

Strategic Portfolio Optimization and Risk Management Project
Risk-Adjusted Performance and Strategic Rebalancing

FINE 441: Investment Management

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I. Investment Objective

The objective of the investment is to raise funds for starting a business, with capital allocated to cover startup costs and operational expenses. The investment strategy should focus on moderate risk management, ensuring sufficient liquidity to access funds when needed while maintaining a balanced approach between risk and returns to achieve steady and reliable growth.

II. List of all trades

1. 01/15/2025: We invested in Amazon.com Inc. (AMZN) by purchasing 1,200 shares at the market price of \$223.35 per share. As a large-cap technology and e-commerce leader, Amazon aligns well with our moderate-risk investment strategy. Its strong market position and consistent revenue growth offer reliable upside potential, while its diversified business model provides resilience. This investment serves as a foundational asset in our portfolio, balancing growth potential with relative stability.
2. 01/16/2025: We invested in JPMorgan Chase & Co. (JPM) by purchasing 1,100 shares at the market price of \$252.71 per share. JPMorgan is one of the largest and most established financial institutions globally, known for its strong balance sheet and consistent long-term performance. This investment reflects our objective of steady and reliable growth, as JPM offers stable dividends and resilience across market cycles, making it a dependable core holding within our portfolio.
3. 01/23/2025: We invested in McDonald's Corporation (MCD) by purchasing 1,200 shares at the market price of \$282.82 per share. As a globally recognized leader in the fast-food industry, McDonald's provides consistent dividend payouts, and a recognizable increase in its stock performance. This investment supports our goal of industry diversification and steady capital appreciation, reinforcing our portfolio with a defensive asset known for performing well across economic cycles.
4. 01/27/2025: We initiated a short position on Microsoft Corporation (MSFT) by short selling 100 shares at the market price of \$433.69 per share. This position represents approximately 1% of our total assets, aligning with our moderate-risk investment strategy and controlled exposure limits. The short was initiated based on seeing a declining trend in the tech sector at the time.
5. 01/29/ 2025: We invested in Pfizer Inc. (PFE) by purchasing 3,000 shares at the market price of \$26.62 per share. This investment was made to further diversify our portfolio by gaining exposure to the pharmaceutical and healthcare sector. As a globally recognized pharmaceutical company with a history of innovation and steady revenue, Pfizer adds a

defensive and stable-growth component to our holdings, aligning with our moderate-risk investment strategy.

6. 02/06/2025: We also see a great performance with our McDonald's Corp (MCD) investment and its continuous alignment with our investment objectives, so we decided to purchase another 1200 shares at the market price of \$292.67 per share.
7. 02/07/2025: We invested in Netflix Inc. (NFLX) by purchasing 600 shares at the market price of \$1013.93 per share. As part of our diversification strategy, we added exposure to the media and entertainment sector. After view its past year of performance, Netflix has demonstrated a 34% increase, signaling strong momentum and a solidified position in the streaming industry. While it carries some volatility, its recent performance and global subscriber growth offer a relatively stable growth profile that aligns with our moderate-risk investment approach.
8. 02/10/2025: We further invested in 500 shares of JPMorgan Chase & Co. (JPM) at the market price of \$269.38 as we believe the stock was undervalued at the time. Investing at a low time, we predict will help us gain a optimistic profit.
9. 02/18/2025: We sought exposure to the energy sector to help diversify the systematic risk in our portfolio. Given that Exxon Mobil Corp (XOM) has demonstrated moderate risk characteristics based on its current volatility, we decided to purchase 4,550 shares at the market price of \$110.14 per share.
10. 02/20/2025: We sold all of our originally invested Amazon.com Inc. (AMZN), as we see a major decline in its data at the market price of \$222.88. This sale was part of our portfolio rebalancing strategy, allowing us to realize gains from our initial investment while reallocating capital to pursue other opportunities aligned with our investment objective.
11. 02/21/2025: After speculating and seeing a major decline trend in the stock, we initiated a short position on Amazon.com Inc. (AMZN) by short selling 800 shares at the market price of \$216.58. This move aims to generate returns from anticipated downside movement, within the bounds of our risk-managed strategy and with appropriate stop-loss measures in place to protect capital.
12. 02/27/2025: We later decided that JPMorgan Chase & Co. (JPM) continually to be undervalued, so we purchased another 800 shares at the market price of \$257.21per share.

13. 03/03/2025: We received a dividends payment of \$3067.75 for our 1200 shares invested in McDonald's Corp (MCD) of \$1.77 per share.
14. 03/07/2025: We closed our short position in Microsoft Corporation (MSFT) by buying back 100 shares at the market price of \$393.31 per share. This action follows our initial short sale of the same number of shares at the same price. The decision to exit the position was based on a reassessment of short-term market conditions and our desire to manage risk exposure. The trade resulted in a neutral return, with a small cost incurred due to transaction fees, aligning with our disciplined, moderate-risk investment approach.
15. 03/11/2025: The decline till continued for Amazon.com Inc. (AMZN), so our group decided to continue to short stocks of 200 shares at the market price of \$196.59 per share as we continue to speculate its market performance.
16. 03/14/2025: We purchased 300 shares of Netflix Inc. (NFLX) at a market price \$918 of using margin financing. Netflix has demonstrated strong recent performance and this margin-based investment reflects our confidence in its growth.
17. 03/18/2025: Purchased 10 units of a U.S. Treasury Bond (T-Bond) with a 6.375% coupon rate, maturing on August 15, 2027, at a price of \$1,034.324 per bond. We added a risk-free asset, for increase in stability as well as income generation to our portfolio.
18. 03/18/2025: In response to recent policy actions taken by the U.S. government and the resulting downward pressure on the stock market, we purchased 70 put option contracts for Tesla Inc. (TSLA) at a market premium of \$5.65 per share. This move was made as a protective and strategic bearish position, anticipating further decline in Tesla's stock price. The purchase aligns with our risk management strategy, providing potential downside protection and allowing us to hedge against broader market volatility.
19. 03/20/2025: After reviewing heightened market volatility at the time, we decided to increase our allocation to risk-free assets in order to help balance the overall risk of our portfolio. To achieve this, we purchased 10 additional units of U.S. Treasury Bonds (T-Bond) with a 6.625% coupon rate, maturing on February 15, 2027, at a price of \$1,014.42 per bond. This investment supports our objective of maintaining a stable, moderately-risked portfolio through strategic asset allocation.
20. 03/20/2025: As the ongoing political regulations on the microchip industry, we decide to buy 80 put options contract from Microchip Technology Inc for the market price of \$0.45 per share .

III. Performance Valuation

Portfolio weights when the project ended (2025/3/21):

COMPANY NAME	SYMBOL	QTY	Adj. Close	market value	weight
Amazon.com Inc.	AMZN	-1000	196.21	\$ (196,210.00)	-7.6%
JPMorgan Chase & Co.	JPM	2400	241.63	\$ 579,912.00	22.5%
Netflix Inc.	NFLX	900	960.29	\$ 864,261.00	33.5%
McDonald's Corp	MCD	2400	305.44	\$ 733,056.00	28.4%
Pfizer Inc.	PFE	3000	26.28	\$ 78,840.00	3.1%
Exxon Mobil Corp.	XOM	4500	115.5	\$ 519,750.00	20.1%

1. Jensen Index

To calculate the Jensen Index, we used the following formula:

$$\alpha_P = \bar{R}_P - [\bar{R}_F + \beta_P \cdot \text{MRP}]$$

Given:

- $\bar{R}_P = 1.091\%$ (see Appendix B-1)
- $\bar{R}_F = 0.0113\%$ (see Appendix B-2)
- $\text{MPR} = -0.118\%$ (see Appendix B-2)
- $\beta_P = 0.985$ (see Appendix B-5)

Calculation:

$$\alpha_P = 1.091\% - [0.0113\% + 0.985 \cdot (-0.118\%)] \approx 1.2\%$$

Conclusion:

$$\alpha_P = 0.012 > 0$$

A Jensen Index of 0.012 showed that the portfolio earned more than the required return, demonstrating its ability to outperform the market on a risk-adjusted basis. The positive alpha achieved confirms that the portfolio not only preserved capital with moderate risk, but also delivered steady and above-benchmark performance, aligning well with the goals of the investment strategy.

2. Sharpe Index

To calculate the Sharpe Index, we used the following formula:

$$S_P = \frac{\bar{R}_P - \bar{R}_F}{\sigma_P}$$

Given:

- $\bar{R}_P = 1.091\%$ (see Appendix B-1)
- $\bar{R}_F = 0.0113\%$ (see Appendix B-2)
- $\sigma_P = 1.326\%$ (see Appendix B-4)

Calculation:

$$S_P = \frac{1.091 - 0.0113}{1.326} \approx 0.814$$

Conclusion:

A Sharpe ratio of 0.814 indicates that the portfolio generated approximately 0.814 units of excess return for every one unit of total risk undertaken. The portfolio's standard deviation of 1.326% reflects a relatively low level of volatility. While the Sharpe ratio is moderate, it suggests that the portfolio provided a reasonably efficient risk-return tradeoff. This performance aligns well with the investment strategy's objective of achieving steady growth while maintaining a balanced approach between risk and return.

3. Treynor Index

To calculate the Treynor Index, we used the following formula:

$$T_P = \frac{\bar{R}_P - \bar{R}_F}{\beta_P}$$

Given

- $\bar{R}_P = 1.091\%$ (see Appendix B-1)
- $\bar{R}_F = 0.0113\%$ (see Appendix B-2)
- $\beta_P = 0.985$ (see Appendix B-5)

Calculation:

$$T_P = \frac{1.091 - 0.0113}{0.985} \approx 1.097\%$$

Conclusion:

A Treynor ratio of 1.097 indicates that for each unit of systematic risk taken, the portfolio generated approximately 1.097% of excess return above the risk-free rate. This is considered a well-risk-adjusted performance in terms of market exposure. This outcome aligns closely with the investment objective: to generate steady, reliable growth under moderate risk conditions while preserving accessible capital.

IV. Efficient Portfolio & Rebalancing Outcome

The correlation matrix and covariance matrix were used to compute the standard deviation of our portfolio (*see Appendix B-4*). Using the portfolio return and risk-free rate (*see Appendices B-1 and B-2*), along with the calculated portfolio standard deviation, we determined the portfolio's Sharpe Ratio to be 0.814.

To improve the portfolio's efficiency, we then used Excel Solver to maximize the Sharpe Ratio by adjusting the weights of each stock, subject to the constraint that the total weight equals 100%, ensuring full investment. Solver generated the following optimized portfolio weights:

COMPANY NAME	weight	STDV	return
Amazon.com Inc.	0	0.017617	-2.42%
JPMorgan Chase & Co.	0	0.016363	-1.18%
Netflix Inc.	0.5149678	0.014207	1.83%
McDonald's Corp	0	0.026718	1.38%
Pfizer Inc.	0.3160381	0.012947	0.98%
Exxon Mobil Corp.	0.1689941	0.015725	0.68%
	100.0%		
Portfolio Return	1.367%		
Risk-free Return	0.01127%		
Portfolio VAR		0.008%	
Portfolio STDV		0.889%	
Sharpe Ratio		1.5245183	

Table 1: optimal risky asset portfolio

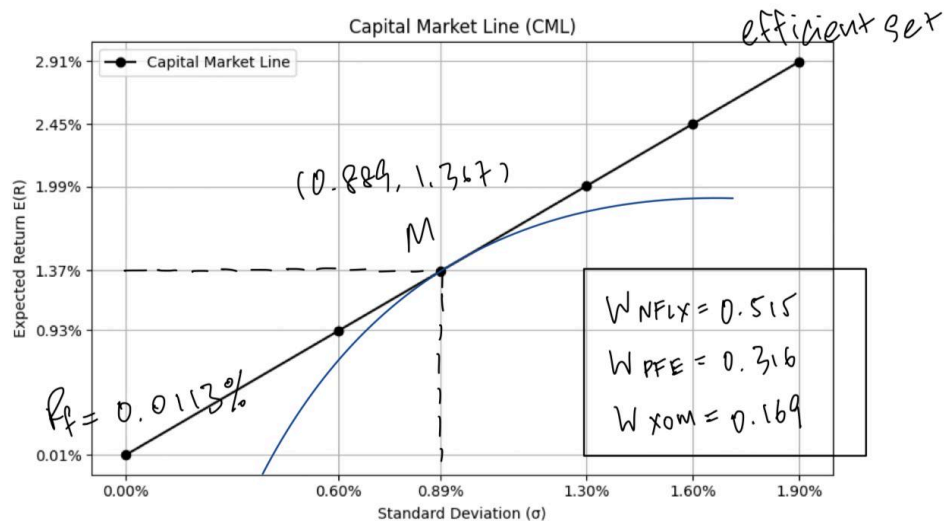
To plot the efficient set, we used CML:

$$E(R_p) = R_F + \text{Sharpe ratio of } M \cdot \sigma_p$$

With:

- $R_F = 0.011272\%$ (*see Appendix B-2*)
- Sharpe ratio = 1.525 (*see Table 1*)

We also know that point M is (0.889, 1.367) (see Table 1), we are able to plot the following graph:



To rebalance our current portfolio with standard deviation of standard deviation of 1.326% (See Appendix B-4), the expected return on CML is 2.033%

$$E(R_p) = 0.0113 + 1.525 \cdot 1.326 \approx 2.033\%$$

We need to then solve for the weights of the risk free asset and risky asset to obtain the expected return on CML:

$$E(R_p) = y \cdot E(R_M) + (1 - y)R_F$$

$$2.033\% = y \cdot 1.367\% + (1 - y) \cdot 0.0113\%$$

$$y \approx 1.49$$

Therefore, to rebalance, we need to invest 149% in the market portfolio and short 49% in the risk-free asset to reach the higher-return point on the CML that matches our current risk level of 1.326%.

V. Appendix A: Data

A-0: Data Collection

Historical data for each stock over the past five years, used in this analysis, was collected from NASDAQ and is available in our GitHub repository:

<https://github.com/chen07051/fine441-analysis>

A-1: Daily Risk-free rate

Date	annual yield	daily yield
15-Jan-25	4.205%	0.0112855%
15-Jan-25	4.195%	0.0112593%
17-Jan-25	4.193%	0.0112540%
21-Jan-25	4.197%	0.0112645%
22-Jan-25	4.215%	0.0113118%
23-Jan-25	4.213%	0.0113066%
24-Jan-25	4.205%	0.0112855%
27-Jan-25	4.188%	0.0112408%
28-Jan-25	4.190%	0.0112461%
29-Jan-25	4.188%	0.0112408%
30-Jan-25	4.182%	0.0112251%
31-Jan-25	4.188%	0.0112408%
03-Feb-25	4.190%	0.0112461%
04-Feb-25	4.213%	0.0113066%
05-Feb-25	4.210%	0.0112987%
06-Feb-25	4.213%	0.0113066%
07-Feb-25	4.228%	0.0113460%
10-Feb-25	4.228%	0.0113460%
11-Feb-25	4.225%	0.0113381%
12-Feb-25	4.228%	0.0113460%
13-Feb-25	4.213%	0.0113066%
14-Feb-25	4.213%	0.0113066%
18-Feb-25	4.213%	0.0113066%
19-Feb-25	4.218%	0.0113197%
20-Feb-25	4.205%	0.0112855%
21-Feb-25	4.197%	0.0112645%
24-Feb-25	4.190%	0.0112461%
25-Feb-25	4.182%	0.0112251%
26-Feb-25	4.193%	0.0112540%
27-Feb-25	4.195%	0.0112593%
28-Feb-25	4.193%	0.0112540%
03-Mar-25	4.193%	0.0112540%
04-Mar-25	4.195%	0.0112593%
05-Mar-25	4.205%	0.0112855%
06-Mar-25	4.197%	0.0112645%
07-Mar-25	4.197%	0.0112645%
10-Mar-25	4.185%	0.0112330%
11-Mar-25	4.195%	0.0112593%
12-Mar-25	4.197%	0.0112645%
13-Mar-25	4.188%	0.0112408%
14-Mar-25	4.188%	0.0112408%
17-Mar-25	4.188%	0.0112408%
18-Mar-25	4.195%	0.0112593%
19-Mar-25	4.190%	0.0112461%
20-Mar-25	4.182%	0.0112251%
average daily yield		0.011272%

VI. Appendix B: Methodologies

B-1: Portfolio's Return

We used adjusted closing prices (source: Yahoo Finance) to calculate HPR for each stock, then used HPR to calculate the return for each stock over the trading period.

$$HPR = \frac{P_1 - P_0}{P_0}$$

$$R_i = HPR \times \frac{365}{t}$$

AMZN:

$$\frac{194.95 - 216.58}{216.58} \times \frac{365}{20} + \frac{194.95 - 196.56}{196.56} \times \frac{365}{5} \approx -2.42\%$$

JPM:

$$\frac{239.01 - 223.35}{223.35} \times \frac{365}{44} + \frac{239.01 - 259.05}{259.05} \times \frac{365}{16} \approx -1.18\%$$

NFLX:

$$\frac{950.84 - 1013.93}{1013.93} \times \frac{365}{29} + \frac{950.84 - 918}{918} \times \frac{365}{5} \approx 1.83\%$$

MCD:

$$\frac{307 - 282.82}{282.82} \times \frac{365}{40} + \frac{307 - 292.67}{292.67} \times \frac{365}{30} \approx 1.38\%$$

PFE:

$$\frac{26.19 - 26.62}{26.62} \times \frac{365}{36} \approx 0.98\%$$

XOM:

$$\frac{115.9 - 110.14}{110.14} \times \frac{365}{28} \approx 0.68\%$$

We calculated the portfolio's return, by multiplying each stock's weight by its daily return and summing the results:

$$R_{Pt} = \sum_{i=1}^6 w_i \cdot R_{it}$$

SYMBOL	weight	return	weight*return
AMZN	-7.6%	-2.42%	0.1841%
JPM	22.5%	-1.18%	-0.2653%
NFLX	33.5%	1.83%	0.6131%
MCD	28.4%	1.38%	0.3922%
PFE	3.1%	0.98%	0.0300%
XOM	20.1%	0.68%	0.1370%
avg portfolio return:		1.091%	

Result:

- **Portfolio's return** over the trading period: 1.091%

B-2: Market Risk Premium

To compute the market risk premium (MRP), we collected the average daily return of the risk-free asset using IRX, which represents the 13-week U.S. Treasury bill. We also collected data for the S&P 500 index as the market benchmark. The data covers the period from January 15, 2025 to March 20, 2025.

Please consult <https://github.com/chen07051/fine441-analysis> for the Python script named avgreturn.py, which contains the code for calculating the average market return.

Result:

- \bar{R}_m over the trading period: -0.1072%

The following formula was used to compute the daily risk-free rate, and we averaged it to get the average daily risk-free rate over the trading period:

$$\text{Daily Rate} = \left(1 + \frac{\text{Annual Yield}}{100}\right)^{\frac{1}{365}} - 1$$

See *Appendix A-1 Daily Risk-free rate* for risk free rate data and calculation

Result:

- \bar{R}_f over the trading period: 0.011272%

The market risk premium is calculated using the following formula:

$$\text{MRP} = \bar{R}_m - \bar{R}_f$$

$$\text{MRP} = -0.1072 - 0.011272 = -0.118472\%$$

Result:

- **MRP** over the trading period= -0.118472%

B-3: Standard Deviation Calculation of Individual Stocks and the Market

We collected daily stock price data for each stock in the past five years from NASDAQ, and then computed the standard deviation of each stock and the market covering the period from January 15, 2020 to March 20, 2025.

Please consult <https://github.com/chen07051/fine441-analysis> for the Python script named stdev.py, which contains the code for calculating the standard deviation for each stock and the market.

Results:

Standard deviation of each stock over the trading period (σ_i)

- **AMZN:** 1.7617%
- **JPM:** 1.6363%
- **MCD:** 1.4207%
- **NFLX:** 2.6718%
- **PFE:** 1.2947%
- **XOM:** 1.5725%

Standard deviation of the market over the trading period (σ_M)

- **SPX:** 1.0289%

B-4: Portfolio Standard Deviation Calculation

To calculate the correlation between each stock and the market, we used the each stock's and market's data over the past five years.

Please consult <https://github.com/chen07051/fine441-analysis> for the Python script named correlation.py, which contains the code for calculating the correlation matrix.

We then used the following formula to calculate the standard deviation of our portfolio:

$$\sigma_p = \sqrt{\sum_{i=1}^6 \sum_{j=1}^6 w_i w_j \sigma_i \sigma_j \rho_{ij}}$$

Standard deviation of each stock were calculated in *Appendix B-3*

COMPANY NAME	weight	STDV	return	Correlation matrix						
Amazon.com Inc.	-7.6%	0.017617	-2.42%		AMZN	JPM	MCD	NFLX	PFE	XOM
JPMorgan Chase & Co.	22.5%	0.016363	-1.18%	AMZN	1	0.2176	0.1282	0.6544	0.0152	-0.0768
Netflix Inc.	33.5%	0.014207	1.83%	JPM	0.2176	1	0.3845	0.4835	0.1816	0.4447
McDonald's Corp	28.4%	0.026718	1.38%	MCD	0.1282	0.3845	1	0.2527	0.2428	0.2852
Pfizer Inc.	3.1%	0.012947	0.98%	NFLX	0.6544	0.4835	0.2527	1	0.045	-0.0123
Exxon Mobil Corp.	20.1%	0.015725	0.68%	PFE	0.0152	0.1816	0.2428	0.045	1	-0.0212
	100.0%			XOM	-0.0768	0.4447	0.2852	-0.0123	-0.0212	1
Portfolio Return	1.090%			Covariance matrix						
Risk-free Return	0.01127%				AMZN	JPM	MCD	NFLX	PFE	XOM
				AMZN	1.79263E-06					
				JPM	-1.0726E-06	1.3555E-05				
				MCD	-1.3024E-06	1.0741E-05	5.75764E-05			
				NFLX	-4.17E-06	8.4721E-06	9.12588E-06	2.26514E-05		
				PFE	-8.1681E-09	2.6834E-07	7.39438E-07	8.59588E-08	1.61087E-07	
				XOM	3.25008E-07	5.1749E-06	6.84004E-06	-1.8503E-07	-2.6894E-08	9.99018E-06
				Portfolio VAR		0.018%				
				Portfolio STDV		1.326%				

Result:

- Portfolio standard deviation over the trading period (σ_p): 1.326%

B-5: Portfolio Beta Calculation

To calculate the covariance between each stock and the market, we collected daily stock price data for each stock in the past five years from NASDAQ. To ensure consistency, we excluded any month that lacked data for the final trading days, thereby removing months with incomplete data.

Please consult <https://github.com/chen07051/fine441-analysis> for the Python script named covariance.py, which contains the code for calculating the covariance between each stock and the market.

Results:

Covariance between each stock and the market

- AMZN and SPX: 0.002879
- JPM and SPX: 0.002506
- MCD and SPX: 0.001304
- NFLX and SPX: 0.003596
- PFE and SPX: 0.001136
- XOM and SPX: 0.001193

To calculate the market's variance over the past five years, We used the S&P 500 Index (SPX) as the market benchmark.

Please consult <https://github.com/chen07051/fine441-analysis> for the Python script named marketVar.py, which contains the code for calculating the variance of the market.

Result:

- **Variance of the market** over the past five years ($Var(R_M)$): 0.223%

We then used the covariance between each stock and the market to compute the beta for each stock. The portfolio beta was calculated as the weighted average of individual stock betas, using each stock's weight in the portfolio.

$$\beta_i = \frac{\text{Cov}(R_i, R_m)}{\text{Var}(R_m)}$$

$$\beta_p = \sum_{i=1}^n w_i \cdot \beta_i$$

	COV	beta	weight	beta*weight	
AMZN	0.002879	1.291298	-7.6%	-0.0981387	
JPM	0.002506	1.1239989	22.5%	0.2528998	
MCD	0.001304	0.5848741	28.4%	0.1661043	
NFLX	0.003596	1.6128891	33.5%	0.5403178	
PFE	0.001136	0.5095223	3.1%	0.0157952	
XOM	0.001193	0.5350881	20.1%	0.1075527	
SPX VAR	0.0022295		Portfolio beta		0.9845311

Result:

- **Portfolio beta:** 0.9845