S&P 500 Recent Statistical Performance Analysis

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Abstract

We statistically analyzed the weekly price of the U.S. S&P 500 Index for the recent decade. The objective of this assignment is to revisit the performance of the S&P 500 ETF for a decade to capture the history under changing market circumstances including externalities (if any) besides normal market dynamics. Furthermore, we reassessed 3 ETFs in the same time period under similar circumstances and compared their performances. This project covers the performance of S&P 500 after the 2008 Global Financial Crisis (GFC). Therefore, this project is designed to fill the gap and assist investors to make informed decisions.

Keywords: *ADF, First Order Serial Autocorrelation, Regime Switching, EDA*

Introduction / Literature Review

Mitchell and Burns (1937) published literature in the research topic of business cycle statistical indicators [1]. This is one of the pioneering works in analyzing business cycle indicators. Since that time, a lot of work has been done in the primary research area of business cycle analysis. Numerous studies have found that a wide range of economic and financial characteristics can provide insight into potential future economic recessions. For the purpose of analyzing recessions, Kajal and Moore (1991) constructed leading economic indicators [2]. Hao and Ng (2011) investigated how well different financial and macroeconomic indicators in predicting Canadian recessions. Several advanced dynamics, autoregressive, dynamic

autoregressive, and static probit models were all evaluated together with the traditional static probit model [3]. Recent research conducted by Huang et al. (2018) illustrated the predictive potential of news sentiment analysis on the U.S. economy. They built a metric that functions as a leading indicator in recession analyzing models through topic modeling algorithms and sentiment scoring techniques [4]. Researchers seek prominent approaches such as ML and Deep Learning algorithms in order to improve efficacy and accuracy [5].

Background / Data

Statistically, we are revisiting the S&P 500 performance of recent years. Our study on the S&P 500 performance shows the adjusted closing price for the past decade starting in October 2012. We aim to capture some rare events and their impact over the S&P 500. There are two points worth noting: First, is the symmetry, spreading, distributions, and inherited features. Second, the effect due to rare events. For instance, COVID-19 and the Russian attack on Ukraine. From a regime switching perspective, COVID-19 has the most significant impact for any market.

We chose to use an adjusted closing price. The adjusted closing price took stock splitting, offering, and dividends declared into the consideration. Therefore, it shows market sentiment of the trading day/week. An ETF is distinct from the S&P 500 index in many ways. Firstly, it weighs 80% of the stock market capital in the U.S. with the size of around 33.8 trillion USD in December 2022. Therefore, it reflects the U.S. economy to a reasonable extent. Our research focuses on the S&P 500 data from October 2012 to September 2022. We also considered three other ETFs weekly returns in our research: Vanguard Real Estate Index Fund ETF – VNQ, Energy sector SPDR - XLE, and Finance Sector SPDR – XLF.

Methodology

We used a Jupyter notebook in the python programming language. We have installed all relevant libraries in the notebook. Then, we imported the S&P 500, VNQ, XLE, and XLF adjusted close price data. We imported Yahoo Finance with the appropriate API Key. We then downloaded a data series into our Jupyter notebook. We aligned the adjusted close price data from the daily to a weekly and calculated the weekly returns for all ETFs. We visualized the data above

through Exploratory Data Analysis (EDA), such as Box-plot (outliers detection), Density-plot, and QQ-plot (normal distribution tracing).

We conducted data summaries to figure out the asymmetry and outliers of the data. From that point, we measured the median and checked if the distribution is symmetric. We also calculated standard deviation, trimmed-mean, and Interquartile range (IQR). We compared them to detect outliers besides Skewness and Kurtosis in order to figure out the degree of asymmetry and tailing pattern of the distribution. Next, we decided to apply bootstrapping to estimate standard error and confidence interval. We conducted a Jarque-Bera test to check sample data Skewness and Kurtosis in terms of normal distribution [6]. We attempted the Augmented Dickey-Fuller (ADF) test to analyze the stationarity of the series. After applying the Markov Regime Switch approach, we detected a regime shift. We are going to apply traditional statistical methods and hyper technical approaches such as Machine Learning and Deep Learning.

Discussion

Our main objective for this project is to conduct an extensive study on the S&P 500 performances for a decade ending October 2022. Since our research is conducted upon almost 10 years of data, we expect to see some notable events and their impact on the financial market, especially during the period of the COVID-19 pandemic and Russia-Ukraine conflict. We expect there will be changes in the data series due to these events.

In the area of regime shift study, we plan to capture the impacts of these rare events as well. We have compared these notable ETF movements, volatility, and correlation. We plan to reveal the statistical features of the S&P 500 in the recent decade, such as its distribution, volatility, and diversification compared to other ETFs.

Conclusion

In summary, our project is focused on the S&P 500 performance analysis of the past decade. This should help investors make informed decisions. The same methodology can be applied to alternative ETFs at different time periods with different matrices.

Our code repo can be viewed through the following link:
https://github.com/krishxx/wqumscfin/blob/main/src/MScFE_Capstone.ipynb

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