

Software Demonstration Project

Fall 2022 BA 422: Financial Data Analytics and Econometrics

Full Points: 100

Final report is due or before 11/29 at midnight.

Background: *To learn finance, we must practice the skills taught and apply those skills to real-world problems. This Project is an important part of learning. There is a Chinese proverb: “Tell me, I’ll forget. Show me, I’ll remember. Involve me, I’ll understand”. The Project involves you implementing the most concepts covered in the class through real-world application.*

Finance is computational and often involves analysis and visualization of complex data, optimization, simulation, and data for risk management. Without the proper use of technology, it is almost impossible to analyze modern finance functions, especially within a time-efficient manner that accommodates modernity. Moreover, the field of finance has become far more data and technology-driven since the early to mid-1990s. Availability of financial data and technology have made large-scale data analysis a norm in any financial analysis. Data-driven decision-making and predictive modeling are becoming at the heart of every strategic financial decision making. As data availability continues to expand, data analysis tools such as Excel fall short in their ability to handle large data sets or offer easy tools for a higher level of statistical analysis of financial data. While a wide range of software is available for modeling and analyzing financial data, we choose R software to do this Project.

Instructions and Grading: This Project must be done in a group of 2. It cannot be done individually. Please reach out to your friend to make your own group. As this Project is challenging choose your group member smartly. The final submission should include one-word file and R Codes. **You must answer all questions in your final word file and use r software to get passing grade.** *Each final report will be assessed based on whether all questions are answered or not, whether every aspect of the question is answered or not, whether it includes charts, graphs or tables required to answer each question, overall organization and writing of report and proper documentation of the outside resources used. Everyone in the group will get the same points regardless of the effort put by each group member unless one gets bad review from other group member.*

Answer the following Questions as thoroughly as you can:

Q1. Graphical Analysis of Fundamental Data (10 points):

- a. Download Apple's annual net income, total assets, and revenues from December 2009, to December 2020 to a csv file from any online source. Then, plot its returns on assets and revenue growth over the period December 2009 to December 2020 on separate graphs, and briefly explain your observations.
- b. Download the annual revenues of Apple, Facebook, Walmart, and Bank of America over the period March 1, 2009, to August 31, 2021 to a csv file from any online data source. Plot revenue growth of these four companies and briefly explain your observations.

Q2. Graphical Performance Overview of Different Stocks (10 points): Please download monthly adjusted close prices of 3 stocks: Netflix Inc (NFLX), Amazon.com, Inc. (AMZN) and NVIDIA Corporation (NVDA) over the period March 1, 2009 to August 31, 2021. Make the following two types of graphs and interpret your results.

- i. First plot showing normalized historical prices (historical prices divided by the price at the beginning) for all stocks.
- ii. Second plot showing cumulative returns for all stocks.

If you invested \$10,000 in each ETF in March 2009, how much would the investment be worth in August 2020?

Q3. Statistical Performance Analysis of Multiple Stocks (10 points): Compute descriptive statistics such as holding period return, arithmetic mean, geometric mean, cumulative return, standard deviation, minimum return, maximum return, skewness, kurtosis, value at risk (VaR) and conditional VaR (CVaR)) for three stocks (Netflix Inc (NFLX), Apple Inc. (AAPL) and Microsoft Corporation (MSFT)) using continuously compounded monthly returns over the period March 1, 2009, to August 31, 2020. Explain your results.

Q4. CAPM and Other Factor Models (20 points): CAPM and other factor models are widely applied in the practice of investment management. They simplify portfolio optimization problem and are used in construction and evaluation of active portfolio management strategies. They are also used in portfolio performance attribution and stress testing.

Therefore, understanding these models is very important for any serious student of asset management. In order to help you understand these models, please, do the following.

- a. Please download the monthly adjusted close price for the following companies from yahoo finance: Apple Inc. (AAPL), Microsoft Corporation (MSFT), Wal-Mart Stores Inc. (WMT), Target Corp. (TGT), Wells Fargo & Company (WFC), JPMorgan Chase & Co. (JPM), American Airlines Group Inc (AAL), Boeing Co (BA), Exxon Mobil Corporation (XOM) and Chevron Corporation (CVX). Please make sure that the start date is January 1, 2010, and the end date is October 1, 2021. Compute monthly log returns. Also, download monthly data for the three-factor model from Prof. Ken French's website. Please choose CSV file next to "Fama/French 3 Factors"- the first one in the list. Combine all these data in one excel file. Use this data set to answer the following questions.
 - i. Estimate the CAPM model $r_i - r_{rf} = \alpha + \beta(r_m - r_{rf})$ for each stock and summarize your results in a table. Your table must include alphas, betas, their p-values, and the adjusted R-square. If you were to make a very defensive portfolio choosing only five stocks, which stocks would you choose and why?
 - ii. Estimate Fama-French three-factor model for each stock using the three-factor model: $r_i - r_{rf} = \alpha + \beta_m(r_m - r_{rf}) + \beta_{HML}HML + \beta_{SML}SML$ and summarize your results in a table. Your table must include alphas, betas, their p-values, and the adjusted R-square. Does your result show that the Fama-French three-factor model is better than the CAPM in explaining the variation in explaining stock returns?
- Q5. Portfolio Optimization (20 points):** Markowitz portfolio theory is one of the most important concepts in modern finance. It essentially quantifies the conventional wisdom of "not putting all your eggs in one basket". In practice, the Markowitz framework has been applied in portfolio construction in two ways. First, it is used to make an asset allocation decision at the asset class level. Second, it is also used to select the securities in a portfolio within an asset class. In this question, you are trying to understand Markowitz's framework of investment analysis.

Please download the monthly adjusted close price for the following companies from yahoo finance: Apple Inc. (AAPL), Microsoft Corporation (MSFT), Wal-Mart Stores Inc. (WMT), Target Corp. (TGT), Wells Fargo & Company (WFC), JPMorgan Chase & Co.

(JPM), American Airlines Group Inc (AAL), Boeing Co (BA), Exxon Mobil Corporation (XOM) and Chevron Corporation (CVX). Please make sure that the start date is January 1, 2010, and the end date is October 1, 2021. Then, compute continuously compounded returns and select five companies in different sectors from the list to answer the following questions.

- a. Compute and plot all pair-wise scatterplots between 5 assets and briefly comment on any relationships you see.
- b. Compute the sample correlation matrix of the returns on your five assets. Which assets are most highly correlated? Which are least correlated?
- c. Compute the mean and variance of an equally weighted portfolio of these five stocks.
- d. Compute the global minimum variance portfolio and calculate the expected return and SD of this portfolio. Are there any negative weights in the global minimum variance portfolio?
- e. Compute the tangency portfolio using a risk-free monthly rate equal to 0.0004167 per month. Graph the weights of the five assets in this portfolio. In the tangency portfolio, are any of the weights negative?
- f. Compute the expected return, variance, and Sharp Ratio of the tangency portfolio.
- g. Using the mean and variance of the tangency portfolio, compute 1% and 5% value-at-risk and interpret your results.

Q6. Technical Analysis of Stocks (10 points): As you know technical analysis is the use of charts to study stock price and volume data for the purpose of forecasting future trends. There are three board groups of technical indicators: trend indicator, volatility indicator and momentum indicator. You are going to make you familiar with each of these indicators in this problem. Using the daily adjusted close prices of the Invesco QQQ Trust (QQQ) from December 31, 2016 to October 31, 2021, answer the following questions.

- a. *Examine buying and selling signals using the simple moving average crossover.* Plot and the both 50-day and 200-day moving-averages together. If the 50-day moving average cross above the 200-day moving average, this may be taken as an indicator to buy the stock.

Conversely, if the 50-day moving average crosses below the 200-day moving average, this may be taken as an indication to sell the stock. If you follow the above criteria to determine the buy-sell strategy: when would you buy and when would you sell? Specify approximate dates.

- b. *Examine buying and selling signals using Bollinger bands.* The Bollinger Bands have three components. The first component is a 20-day simple moving average (SMA). The second component is an upper band, which is two standard deviations above the 20-day SMA. The third component is a lower band, which is two standard deviations below the 20-day SMA. Bollinger Bands are considered as volatility indicators. Please compute the Bollinger bands for QQQ stock and plot the Bollinger bands together with the stock price.

For a trend follower, when QQQ's stock price is right around the upper band, this may be taken as an indication that the stock is overbought. Conversely, when QQQ's stock price moved right around the lower band, this may be taken as an indication that the stock is oversold. Based on this criterion, specify approximate dates when the stock was overbought and when the stock was oversold during the period of study?

- c. *Examine buying and selling signals using the Relative Strength Index (RSI).* The RSI is calculated as: $RSI = 100 - 100/RS^*$, where $RS^* = \text{Average of } x \text{ days' up closes} / \text{Average of } x \text{ days' down closes}$. In a typical calculation $x=14$ days. The RSI is used in conjunction with an overbought line and an oversold line. The overbought line is typically set at a level of 70 and the oversold line is typically set at a level of 30. Calculate QQQ's stock RSI and plot it.

A buy signal is created when the RSI rises from below the oversold line and crosses the oversold line. Conversely, a sell signal is created when the RSI falls from above the overbought line and crosses the overbought line. Based on this criterion, specify approximate dates when the stock was overbought and when the stock was oversold during the period of study?

- Q7. Stock Screening (10 points):** Stock screening refers to searches through a large amount of stock data and return of a list of stocks that match one or more selection criteria. Equity investment managers use stock screens to rank stocks in the investment universe according to one or multiple criteria in such a way that it makes it possible to differentiate between desirable and undesirable investments. These criteria are often based on the factors

investment managers consider important for portfolio performance. Please download daily historical close price of all stocks included in NASDAQ 100 for the last five years from September 1, 2016 to September 15, 2021. Using this data, answer the following questions.

- a. Make a table that shows five stocks that yielded the highest holding period returns during the last five years and their holding period returns.
- b. Make a table that includes five stocks that are close to five-year low price, five stocks that are close to five-year high price, and five stocks that are close to 200 day moving average prices.

Q8. Fund Screening and Performance Analysis (10 points): Practitioners typically evaluate fund performance by comparing their returns to benchmark indices such as the S&P 500 for large-cap stocks and the Russell 2000 for small-cap stocks. In contrast, academics use CAPM, the Carhart four-factor model and the Fama-French (FF) five-factor model as the standard benchmarks. This question attempts to familiarize you with measures that are commonly used to evaluate portfolio performance. You should compare the performance of the following mutual funds against the bench mark ETF SPY (SPDR S&P 500 ETF). using last five years of monthly data ().

Download monthly adjusted close price of SPDR S&P 500 ETF (SPY) Alliance Bernstein Growth (AGRYX), Ariel Appreciation (CAAPX), Buffalo Small Cap (BUFSX), Fidelity Magellan (FMAGX), Goldman Sachs Mid Value (GCMAX), Janus Twenty (JAVLX), Wells Fargo Small Cap Opp (NVSOX), JPMorgan Small Growth (PGSGX), T. Rowe Price Dividend Growth (PRDGX), Putnam Small Cap Value (PSLAX), and Vanguard Selected Value (VASVX) from October 1, 2016 to October 1, 2021 and compute the following performance measures for each of these funds using SPY as a market index and 0.0016 monthly risk-free rate. Based on the measures of performance summarized in the following table, answer the following questions.

- a. Identify three mutual funds with highest cumulative returns.
- b. Identify three mutual fund with highest Sharpe ratios.
- c. Identify three mutual find with highest information ratio.
- d. Identify three mutual find with highest Historical 95% CVaR.

SN	Measures	SPY	AGRYX	CAAPX	VASVX
1.	Arithmetic Mean					
2.	Standard Deviation					
3.	Geometric Mean					
4.	Cumulative Return					
5.	Sample skewness					
6.	Excess Kurtosis					
7.	Sharpe Ratio					
8.	Adjusted Sharpe Ration					
9.	Information Ratio					
10.	Adjusted Information Ratio					
11.	Sortino Ratio					
12.	Continuous Drawdown					
13.	Pure Downside Risk					
14.	Historical 95% VaR					
15.	Normal 95% VaR					
16.	Historical 95% CVaR					
17.	Normal 95% CVaR					

Note:

- Start with my article Adhikari, R. (2020), “Foundations of Computational Finance”, *The Mathematica Journal*, Vol 22. Available here: <https://doi.org/10.3888/tmj.22-2>
- For reference, please check two sites that I like. (a) <https://www.portfoliovisualizer.com/> and (b) <https://finviz.com/>
- Complete peer evaluation form before the due date and upload it to the canvas. It should be confidential.

Good Luck!

Peer Evaluation Form for Group Project

This will be confidential. Fill out and give it me.

Your name _____

Write the name of each of your group members in a separate column. In the space below, honestly evaluate the work of other students in your group by using a scale of 1-4 (1=strongly disagree; 2=disagree; 3=agree; 4=strongly agree). Total the numbers in each column.

Evaluation Criteria	Group member 1:	Group member 2:
• did fair share of work		
• was cooperative and supportive.		
• contributed significantly to overall project success		
• helped me learn		
• Would like to work with this person again.		
TOTALS		
• Rank this person's performance in the group		

Any other comments: