Time Series Analysis

Homework Assignment #1

Andrew Lesniewski
Baruch College
New York

August 31, 2023

Problems

1. **Programming project**. This is an **open ended project** whose purpose is to build a predictive housing pricing model. Your solution to this project should not be submitted to the course TAs. Instead, your homework team will give a 15 min in class presentation on September 14.

   As a quant researcher working for an asset manager of mortgage backed / credit securities, you are tasked with building a US housing pricing model.

   (i) We assume that the housing price level is given by the *Case-Shiller U.S. National Home Price Index*. The time series of this index (as well as other useful financial and macroeconomic data) can be found on the website of the St. Louis Federal Reserve Bank `https://fred.stlouisfed.org/series/CSUSHPINSA`. Before you start working on the project, you may want to do some reading about the economics of the C-S Index.

   (ii) In your thinking about the model, you may want to consider the autoregressive character and stickiness of the housing prices. You may also want to include auxiliary explanatory variables (of your choice), time series of which can be found on the St. Louis Fed website or elsewhere.

(iii) Develop a framework for backtesting the model. Make sure that you avoid data snooping fallacy.

(iv) For this project, **do not** use any neural net based methodologies.

2. Consider the time series of daily returns (i.e. $(price_t - price_{t-1})/price_{t-1}$) on the Nasdaq 100 ETF QQQ over the past 10 years (use *adjusted closing prices* from Yahoo Finance or Bloomberg). *Assume* that this time series is stationary. Test, using the Ljung-Box stats $Q(5)$ and $Q(10)$, at the level of confidence of 95%, the presence of autocorrelations in this time series.

3. Is the following $AR(2)$ process :

$$X_t = 1.92 - 1.1X_{t-1} + 0.18X_{t-2} + \varepsilon_t, \quad \varepsilon_t \sim N(0,1), \tag{1}$$

covariance stationary? If so, calculate its mean and all autocovariances.

4. Carry out a detailed discussion of the conditions on β_1 and β_2 under which the $AR(2)$ time series

$$X_t = \alpha + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \varepsilon_t, \quad \varepsilon_t \sim N(0,\sigma^2), \tag{2}$$

is covariance stationary.

This assignment (Problems 2 - 4) is due on September 7