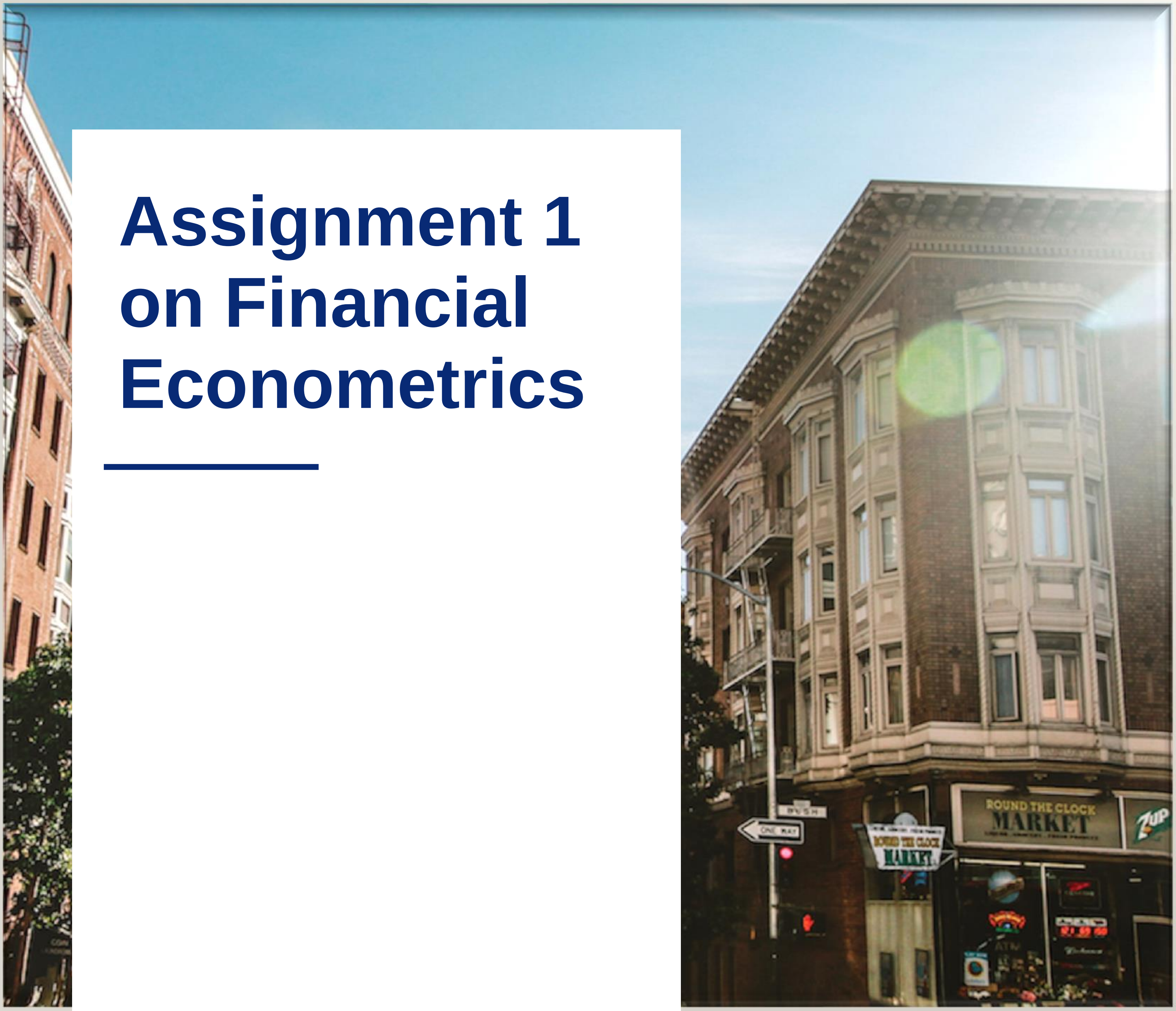
Assignment 1 on Financial Econometrics



OCTOBER 6

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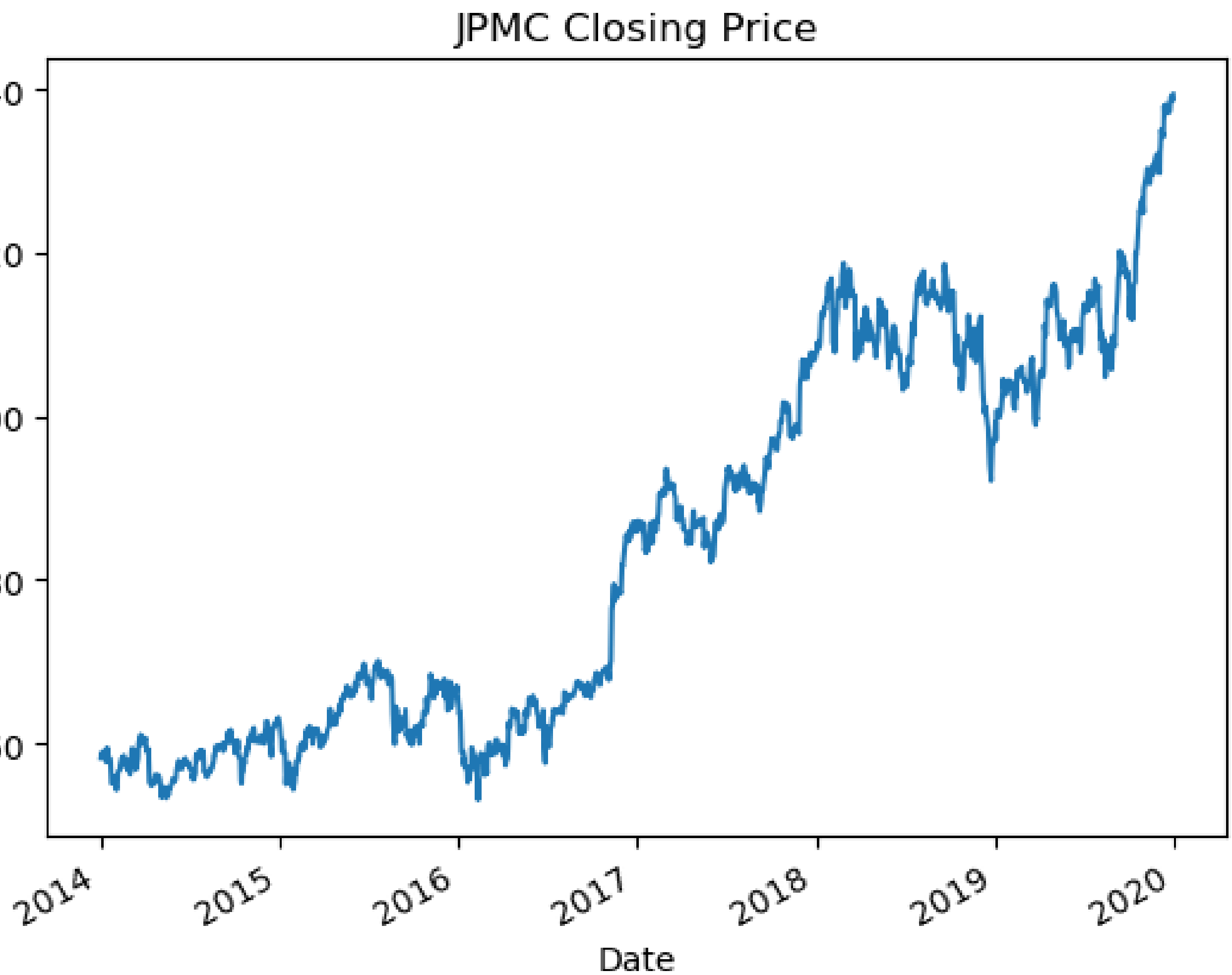
The Box-Jenkins approach is a method for identifying, estimating, and checking the best ARIMA model for a given univariate time series. A univariate time series is a sequence of single observations recorded over equal time intervals.

To apply the Box-Jenkins approach, we need to follow these steps:

- Choose a financial asset and obtain its closing price data for the specified period. For this assignment, I have chosen the JPMC – JPMorgan Chase's closing price data from 1 Feb, 2014 to 31 Dec, 2019.
- Check if the time series is stationary, meaning that its mean, variance, and autocorrelation do not change over time. If the series is not stationary, we need to apply differencing or transformation to make it stationary. We can use plots and statistical tests to check for stationarity. For example, the Augmented Dickey-Fuller test is a common test for testing the null hypothesis of a unit root in the series.
- Identify the appropriate order of the ARIMA model by looking at the autocorrelation function (ACF) and the partial autocorrelation function (PACF) of the stationary series. The ACF measures the correlation between the series and its lagged values, while the PACF measures the correlation after removing the effect of previous lags. The order of the ARIMA model is denoted by (p,d,q), where p is the order of the autoregressive part, d is the degree of differencing, and q is the order of the moving average part.
- Estimate the parameters of the ARIMA model using a suitable estimation method, such as maximum likelihood or non-linear least squares. The estimated parameters should be statistically significant and conform to the assumptions of the model.
- Check the validity of the fitted model by examining the residuals (the difference between the observed and fitted values). The residuals should be independent, normally distributed, and have constant mean and variance. We can use plots and tests to check these assumptions. For example, the Ljung-Box test is a common test for testing the null hypothesis of no autocorrelation in the residuals.

- **Use the fitted model to forecast the future values of the series for a desired number of periods. Evaluate the accuracy of the forecasts by comparing them with the actual values (if available) or using some error measures, such as mean absolute error (MAE) or root mean square error (RMSE).**



ADF Statistic: -2.107576

p-value: 0.241479

Critical Values:

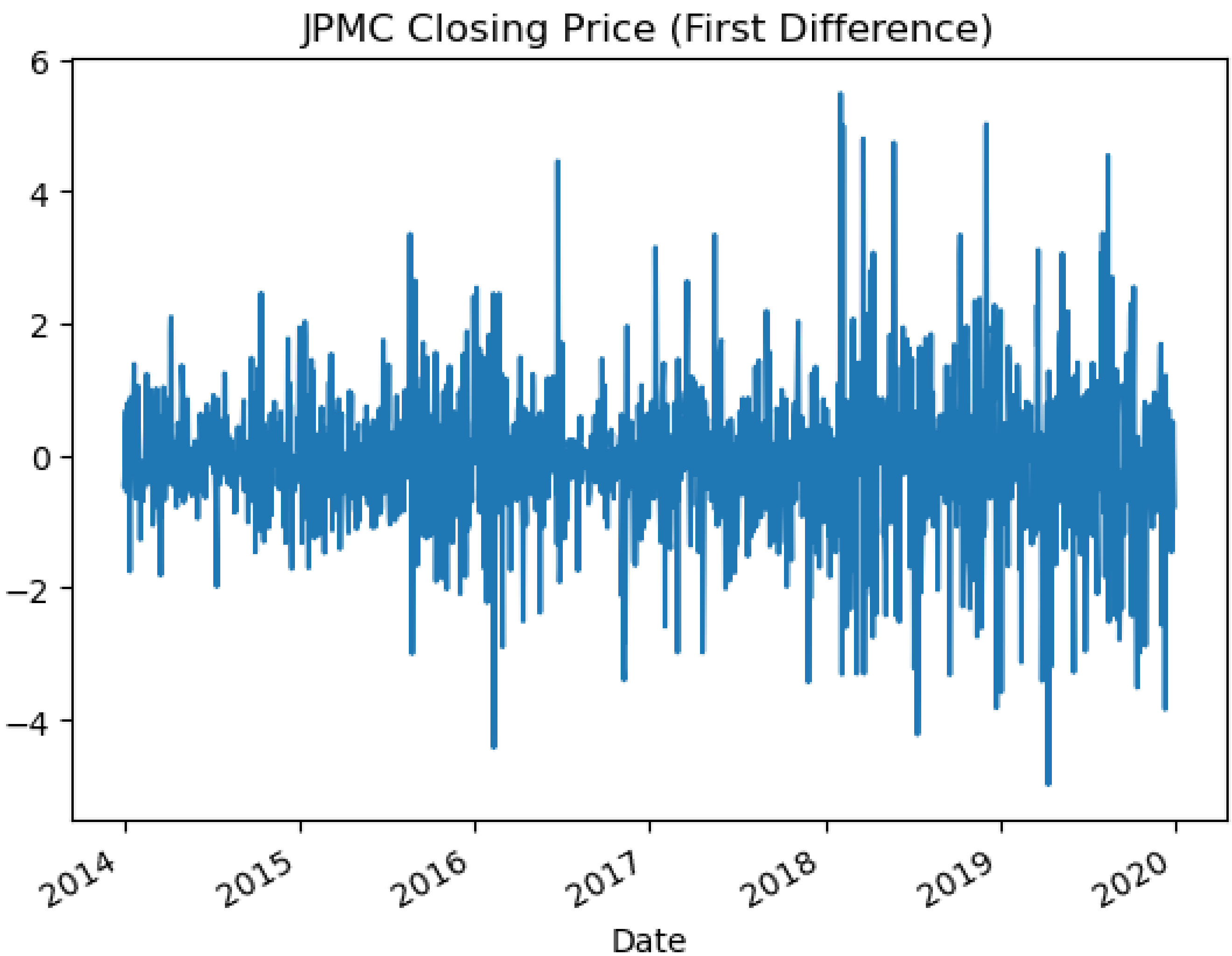
1%: -3.435

5%: -2.863

10%: -2.568

Interpretation

- **The p-value is greater than 0.05, so we cannot reject the null hypothesis of a unit root**
- **The ADF statistic is greater than the critical values, so we cannot reject the null hypothesis of a unit root**
- **The series is not stationary and has a unit root**
- **We need to apply differencing to make it stationary**



ADF Statistic: -38.937983

p-value: 0.000000

Critical Values:

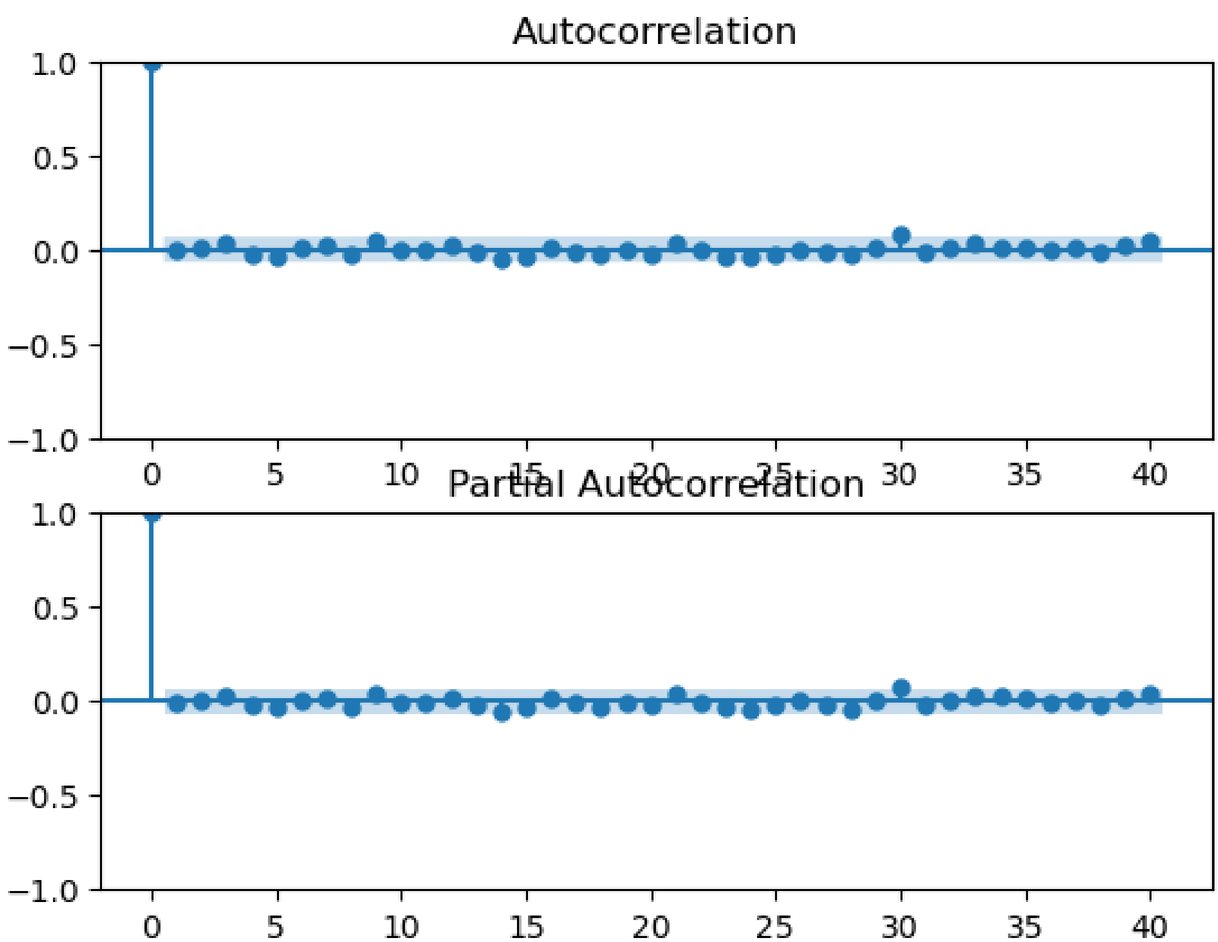
1%: -3.435

5%: -2.863

10%: -2.568

Interpretation

- The p-value is less than 0.05, so we can reject the null hypothesis of a unit root
- The ADF statistic is less than the critical values, so we can reject the null hypothesis of a unit root
- The differenced series is stationary and has no unit root
- The degree of differencing is d = 1



This means that there is no significant correlation between the series and its lagged values, except for lag 0, which is always 1 by definition.

This pattern suggests that the series may be white noise, which means that there is no autocorrelation or trend in the data. White noise is unpredictable and cannot be modeled by an ARIMA model.

However, to confirm if the series is white noise, we need to apply a more rigorous test than the ACF and PACF plots. One of the most common tests for white noise is the portmanteau test, which checks whether the autocorrelations of a time series are significantly different from zero up to a given lag. One of the most popular portmanteau tests for white noise is the Ljung-Box test.

The null hypothesis of the portmanteau test is that the time series is white noise, meaning that there is no autocorrelation or trend in the data. The alternative hypothesis is that the time series is not white noise, meaning that there is some autocorrelation or trend in the data.

If the p-value is less than a chosen significance level (e.g., 0.05), we reject the null hypothesis and conclude that the time series is not white noise. If the p-value is greater than or equal to the significance level, we fail to reject the null hypothesis and conclude that the time series is white noise.

Lag	Ljung-Box Statistic	p-value
1	0.0161	0.8990
2	0.0530	0.9738
3	1.1112	0.7744
4	2.1400	0.7100
5	4.2528	0.5136
6	4.3596	0.6281
7	4.7343	0.6924
8	5.9135	0.6569
9	9.1202	0.4263

10	9.1566	0.5173
11	9.2108	0.6024
12	9.7686	0.6363
13	10.2923	0.6699
14	14.7783	0.3935
15	16.7349	0.3350
16	16.9438	0.3892
17	17.5434	0.4182
18	18.5552	0.4197
19	18.5562	0.4856
20	19.3880	0.4967
21	21.0620	0.4552
22	21.1104	0.5139
23	22.9668	0.4627
24	25.1656	0.3968
25	26.0088	0.4071
26	26.0093	0.4626
27	26.6621	0.4821
28	28.2354	0.4520
29	28.2982	0.5020
30	37.4847	0.1634
31	38.1488	0.1763
32	38.3627	0.2032
33	39.9471	0.1888
34	40.2346	0.2136
35	40.2765	0.2481
36	40.3889	0.2825
37	40.5235	0.3176
38	40.9226	0.3434
39	41.6806	0.3550
40	44.2836	0.2957

The interpretation of this output is as follows:

The Ljung-Box statistic is a measure of the overall significance of the autocorrelations up to a given lag.
The p-value is the probability of obtaining a higher Ljung-Box statistic under the null hypothesis of white noise.
The null hypothesis of the portmanteau test is that the time series is white noise.
The alternative hypothesis is that the time series is not white noise.
If the p-value is less than a chosen significance level (e.g., 0 .05), we reject the null hypothesis and conclude that the time series is not white noise.
If the p-value is greater than or equal to the significance level, we fail to reject the null hypothesis and conclude that the time series is white noise.
In this case, all the p-values are greater than 0 .05, so we fail to reject the null hypothesis and conclude that the differenced series is white noise.

Concluded!