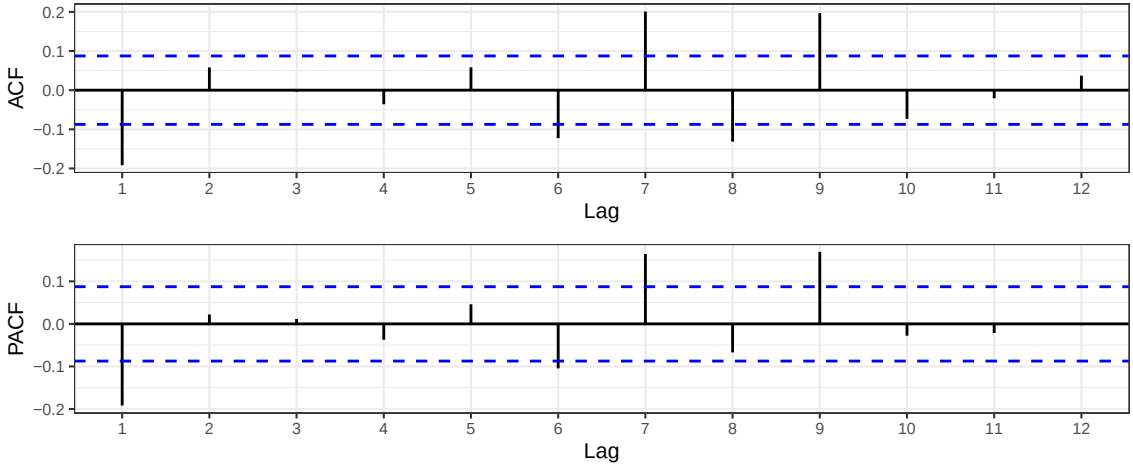

Outline

Summary of Main Points

Main Learning Outcomes

- **Determine if a sample ACF plot "cuts off" or "dies down".**
- **Explain how sample partial autocorrelation is calculated.**

Things to Do

- Thoroughly read Chapter 6.1-6.2.5 of our textbook.
- Go through the slides, examples and make sure you have a good understanding of what we have covered.
- Complete the assignment (see details in next slide).

Graded Assignment 13: Evaluating your Understanding

Please go to Canvas (click here) and answer the questions. **The assignment is due March 15, 2021 [11:40 AM, Ohio local time], and will be posted by 8 AM on March 11, 2021.**

What/Why/Prep? The purpose of this assignment is to evaluate your understanding and retention of autocorrelation and PACF. To reinforce your understanding of the covered material, I also suggest reading Chapter 6.1-6.2.5 of the book.

General Guidelines:

- Individual assignment.
- This is **NOT** a timed assignment.
- Proctorio is NOT required for this assignment.
- You will need to have R installed (or accessible through the Remote Desktop)

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