Predicting the Direction and Magnitude of Stock Market Fluctuations from Sentiment Scores of Financial News Articles

Bernard Wittmaack

Springboard Capstone 3

A better way to "read" financial news?

- Many financial news sources used by investors every day to understand the financial markets and make predictions.

- Difficult to read and ingest the myriad of articles coming out each day.

- Can the averaged sentiment of a group of articles be a good predictor of how the market will perform in the future?

Executive Summary

Calculate sentiment scores for article headlines and description data from three financial news sources (CNBC, Guardian, and Reuters) over a period between 2017-2020.
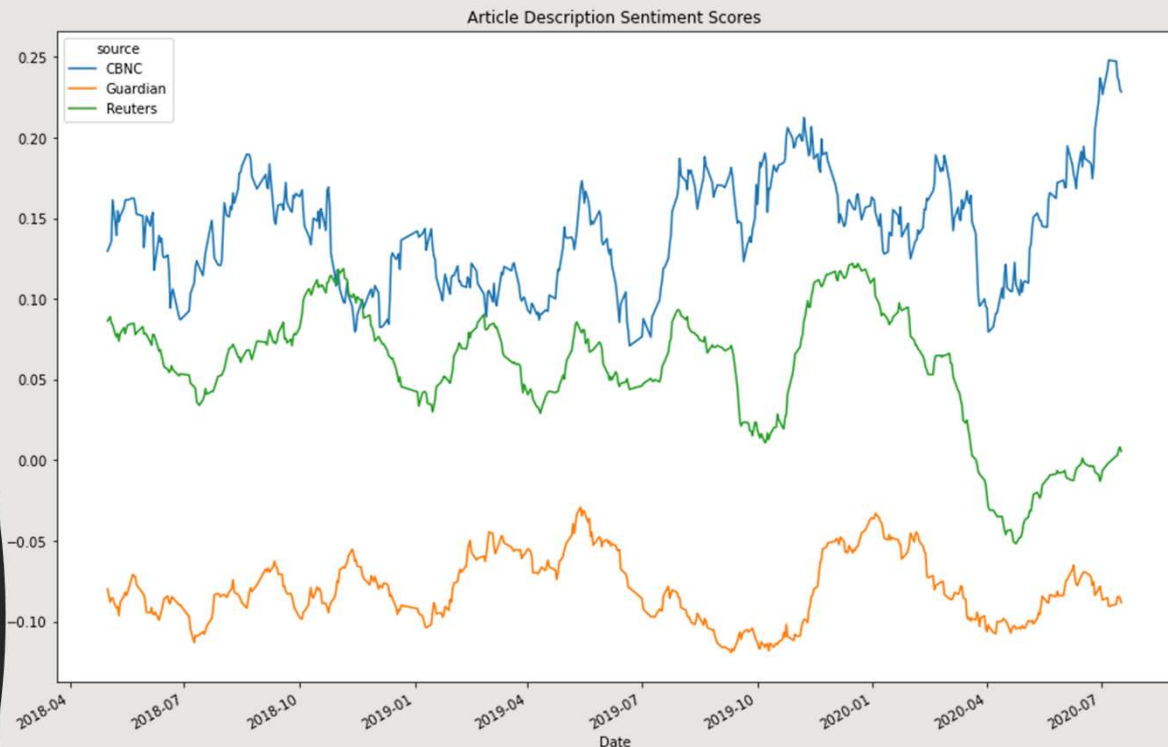
Found statistically significant correlation (corr=0.4) sentiment scores to changes in closing price of S&P 500 index 4 weeks ahead.

ARMA(2,3) time series fit to difference of sentiment scores and S&P 500 index fluctuations with 50% error rate compared to naïve forecast model.

Sentiment Scores for Each News Source

Article Description Sentiment Scores

- Clear difference in average sentiment between news sources calculated using NLTK VADER algorithm.

- CNBC has most positive average sentiment and the Guardian is the most negative.

- American news outlet CNBC has best correlation with S&P 500 index fluctuations.

Headline Scores
Offset = 4 weeks (corr=0.25)
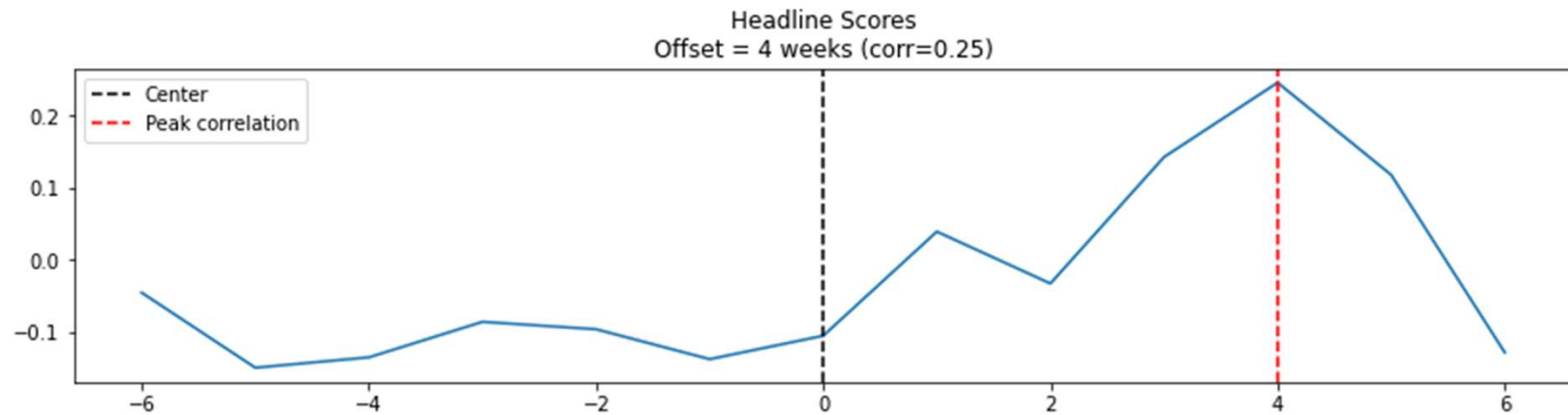
Can Article Sentiment Predict the Future?

- Best correlation between CNBC article description sentiment scores and index fluctuations for offset of 4 weeks.

- Statistically significant correlation of 0.25 for articles published today and index fluctuations 4 weeks ahead.
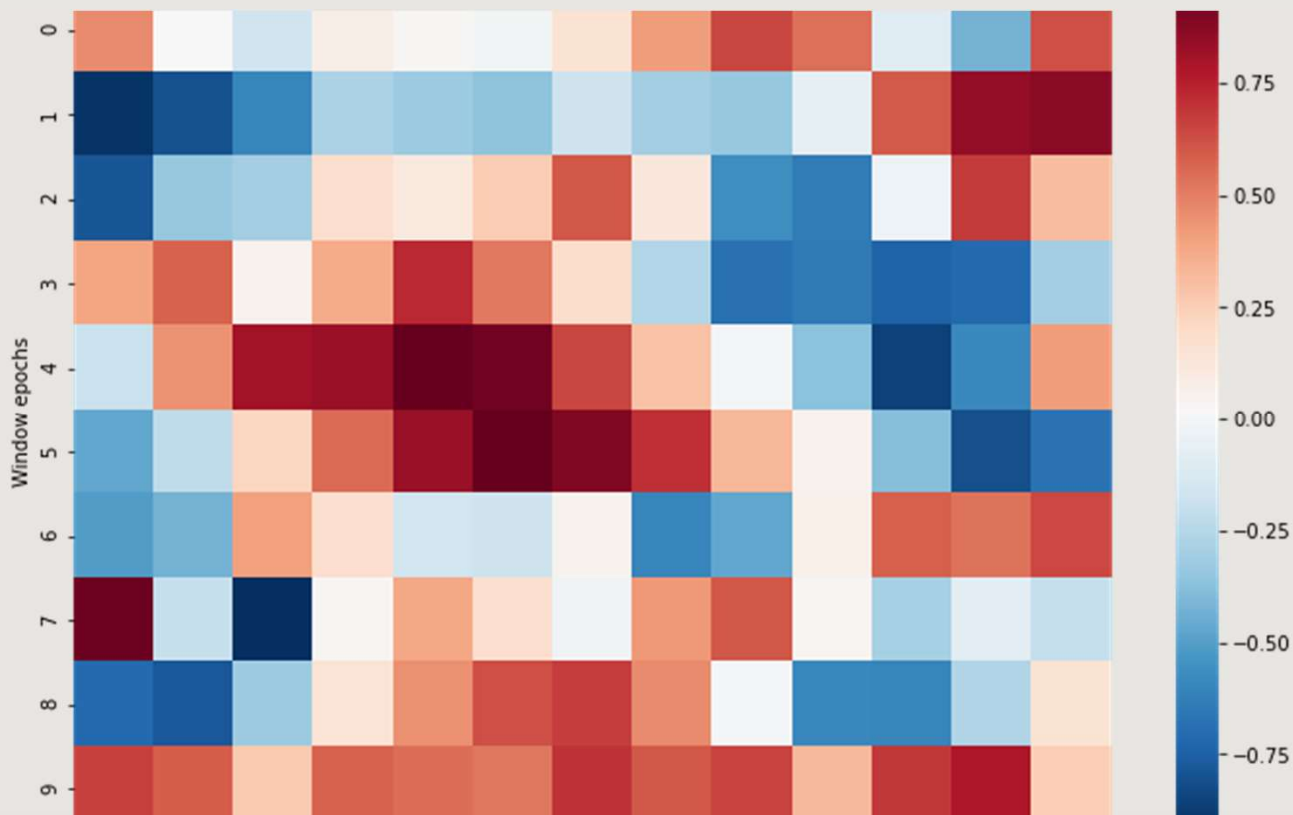
Correlation as function of Moving Average Window Size
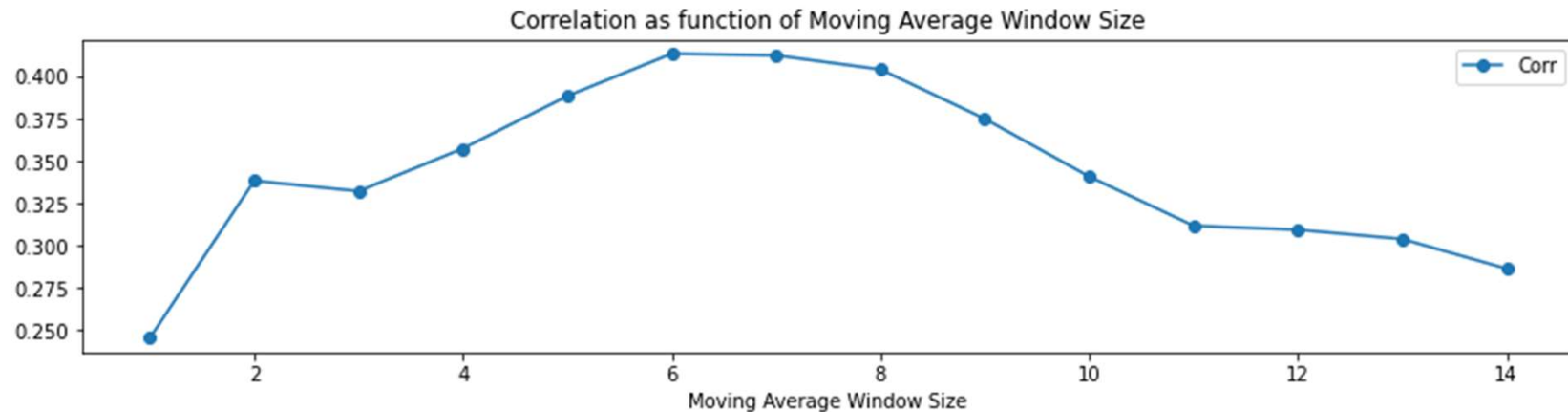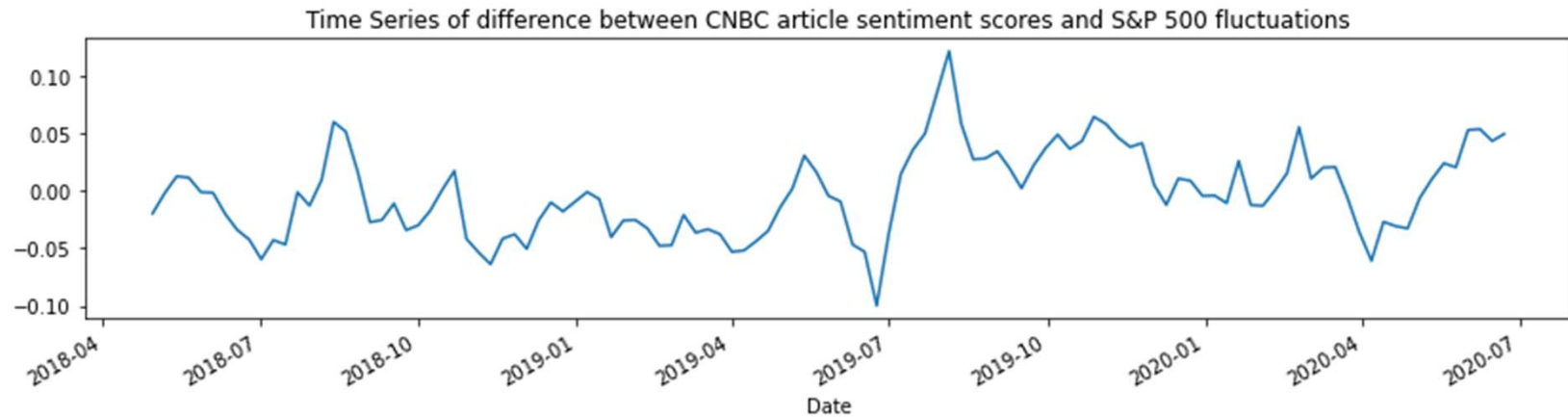
Moving Average Improves Correlation

- A moving average of 6-week window size improves statistically significant correlation almost two-fold to 0.41.

- Averaged data also more robust against outliers

Epoch Correlations

- The epochs show, by and large, a positive correlation between the moving averaged and offset S&P 500 changes and the CNBC article description sentiment scores

- Correlations fluctuate between positive and negative for non-optimal offsets across epochs.

Time Series of difference between CNBC article sentiment scores and S&P 500 fluctuations

Finding Patterns with Time Series

- Time series of difference between article description sentiment scores and index fluctuations (with MA and offset)

- Can we improve upon averaged correlation?

Time Series Properties

- Augmented Dickey-Fuller test suggests stationary time series.

- ACF and PACF correlograms indicate that an either an AR or ARMA model can be well fitted to the data.
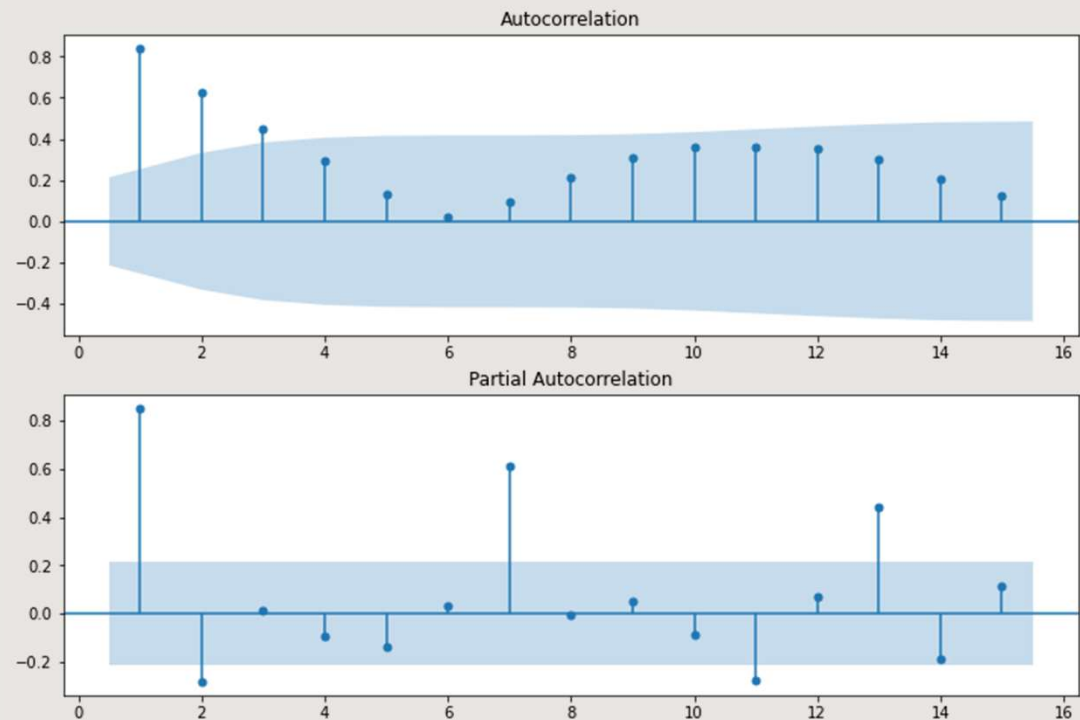
Finding the best ARMA model

p	r	q	AIC	BIC
2.0	0.0	3.0	-408.368233	-391.352515
2.0	0.0	0.0	-398.124524	-388.401257
1.0	0.0	1.0	-397.754265	-388.030998
1.0	0.0	0.0	-394.557851	-387.265401
2.0	0.0	1.0	-396.144480	-383.990396
3.0	0.0	0.0	-396.137147	-383.983063
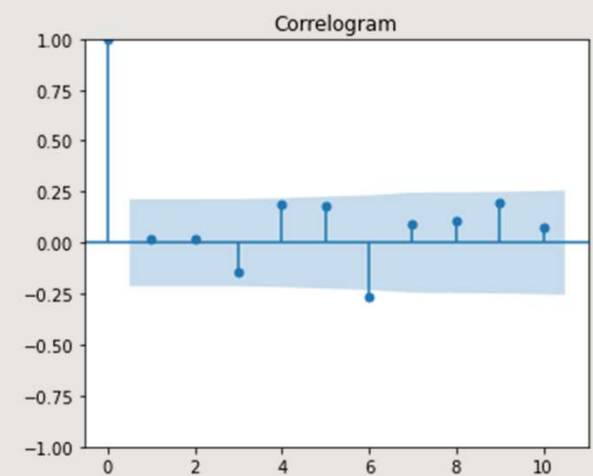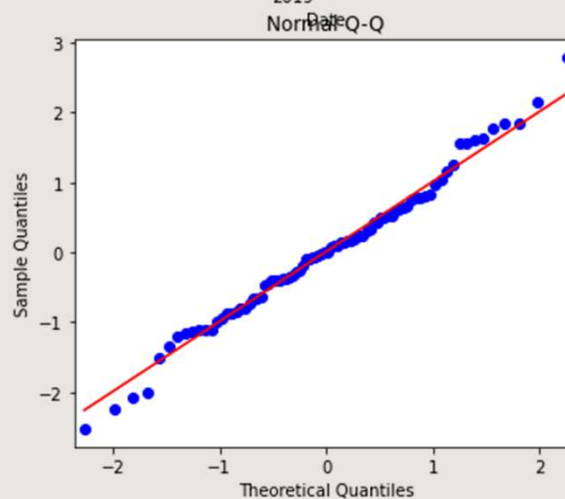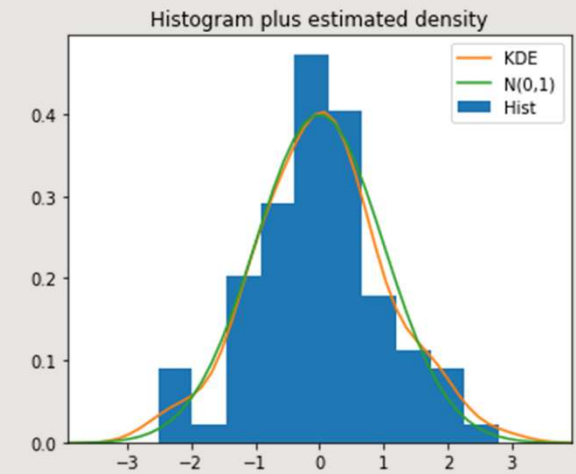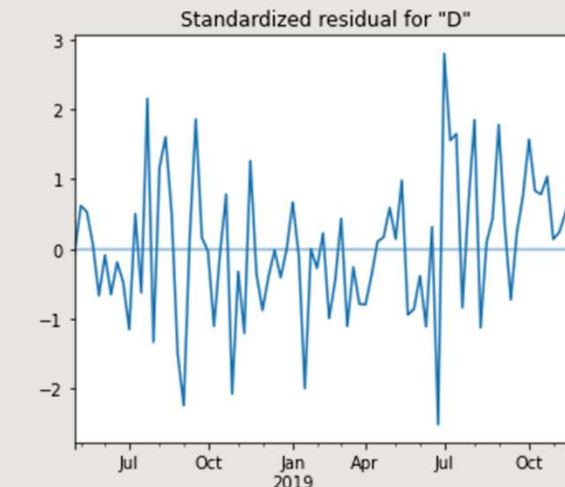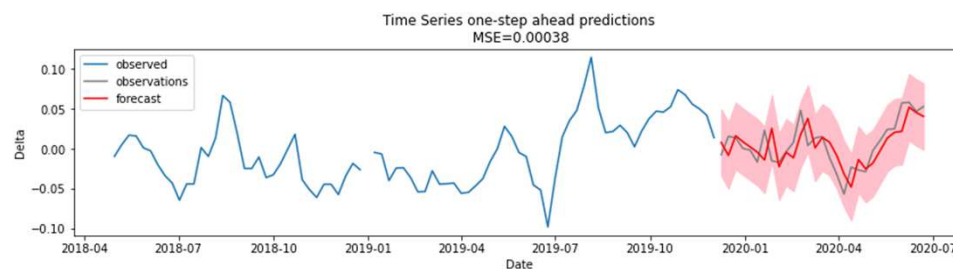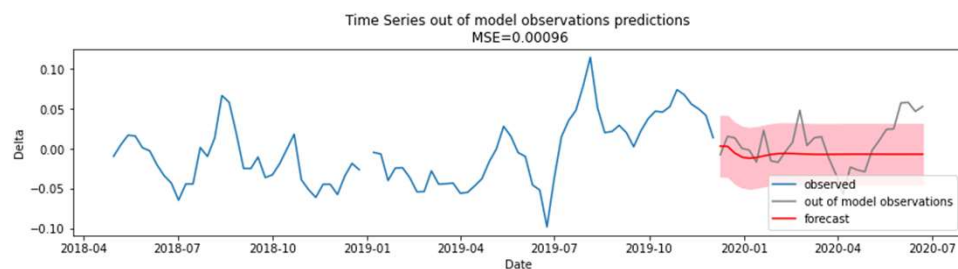
Forecasting

- Split time series into 75/25 training/test.
- Naïve forecast of using last training value yields MSE = 0.0008
- One-step ahead predictions gives best fit (MSE=0.0004) while dynamic fit yields largest error (MSE=0.0009)

Summary and Future Work

Statistically significant and moderately strong correlation between CNBC article sentiment scores and S&P 500 index fluctuations.

ARMA(2,3) model fit to further improve predicted correlations.

Improve results by fitting sentiment analyzer trained on financial textual data. Remove more stop-words.

More robust time series model comparison using windowed validations as opposed to a single split.

Fit new time series with each step.