North South University

Group Report (Part-02) on "Portfolio Optimization on USA Auto Manufacturing Industry"

Course Title : **Investment Theory**

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INTRODUCTION

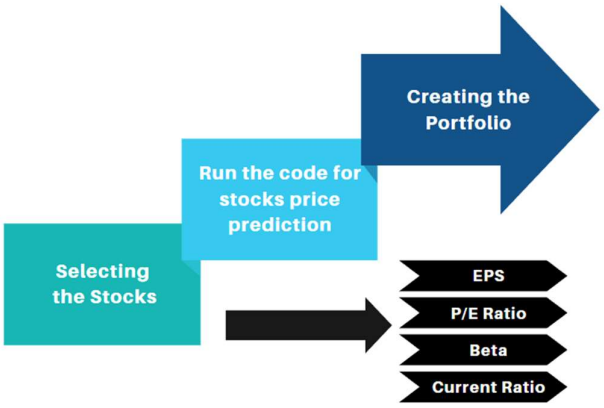
The primary objective of this project is to implement portfolio optimization strategies to maximize profits by investing in selected stocks within a specified time frame. As the previous Portfolio Optimization on DSE stock market is not profitable to invest, so that we are decided to invest in NASDAQ stock in US market. The project focuses on three stocks from the auto manufacturing industry: Federal Signal Corporation (FSS), Ford Motor Company (F), and General Motors Company (GM).

Given the volatile market conditions, the project considers investing in these stocks on March 15th, 2023, and selling them after 70 days, approximately on June 30th, 2023. The project aims to optimize the portfolio by analyzing financial indicators such as P/E, EPS, Beta and current ratio, along with considering the direction of stock price movements and predicted prices at specific time points.

To gather comprehensive data for this research, both primary and secondary data sources are utilized. Primary data is collected from Yahoo Finance, while secondary data is obtained from various web pages and articles, such as macrotrend.net. To assess the effectiveness of the portfolio optimization strategies, a comparison between predicted and actual stock prices is conducted.

The overarching goal of this research is to develop an effective portfolio tailored to a specific time period, adhering to financial benchmarks. The project employs LSTM (Long Short-Term Memory) models for price prediction, ensuring a data-driven approach to portfolio optimization.

METHODOLOGY



In the Portfolio Optimization project aims to identifying and invest in three stocks from the same industry (Information Technology Industry) that exhibit strong financial indicators, such as EPS, P/E Ratio, Beta, and Current Ratio. The project utilizes LSTM (Long Short-Term Memory) models to predict the future prices of these selected stocks. These predicted prices are then used to construct a portfolio, optimizing the allocation of funds among the stocks based on their anticipated performance. The performance of the portfolio is evaluated using financial metrics such as return on investment (ROI) and risk-adjusted return.

The research methodology involves gathering primary data from finance.yahoo.com and secondary data from various web pages and articles, as cited in the reference section. The financial indicators of the stocks are analyzed to identify the most promising candidates for investment. The LSTM models are trained on historical price data to predict future price movements. The predicted prices are then incorporated into a portfolio optimization algorithm to determine the optimal allocation of funds among the stocks. Finally, the performance of the portfolio is evaluated using financial benchmarks.

INDUSTRY BACKGROUND

Federal Signal Corporation (FSS): Federal Signal Corporation, based in Oak Brook, Illinois, is a prominent American manufacturer specializing in safety and environmental solutions. Established in 1901 as the Federal Electric Company in Chicago, it initially focused on incandescent lamp-lit store signs. Over the years, the company evolved to become a key player in the production of emergency vehicle equipment, street sweeper vehicles, and public safety systems. Operating through two groups, Federal Signal Environmental Solutions and Federal Signal Safety and Security Systems, the company manufactures a diverse range of products, including street sweepers, emergency sirens, and alarm systems.

With a history dating back over a century, Federal Signal became a corporation in 1955 and went public in 1961. The company's contributions to public safety include iconic products like the Thunderbolt series of outdoor warning sirens. Federal Signal has expanded globally with manufacturing facilities in five countries and strategic acquisitions, including P.C.S. Company, Joe Johnson Equipment, Truck Bodies and Equipment International, and most recently, Blasters, Inc. The company's commitment to innovation and growth underscores its position as a leader in the industry, providing essential solutions for emergency and environmental services.

Ford Motor Company (F): Ford Motor Company, an iconic American multinational automobile manufacturer headquartered in Dearborn, Michigan, was founded by Henry Ford on June 16, 1903. Renowned for revolutionizing the automotive industry, Ford introduced large-scale manufacturing and pioneered industrial workforce management through moving assembly lines—methods globally recognized as Fordism by 1914. The company sells vehicles under the Ford and Lincoln brands and holds a 32% stake in China's Jiangling Motors. With joint ventures in China, Taiwan, Thailand, and Turkey, Ford is listed on the New York Stock Exchange and remains predominantly controlled by the Ford family.

As the second-largest U.S.-based automaker and the sixth-largest globally, Ford has a significant presence, producing 5.532 million automobiles in 2008 with a workforce of around 213,000 employees. Despite financial struggles during the 2007–08 financial crisis, Ford rebounded without federal assistance. Notably, the company discontinued the Mercury brand

in 2011. With a legacy dating back to Henry Ford's vision, the company's continuous family control for over a century underscores its position as one of the world's largest family-controlled entities, playing a pivotal role in making automobiles accessible to the middle class.

General Motors Company (GM): General Motors Company (GM), headquartered in Detroit, Michigan, is a renowned American multinational automotive manufacturing giant, recognized for its core automobile brands—Chevrolet, GMC, Cadillac, and Buick. Once the largest global automaker for 77 years, GM remains a powerhouse, ranking as the top automaker in the United States by sales in 2022. Operating manufacturing plants in eight countries, GM extends its influence beyond its core brands to include Chinese interests in Baojun and Wuling, ownership of BrightDrop for delivery vehicles, a defense vehicles division, OnStar for safety and information services, ACDelco for auto parts, and majority ownership in self-driving cars enterprise Cruise LLC.

Founded in 1908 by William C. Durant, GM evolved from a holding company for Buick, becoming an automotive behemoth through strategic acquisitions in the early 20th century. Following a Chapter 11 reorganization in 2009, GM emerged stronger, presently ranking 25th on the Fortune 500. The company is aggressively advancing toward a sustainable future, with plans to cease production and sales of internal combustion engine vehicles by 2035, aiming for carbon neutrality by 2040. With a rich history and a commitment to innovation, General Motors continues to shape the automotive landscape globally.

RATIO ANALYSIS

Ratio analysis plays a crucial role in evaluating the financial health and performance of a company, providing valuable insights for selecting stocks with the potential for growth and profitability. In this context, we focus on four key financial ratios (EPS, P/E Ratio, Beta, and Current Ratio) for the period of January to June 2023:

Industry Name	EPS	P/E Ratio	Beta	Current Ratio
Federal Signal Corporation (FSS)	2.38	29.41	1.04	2.30
Ford Motor Company (F)	1.53	6.80	1.69	1.21
General Motors Company (GM)	7.12	3.96	1.49	1.38

Note: In the auto manufacturing industry in USA, the historical P/E Ratio average in 2023 is 29.6, Beta is 1.47, and the Current Ratios, and EPS are good for every stock compared to the US auto manufacturing industry, which indicates that investing those stocks are getting the higher return.

STOCK SELECTION

Stock selection is a critical step in the portfolio optimization process, as it involves identifying stocks that exhibit strong financial performance and hold the potential for future growth and profitability. In this project, we consider two key aspects for stock selection:

- Historical background / theoretical background
- Ratio Analysis

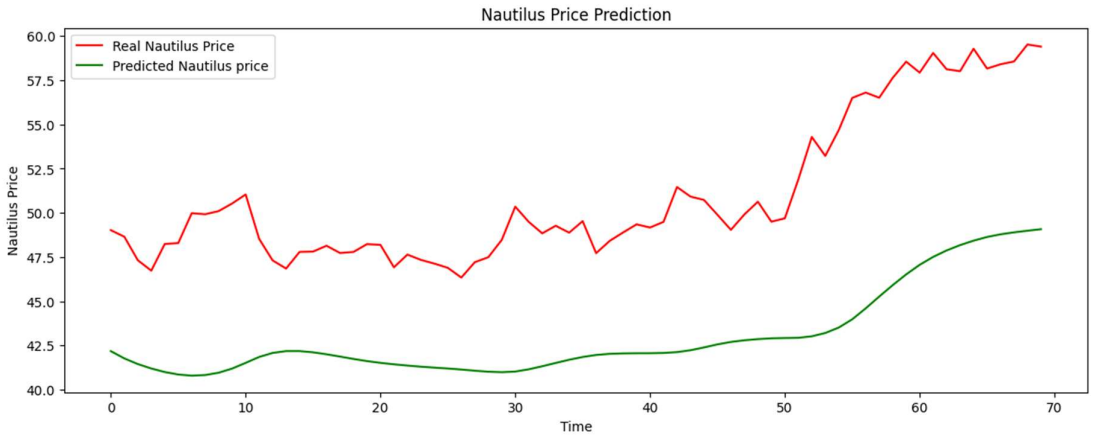
In the auto manufacturing industry, we select all these stocks because - everyone's EPS is increasing which is a good sign for investment. F and GM's P/E Ratio is not in the range of average industry P/E ratio, but FSS is in it. The Current Ratio of F and GM is good. The reason for selecting those stocks are those company's historical background and ratio analysis indicates that those stocks are getting the higher profit margin.

FORECASTING ACCURACY

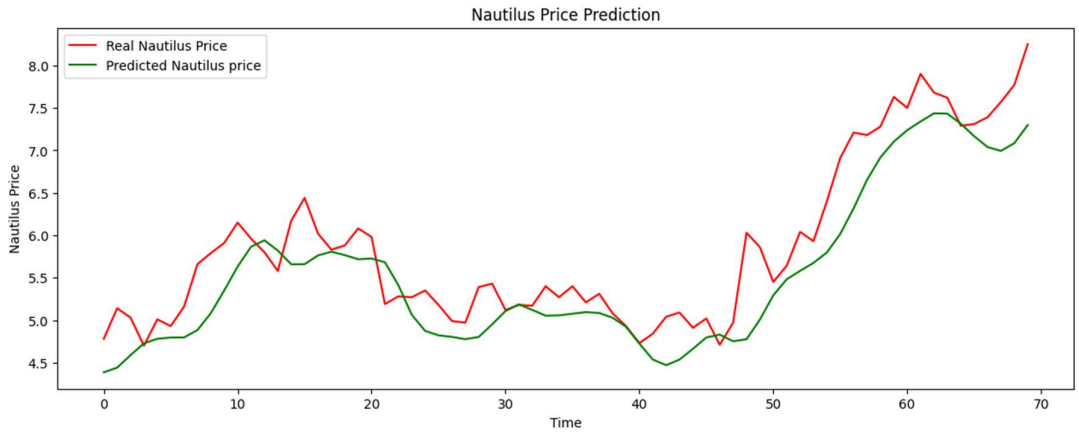
In this portfolio analysis research, we selected three stocks from the auto manufacturing industry: Federal Signal Corporation (FSS), Ford Motor Company (F), General Motors Company (GM). We analyzed the financial ratios of these stocks from January 1st, 2010, to June 30th, 2023, to assess their financial health and stability. Based on this analysis, we decided to invest $1000 in each stock on March 15th, 2020. We then sold all stocks after 70 days, on June 30th, 2023, to determine the portfolio's performance. So, we are testing the data at the date of 15-03-2023.

```
[ ]  data_training = df[df['Date'] < '2023-03-15'].copy()
     data_testing = df[df['Date'] >= '2023-03-15'].copy()
```

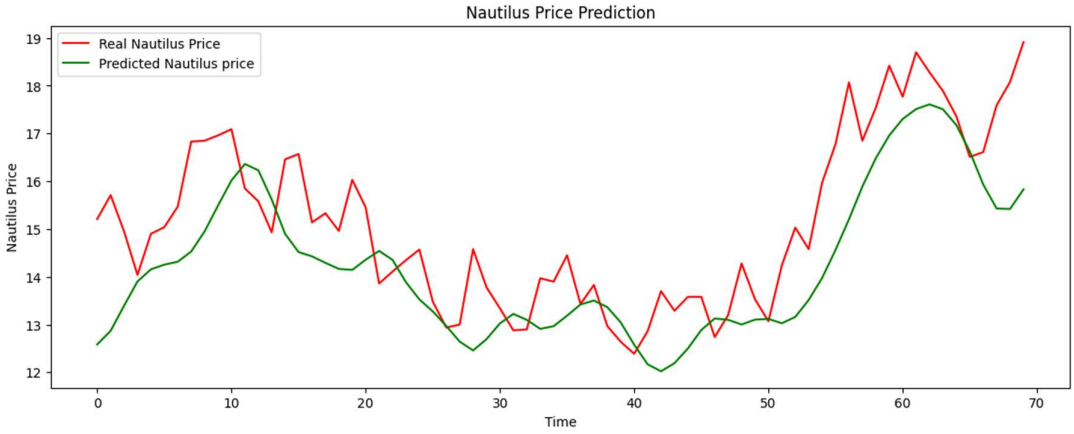
After testing the data, we get the predicted price in every stocks. In those predicted price attached in a excel file for the portfolio optimization. In all the stocks FSS, F, and GM we have selected, the predicted price is lower than the real price. Predicted prices and Real prices of those stocks are given below:



Federal Signal Corporation (FSS) Predicted and Real Prices



Ford Motor Company (F) Predicted and Real Prices

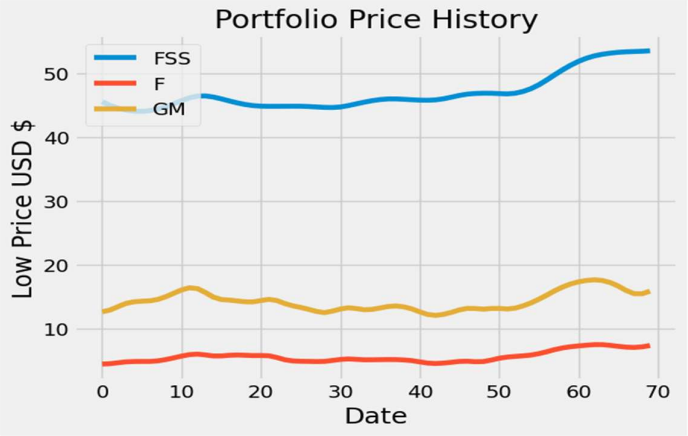


General Motors Company (GM) Predicted and Real Prices

If a stock's predicted price is lower than its actual price, investors may perceive a bearish sentiment, leading to selling and potentially driving the stock price down further. However, predicted prices are estimates, and real stock prices can fluctuate for various reasons. A lower predicted price doesn't always guarantee future stock declines. Some investors may still buy a stock with a lower predicted price, considering it undervalued and expecting its future increase, reflecting a bullish sentiment.

PORTFOLIO PERFORMANCE

In the portfolio optimization project, to run the code in each stock we get the predicted prices in 70 days. We also attached the predicted prices in a excel sheet to run the python code for optimizing the portfolio.



Here, in the graph, we see that FSS, F, and GM; all the stocks prices are rising in the portfolio. Which can indicate that the portfolio will give the better profit as a whole.

```
#Portfolio Optimization
#Calculate the Expected Returns
#Calculate the annualized Sample Covariance Matrix of Asset Returns
average = expected_returns.mean_historical_return(df)
s = risk_models.sample_cov(df)

#Optimize for Maximum Sharpe Ratio
ef_line = EfficientFrontier(average, s)
weights = ef_line.max_sharpe()
cleaned_weights = ef_line.clean_weights()
print(cleaned_weights)
ef_line.portfolio_performance(verbose = True)
```

```
OrderedDict([('FSS', 0.57181), ('F', 0.42819), ('GM', 0.0)])
Expected annual return: 278.5%
Annual volatility: 20.5%
Sharpe Ratio: 13.52
(2.7849832709391116, 0.2045497647902675, 13.517411148207145)
```

After running the program, we can see in the portfolio optimization that GM has left out, and only FSS and F were selected and the weight given to FSS is 0.57181, & F was 0.42819. The expected annual return of the portfolio is 278.5%, which is a massive return in investing those stocks. The Sharpe ratio of the portfolio is 13.52, which is also good for the portfolio, and the annual volatility of the portfolio is 20.5%.

```
#Get the discrete allocation for each pair of Stock
from pypfopt.discrete_allocation import DiscreteAllocation, get_latest_prices

latest_prices = get_latest_prices(df)
weights = cleaned_weights
da = DiscreteAllocation(weights, latest_prices, total_portfolio_value = 1000)

allocation , leftover = da.lp_portfolio()
print('Discrete Allocation: ', allocation)
print('Funds Remaining: ${:.2f}'.format(leftover))
```

```
Discrete Allocation:  {'FSS': 11, 'F': 56}
Funds Remaining: $1.97
```

With an investment of $1000 in the portfolio, as an investor, we can buy “11 FSS”, and “56 F”, stocks to optimize the portfolio, and also getting the better return. The funds have the remaining balance of $1.97.

```
buy_FSS = 52.61 * 11
sell_FSS = 62.99 * 11
buy_F = 11.4 * 56
sell_F = 14.87 * 56
funds_remaining = 1.97
approximate_gain = (sell_FSS + sell_F) - (buy_FSS + buy_F) + funds_remaining
print('Approximate Gain: $', approximate_gain)
```

```
Approximate Gain: $ 310.4699999999998
```

So, the approximate gain after 70 days is $ 310.47. If we invest $1000; with the proportion of investment “FSS: 1”, and “F: 1”, the portfolio gain maximizes and a huge profit of $310.47.

```
buy_FSS = 52.61 * 11
buy_F = 11.4 * 56
act_sell_FSS = 62.99 * 11
act_sell_F = 14.79 * 56
funds_remaining = 1.97
actual_gain = (act_sell_FSS + act_sell_F) - (buy_FSS + buy_F) + funds_remaining
print('Actual Gain: $', actual_gain)
```

```
Actual Gain: $ 305.99
```

If we look at the actual gain of the portfolio; the actual gain will be approximately $306.

```
[19] portfolio_efficiency = actual_gain / approximate_gain
     print("Portfolio Efficiency: ", portfolio_efficiency)

     Portfolio Efficiency:  0.9855702644377885
```

In our portfolio, the efficiency of the portfolio is approximately 98.56%

```
contribution_margin = 1000
ROI = (approximate_gain / contribution_margin) * 100
print("Return on Investment: ", ROI)

Return on Investment:  31.04699999999998
```

Here, we can see that in our portfolio will give us the Return on Investment on 31.05%, whereas the USA auto manufacturing industry average ROI is 14.21%. So, investing in those three stocks will get the higher profit, rather than investing in the DSE stock.

CONCLUSION

In conclusion, this portfolio optimization project focused on investing in three auto manufacturing industry stocks on the NASDAQ: Federal Signal Corporation (FSS), Ford Motor Company (F), and General Motors Company (GM). The stock selection process considered historical backgrounds and crucial financial ratios (EPS, P/E Ratio, Beta, and Current Ratio) within the context of the industry averages.

Utilizing LSTM models for price prediction and a portfolio optimization algorithm, the project aimed to maximize returns within a 70-day investment period. Despite predicted prices being lower than actual prices, the portfolio demonstrated a substantial gain, with GM being excluded in favor of FSS and F. The investment strategy suggested buying "11 FSS," and "56 F," stocks, leading to an approximate gain of $310.47 from a $1000 investment.

The optimized portfolio exhibited an impressive 278.5% expected annual return, a Sharpe ratio of 13.52, and an annual volatility of 20.5%. With an investment of $1000, the portfolio suggested purchasing 11 FSS and 56 F stocks, yielding a significant gain of $310.47, showcasing an efficiency of approximately 98.56%.

In comparison to the DSE stock market, this portfolio's 31.05% return on investment significantly outperformed the USA auto manufacturing industry average of 14.21%. This underscores the effectiveness of the portfolio optimization strategies employed in maximizing profits within the specified timeframe and market conditions.

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