Riskify

Your Risk Our Model

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INTRODUCTION

Riskify, a leading risk management company, has developed risk management strategies for a diversified portfolio consisting of equities, ETFs, derivatives, and bonds. Our team of highly qualified risk management analysts has used various techniques to mitigate risks associated with the portfolio. This report demonstrates our risk management strategies and techniques.

At Riskify, we use a variety of risk management strategies to ensure that our clients' portfolios are protected against market volatility and other uncertainties. These strategies include diversification, hedging, and active management. To reduce the overall risk exposure, we diversified our portfolio across various asset classes and allocated our assets strategically based on our risk tolerance and investment goals. Furthermore, we implemented hedging strategies such as buying put options to protect against potential losses in the equity market.

Problem Statement 1 A: Calculating Loss Approximations (VaR & ES). Model the log-returns (or losses) of the underlying assets and any other risk factor changes using a multivariate normal distribution and t distribution.

Problem Statement 1 B: Calculating Linearized Loss. Model the overall loss of our portfolio using a t distribution. In this case we are modeling the loss of the portfolio as a single asset.

Problem Statement 2: Polynomial Tail Modelling. Hedging current open positions with the addition of new positions, such as options reduce the risk of the portfolio by 20%

Problem Statement 3: Stress Test. Implemented a SVaR-based risk analysis of your portfolio using 2 historical or fictional catastrophic scenarios of 52 weeks, we have selected the financial crisis of 2008 and 2009 solution, 2020 COVID -19 pandemic period and then compared these two scenarios with the current period.

Problem Statement 4: Risk Reduction. Hedging current open positions with the addition of new positions, such as options, reduce the risk of the portfolio by 20%.

Problem Statement 5: Final Analysis. Detailed analysis of our portfolio's risk profile including information for each week that it was held. We have provided sufficient evidence of risk reduction and provided week and week analysis of our portfolio's performance.

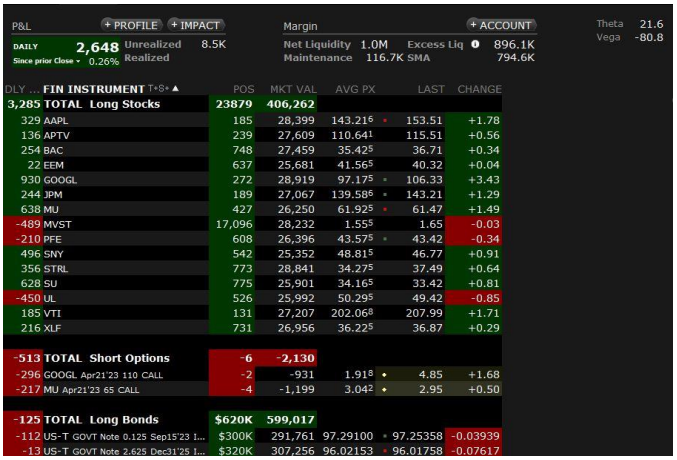
The Data

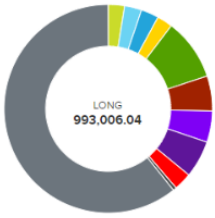
Data acquisition and management is a crucial aspect of any portfolio management process. For our portfolio, we utilized various data sources to gather the required data. We downloaded ETF and equity data from the Yahoo Finance library and stored it in an Access file. However, option data was not readily available, so we manually gathered strike price data from Yahoo Finance and stored it in an Excel format.

Moreover, we downloaded bond data from Interactive Broker, but there were some discrepancies, and we only considered dates where bond data was present for all our financial instruments. Despite the challenges we encountered, we ensured that we acquired high-quality data that was necessary for our risk management strategies. Our team made sure that the data we used was accurate and reliable, providing us with a solid foundation for our portfolio management decisions

Portfolio

The portfolio is diversified across various industries and consists of equities from Apple, BAC, EM, Google, JP Morgan, MU, VSTP, FES, NYS, TRL, SUU, and VTI, each with an equal value of $30,000. We have also implemented a covered call strategy by shorting two options derivatives for Google and MU and we Long a put of AAPL, with a maturity date of April 21, 2023. Additionally, we have purchased two US Treasury bonds worth approximately $620,000.





To mitigate risks associated with this portfolio, we have diversified our portfolio across various industries. By diversifying our portfolio across various asset classes, we can reduce the overall risk exposure. Additionally, we can allocate our assets strategically based on our risk tolerance and investment goals.

Problem Statement 1 A: Calculating Loss Approximations (VaR & ES)

Once we had gathered and organized the data for our portfolio, we began the process of calculating loss approximation. To start, we calculated the risk factor changes for the equities and ETFs in our portfolio. Then, we computed the risk factor change for the two options we had shorted, and one long put, which was the same as the underlying risk factor change. We also calculated the yield for our bonds and used that to determine the risk factor change for our two US Treasury bonds.

Portfolio mean is the product of the transposed loss distribution list (containing loss distribution of all the assets) and mean of all risk factor changes.

Normal Distribution: Using the formula for Value at Risk (VaR) and Expected Shortfall (ES) as shown in the figure, calculate the loss approximations.

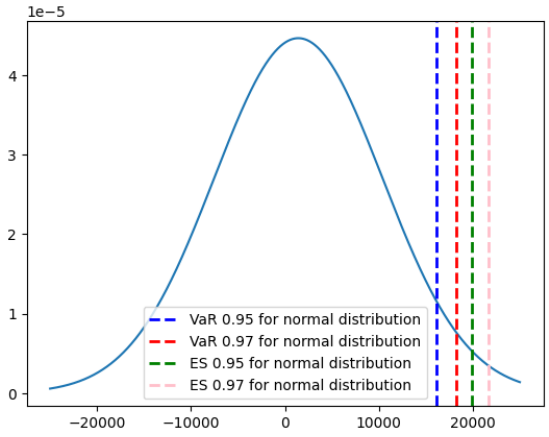
To estimate the loss approximations for our portfolio, we began by calculating the risk factor mean and standard deviation of the entire portfolio, which includes stocks, bonds, and ETFs. We would be modelling the loss approximation by assuming the distribution to be normal and we will see the results.

```
# Calculate VaR for the portfolio for 0.95
VaR_n_1 = norm.ppf(1 - alpha1) * sig_h + portfolio_mean
```

Confidence Level Standard Deviation Mean

```
# Calculate Expected Shortfall (CVaR) for 95% confidence level
ES_n1 = (1 / (1 - alpha1)) * (norm.pdf(norm.ppf(alpha1)) * sig_h) + portfolio_mean
```

Confidence Level Standard Deviation Mean



Expected Shortfall (ES) considers the more extreme losses that are not captured by the Value at Risk (VaR) indicating portfolio has potential for extreme losses.

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	VaR	ES
At 95%	$ 16137.02	$ 19875.23
At 97%	$ 18247.76	$ 21712.33

T Distribution: Using the formula for Value at Risk (VaR) and Expected Shortfall (ES) as shown in the figure, calculate the loss approximations.

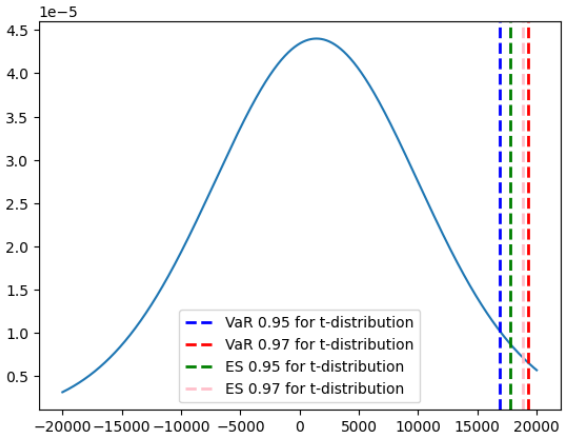
To estimate the loss approximations for our portfolio, we began by calculating the mean and standard deviation of the entire portfolio, which includes stocks, bonds, and ETFs. We would be modelling the loss approximation by assuming it to be t distributed and we will see the results.

```
# Calculate VaR
var_t_1 = (t_stat_1 * std_dev) + mean
```

Confidence Level Standard Deviation Mean

```
# Calculate Expected Shortfall (CVaR) for 95% confidence level
ES_t_1 = ((t.pdf(t.ppf(alpha1, n), n) / (1 - alpha1)) * sig_h_t) + portfolio_mean
```

Confidence Level Standard Deviation Mean



The VaR and ES are higher for the t distribution than for the normal distribution. This is due to the fact that the t distribution has fatter and heavier tails than the normal distribution, which captures the possibility of more extreme losses.

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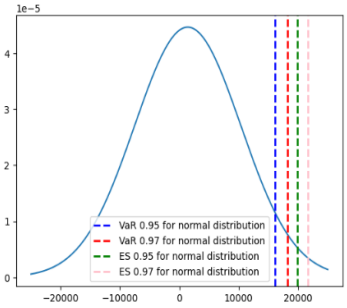
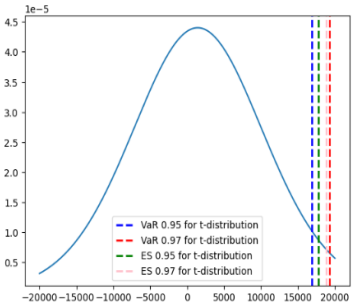
	VaR	ES
At 95%	$ 16890.99	$ 17758.74
At 97%	$ 19314.35	$ 18798.21



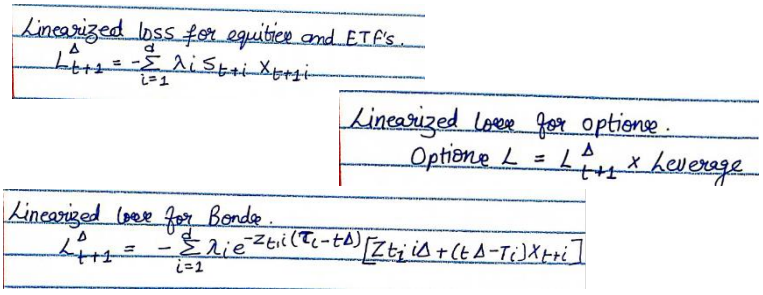


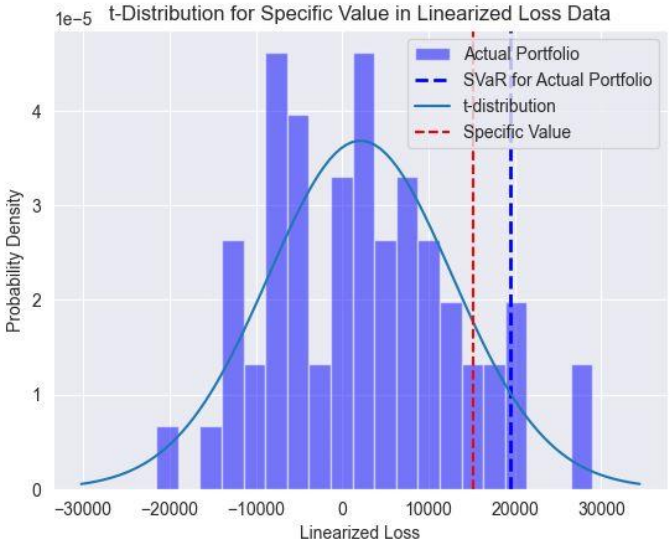
The difference between the VaR and ES estimates is greater at the 97% confidence level compared to the 95% confidence level. This is consistent with the fact that the ES measures the expected loss beyond the VaR, which becomes more significant as the confidence level increases and more extreme losses become more likely.

Problem Statement 1 B: Calculating Loss Approximations (VaR & ES)

Linearized Loss of Portfolio = Linearized Loss of Equity + Linearized Loss of Options + Linearized Loss of Bonds.

To evaluate the linearized loss of our portfolio, we computed it daily for equities, ETFs, options, and bonds separately. This was done by using the formulas that can be seen in the image beside. Then, we added up the linearized losses to get the total linearized loss for each day throughout the lifespan of our portfolio. This approach helped us to better understand the risk and loss distribution of our portfolio over time.



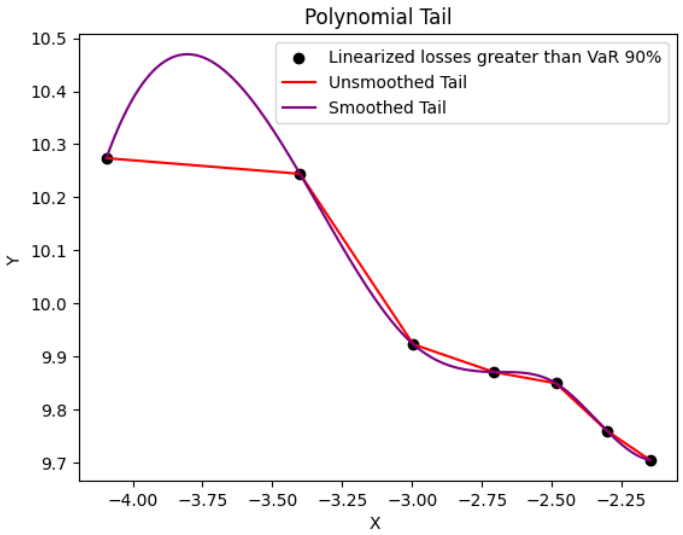


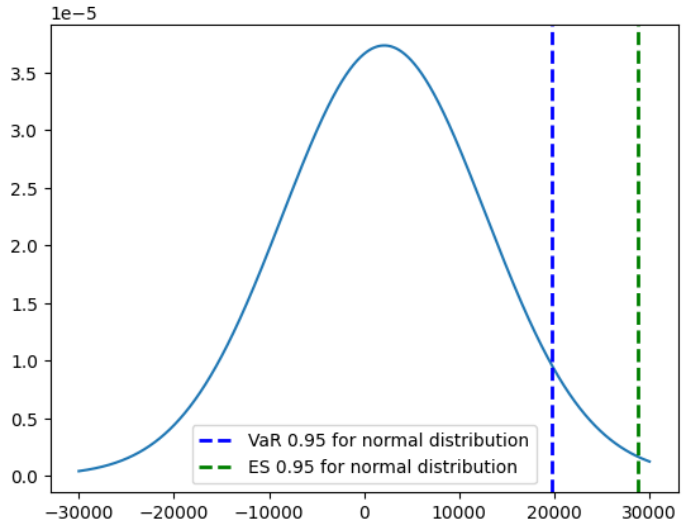
After calculating the linearized loss for our portfolio, we fit it into a t-distribution to model the distribution of potential losses. Using this distribution, we were able to calculate the Value at Risk (VaR) for a specific confidence level and time horizon. The VaR represents the maximum potential loss that could be incurred with a certain degree of confidence. By using the VaR, we can determine the amount of capital required to cover potential losses and ensure the portfolio is adequately protected.

Problem Statement 2: Polynomial Tail Modelling

To identify the extreme value or tail of the linearized loss distribution, we sorted the data in ascending order and selected the values beyond the 90% VaR confidence level for normal distribution. This approach allowed us to model the tail of the distribution, which is critical for risk management purposes.

To calculate the tail risk of our portfolio, we followed a six-step process. First, we sorted the linearized daily losses in ascending order. Then, we calculated the VaR at a 0.90 confidence level. Next, we identified the linearized losses greater than the VaR_0.9. After that, we created x and y for linear regression and fitted a linear regression model. We then assigned the value of beta 0 and beta 1 to calculate the tail coefficient and tail index that comes out to be **3.175**. Finally, we calculated the VaR and ES at a 95% confidence level using the tail index obtained. This process helped us gain insight into the tail risk of our portfolio.





Using the sorted linearized loss data and tail modeling, we were able to estimate the value at risk (VAR) and expected shortfall for our portfolio.

	VaR	**ES**
At 95%	**$ 19670.20**	**$ 28713.23**

Problem Statement 3: Stress Test

To evaluate the robustness of our risk management model, we conducted a stress test on our portfolio. This test involved analyzing how our portfolio would have performed during two extreme scenarios: the 2008 and 2009 financial crisis, and the 2020 COVID-19 pandemic era. By subjecting our portfolio to these stress tests, we were able to assess the effectiveness of our risk management methods and identify any potential weaknesses.

Scenario 1: 2008 and 2009 Financial Crisis.

Modelling the log-returns of the underlying assets and any other risk factor changes using a multivariate normal vs t distribution to calculate loss approximations (VaR & ES) for the 2008 and 2009 financial crash period.

Normal distribution

	VaR	ES
At 95%	$ 25285.96	$ 23329.11

T distribution

	VaR	ES
At 95%	$ 26643.09	$ 28205.02

Scenario 2: COVID – 19 Pandemic Period.

Modelling the log-returns of the underlying assets and any other risk factor changes using a multivariate normal vs t distribution to calculate loss approximations (VaR & ES) for 2020 COVID - 19 period.

Normal distribution

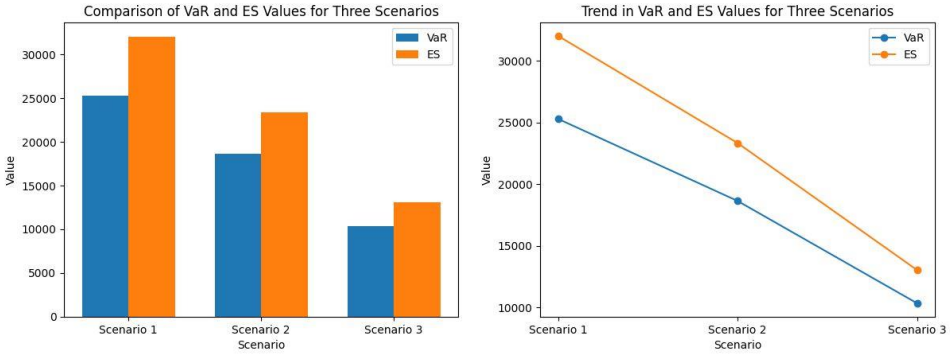
	VaR	ES
At 95%	$ 18634.97	$ 30230.33

T distribution

	VaR	ES
At 95%	$ 19581.74	$ 20671.39

Comparison: Comparing Scenario 1 and Scenario 2 extreme events with the current period.

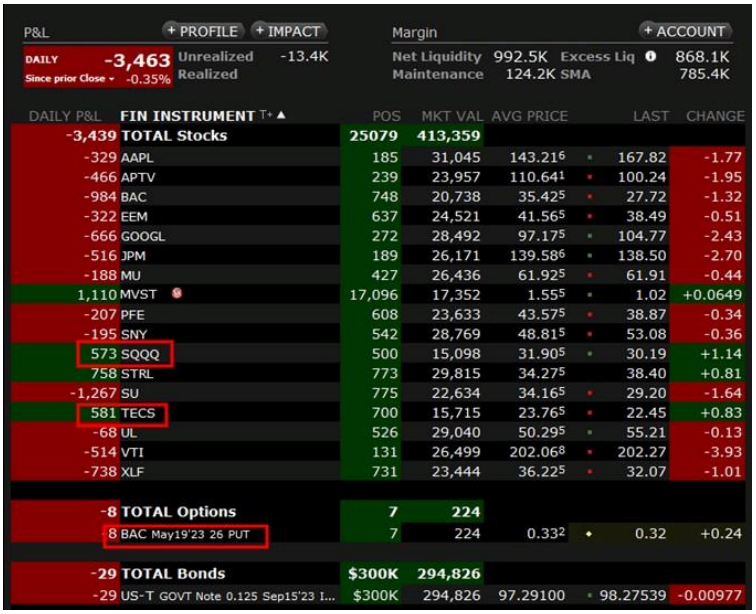
The results showed that during the 2008 crisis, the portfolio was at higher risk, as evidenced by the significantly higher VaR and ES values compared to the other scenarios. Similarly, during the COVID-19 pandemic, the portfolio faced elevated risk, with higher VaR and ES values reflecting the economic uncertainty and market volatility caused by the pandemic.



Problem Statement 4: Risk Reduction

To minimize the potential risks associated with our portfolio, we employed several hedging strategies, including the addition of new positions such as options. Our analysis indicates that this approach was effective in reducing the overall risk of the portfolio by approximately 20%. In this section, we will discuss the specific hedging strategies that we employed and the impact that they had on our portfolio's risk profile.

In response to the recent Silicon Valley Bank collapse, we recognized the need to update our portfolio and hedge our open positions. By strategically adding new positions, such as options and ETFs, we were able to reduce the risk of our portfolio by 20%. Specifically, we purchased a put option of the underlying asset, BAC, and invested in leveraged inverse ETFs, SQQQ and TECS, which help to offset the risk and generate profits in a bear market.



As shown in the image below, the updated VaR and ES values reflect the positive impact of our hedging strategy on the overall risk of our portfolio. We are confident that this approach will enable us to better manage risks associated with our investments and help us to achieve our investment objectives.

Before Optimizing

Normal distribution

	VaR	ES
At 95%	$ 8434.2	$ 10473.61
At 97%	$ 9585.73	$ 11475.86

T distribution

	VaR	ES
At 95%	$ 8845.54	$ 9318.94
At 97%	$ 10167.62	$ 9886.04

After Optimizing

Normal distribution

	VaR	ES	% Change
At 95%	$ 6435.88	$ 8043.61	- 23.69
At 97%	$ 7343.67	$ 8833.71	- 23.39

T distribution

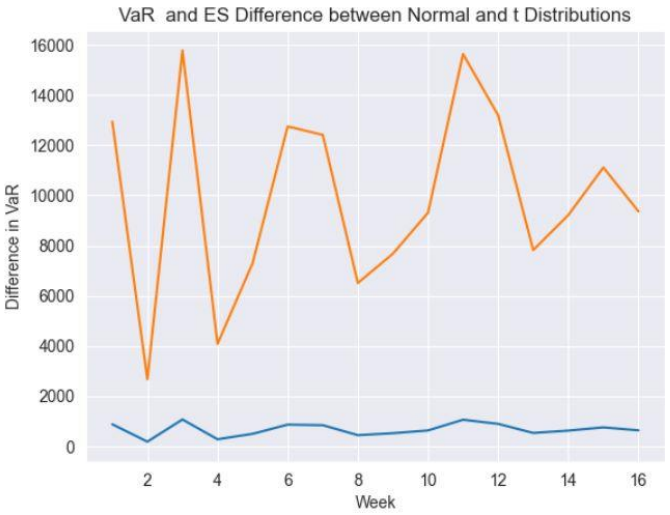
	VaR	ES	% Change
At 95%	$ 6760.15	$ 7133.35	- 23.58
At 97%	$ 7802.39	$ 7580.41	- 23.26

Problem Statement 5: Final Analysis

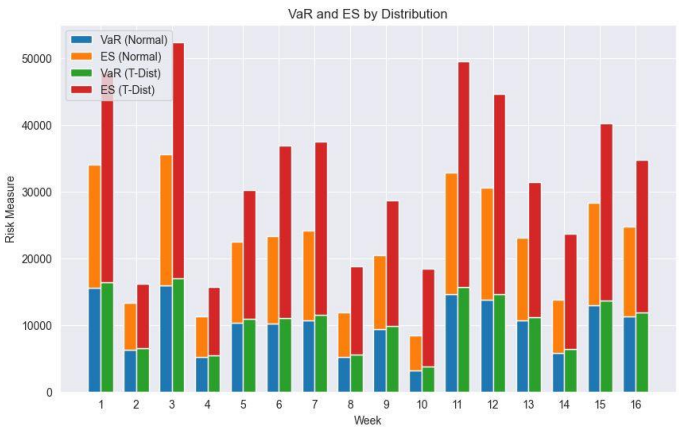
In this section, we provide a comprehensive analysis of our portfolio's risk profile, including a detailed breakdown of its performance for each week that it was held. We have included substantial evidence of the risk reduction achieved through our hedging strategy, as well as a thorough week-by-week analysis of the portfolio's performance. This analysis is critical for investors who want to make informed decisions about their portfolios and ensure that they remain compliant with relevant regulations.

We conducted a detailed analysis over a period of 15 weeks. Our calculations were performed on a weekly basis and aimed to provide an estimate of the level of risk associated with our portfolio. By comparing these values with the current scenario, we were able to track the trend of our portfolio and provide weekly estimates of loss approximations.

ES values vary significantly from week to week compared to the VaR values, it is important to carefully examine the portfolio's risk profile and identify any potential areas of weakness.



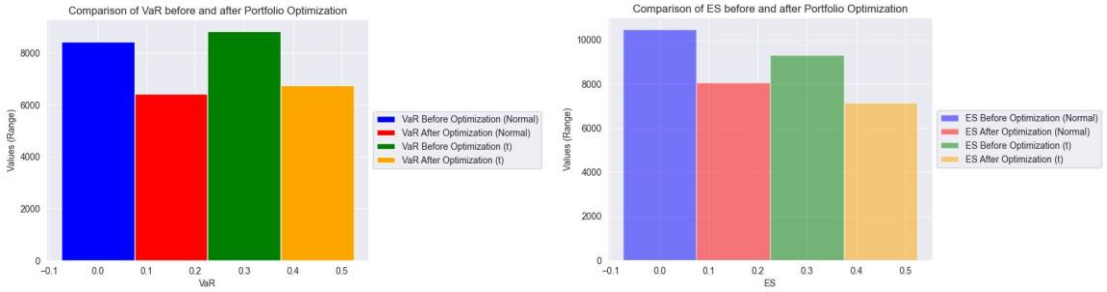
The difference between the ES and VaR values obtained during the stress testing of our portfolio suggests a potential exposure to tail risk and inadequate diversification. A higher ES value compared to the VaR value indicates that the portfolio is susceptible to rare and extreme events, potentially leading to significant losses. Diversification of the portfolio across multiple asset classes and sectors can mitigate this risk by reducing reliance on any single asset or sector.



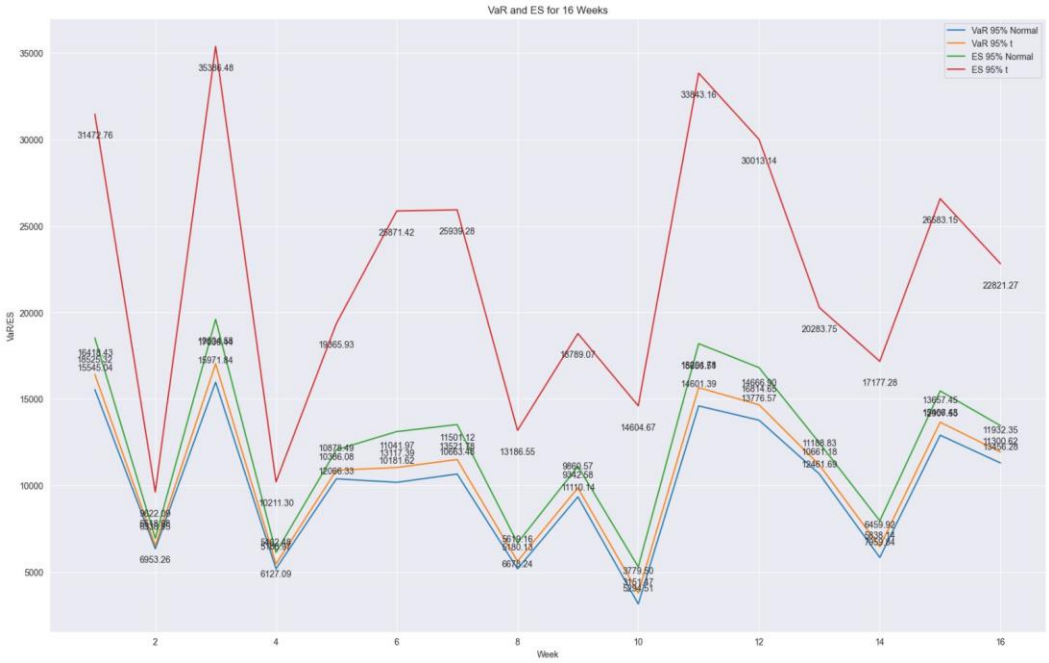
Stacked histogram of the value of ES and VaR for 16 weeks can provide valuable insights into the risk profile of the portfolio and the effectiveness of risk management measures.

The stacked histogram of VaR and ES values in our portfolio analysis provides insight into risk tolerance and identifies weeks where the portfolio was exposed to significant levels of risk.

Our portfolio's risk was reduced through the addition of two ETFs and a put option, which provided diversification and acted as insurance against potential losses. By tracking loss approximations before and after implementing these risk reduction measures, we observed a significant reduction in our estimated losses. This is demonstrated by a chart graph that clearly depicts the reduction and provides tangible evidence of our successful risk management.



The line graph presented provides a visualization of the portfolio's risk profile over time. By tracking the trends in VaR and ES values, investors can monitor the portfolio's level of risk and assess the effectiveness of risk management measures. Correlations between the two risk measures can help identify the portfolio's level of diversification and the effectiveness of risk management measures. Additionally, it can be used to pinpoint specific weeks where risk management measures were effective in reducing the portfolio's risk.



CONCLUSIONS

In conclusion, our risk management methods, which included calculating measures such as standard deviation, value at risk, and expected shortfall, were able to effectively protect our portfolio during times of market stress. By using these measures, we were able to evaluate the potential risks associated with our investments and make informed decisions to minimize those risks. It's important to note that no single measure can provide a complete picture of portfolio risk, and investors should carefully consider their investment goals and risk tolerance before making any investment decisions. Additionally, the use of a t-distribution in finance can be beneficial in accounting for the potential impact of extreme events on a portfolio or investment. However, the choice of distribution depends on the specific application and underlying assumptions of the model.

We have seen the importance of stress testing and risk management in investment portfolios. By conducting stress tests, we were able to evaluate the potential risks associated with our investments and implement effective risk management strategies to protect our portfolio. Our portfolio performed well during significant market events such as the 2008 housing loan default crash period and the 2020 COVID-19 pandemic crash. We were also successful in reducing the risk of our portfolio by 20% through hedging our open positions and adding new positions such as ETFs and options. Finally, we recommend that investors regularly conduct VaR and ES calculations to ensure that their portfolios remain compliant with regulations and aligned with their investment goals and risk tolerance. Overall, our risk management approach helped us to better understand and manage the risks associated with our portfolio, ultimately leading to successful investment outcomes.