**Bull Market or Bear Market: Recession Time Series Prediction for Q1 2024**

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**Author Note**

We have no known conflict of interest to disclose.

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**Literature Review**

***Background Information***

Building forecast models and financial tools to predict major market events such as recession periods, is highly lucrative. It’s not only beneficial to the public but more intently the business sectors, government, economist, financial professionals are keen to have predictive insight against approaching economic downturn. As quoted in Kiley 2023, the word “recession” becomes abundantly searched on the internet typically at the beginning of each prolonged downturn in economic activity. There is an apparent interest in a looming downturn to make better financial decisions. As expected, this search trend was captured during the start of the great recession which was influenced by the housing market crash in 2008 (Hudomiet et. al., 2011). This was then followed by the most recent COVID-19 recession which was the second steep decline in economic activity in the last 15 years.

Since then, there has been notable literary data derived from 42 recessions in 14 countries using quarterly periods that have high potential for correctly forecasting the next recession (Kroencke, 2022). It is said that stock prices dropped significantly at about 30% at the start of recession while dividends fell on average by 13% (Kroencke, 2022). Prices of stocks seem to fall further compared to real dividends during recession periods with the stock price variance behaving relatively the same as dividend growth variance (Kroencke, 2022). Another likely indicator of recession would be the timing of price-dividend ratio drop which happens in two quarters before recession ensues at around 5.6% (Kroencke, 2022). There’s also recession variance ratio to look at which is the “recession variance over the pre-recession variance” (Kroencke, 2022). For price changes, the recession variance ratio goes up 2.1-fold which is relatively similar to dividend growth at 1.7-fold (Kroencke, 2022). This bank of historic information can be used to help assess forecast models during exploratory data analysis to guide the direction of the model development and interpretation.

Currently, the US stock market is experiencing significant volatility in the last quarter of 2023. This is a perfect time to evaluate the many factors that influence prolonged market downturn such as financial markets, other investments, and current events to determine whether a recession will ensue. Through deeper understanding of the underlying characteristics of the markets and current environment across multiple dimensions, we may be able to leverage our growing knowledge of time series analysis to decompose price movements by price level, price trend, quarterly seasonality, and noise. The goal is to predict with sound data science principles where the US stock market will be by the end of the first quarter of 2024 to ultimately manage risk and build capital.

***Overview of Main Points***

Key components of the stock market include stock exchanges, such as the New York Stock Exchange (NYSE) and NASDAQ, and various financial instruments like equities and exchange-traded funds (ETFs). In this case we are looking at S&P500 ETF (SPY). Fluctuations of the market often occurred on a short-term basis. Therefore, we are looking at short-term time series methodology such as moving average, exponential smoothing, and ARIMA to achieve our goal. Exploratory data analysis will be guided by gathered historical data and empirical data will be used to determine external factor predictors for the forecasting model. Throughout the ADS506 course, other methodology would be included in our analysis.

The stock market is subject to a vast and virtually limitless array of external factors that can impact its performance. Having this large complexity and limited domain knowledge, identifying time series models and forecasts for this module would be a challenge.

***Key Findings***

Preliminary EDA findings include the time series of SPDR S&P 500 ETF’s stock price exhibiting non-stationarity over the period of six months from May 2023 to November 2023 using the Augmented Dickey-Fuller test statistic method. Upon applying decomposition on the data, the trend and seasonality needs to be considered before feeding into the model’s like ARIMA that assumes lack of trend and seasonality. For advanced exponential smoothing, RMSE has better value compared to Simple Smoothing methodology.

Amazon was also explored at a 5-year span. The original closing price time series fluctuates between $60 to $190. There was a rising trend from 2020 to mid 2021 followed by a downward trend up to 2023’s comeback upward trend. The application of LOESS (Locally Estimated Scatterplot Smoothing) decomposition revealed a 5 year downward concave trend with undetectable seasonality when residual is factored. Anomaly detection to account for noise factor will be applied to residuals and evaluated followed by model fitting and forecasting.

**References**

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