Assessing The Financial Impact of COVID-19 On a Multi Sector Portfolio

Risk Modeling & Assessment- Final Project

Rumana Myageri

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Executive Summary - This research paper will use the tools in R to explore the effect of COVID-19 on six different securities within 3 different sectors (Energy, Healthcare, Consumer Staples) in our portfolio. Question to be answered are:

(1) Did the pandemic impact the performance of the selected securities, and if so, were all the sectors affected equally? (2) The proper weight of each security in the portfolio to reduce risks and maximize profits during peak COVID-19.

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I. INTRODUCTION

Stock markets were at their peak before the outbreak of COVID- 19 triggered a global landslide in share prices. It will be interesting to explore how securities in the sectors of healthcare, consumer stapes and energy were impacted by this phenomenon. We will also be assessing if all the sectors were equally affected, and if not, which ones were affected differently and to what extent. Furthermore, we will investigate the ideal weight of each security in the portfolio to maximize profits and reduce risks during peak COVID-19. We are using a ten-year period for our portfolio, from 2010 to 2021. Securities are taken from Yahoo Finance.

RESEARCH QUESTIONS:

i. *Did the coronavirus pandemic impact the performance of selected portfolios, and which ones were more severely impacted?*
ii. *What's the ideal weights of each security in the portfolio to maximize returns on investments and minimize risks during peak COVID-19?*

A. *Portfolio Sectors-*

Healthcare, Energy, and Consumer Staples

B. *Portfolio Securities –*

Energy : NextEra Energy, Inc(NEE) and TC Energy Corporation (TRP)
Consumer Staples : Target (TGT) and Costco Wholesale (COST)
Healthcare : Vertex Pharmaceutical (VRTX) and Johnson & Johnson (JNJ)

C. *Time Scope*

Jan 1, 2010 to Jan 1, 2021.

TABLE I

PORTFOLIO DESCRIPTION

Sector	Securities
Energy	NextEra Energy, Inc (NEE) TC Energy Corporation (TRP)
Consumer Staples	Target (TGT) Costco Wholesale (COST)
Healthcare	Vertex Pharmaceutical (VRTX) Johnson & Johnson (JNJ)

II

A. *Individual security returns- Simple Moving Averages and Bollinger Bands for selected securities.*

Historical data for our securities has been collected from Yahoo Finance for our target time scope (Jan 1, 2010 to Jan 1, 2021). Our dataset consists of open, close, high, and low prices. We are going to analyze if COVID-19 impacted all the securities in our portfolios, and if securities in each sector were equally affected. On plotting closing prices for all our securities, it is evident that though all of them were impacted by covid, not all of them were affected equally. Fig. 1 shows the stock prices for COSTCO and Fig. 2 for Target. Although both belong to the consumer staples sector, Target seems to be impacted more by covid as the prices show a sharp fall in early 2020, more so than Costco.

On analyzing the healthcare sector, it becomes clear that Johnson & Johnson prices fell sharply in early 2020 (Fig. 3) , and while Vertex Pharmaceutical (Fig. 4) incurred losses too, it does not seem to be quite as much as Johnson & Johnson.

Next we analyze the Energy sector, and we see the graph for TC Energy Corp. has a sharper fall in 2020 than that of Next era energy.

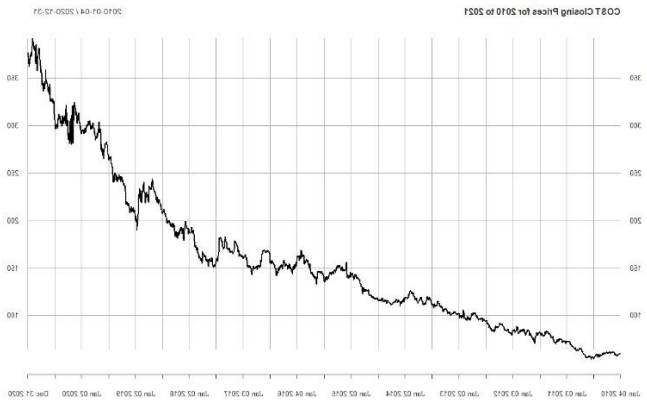


Fig. 1. Costco stock prices 2010-2021

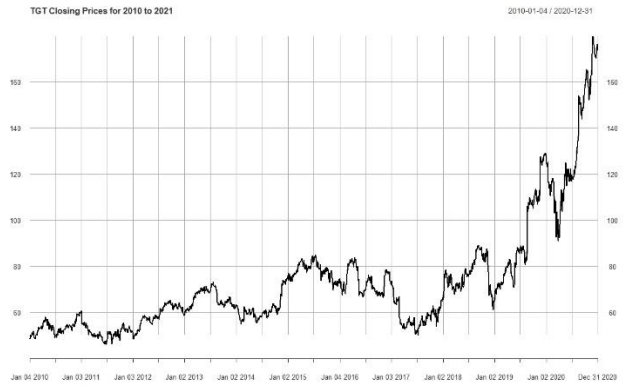


Fig. 2. Target stock prices for 2010-2021

Fig. 3. Johnson & Johnson stock prices for 2010-2021

Fig. 4. Vertex Stock prices for 2010-2021

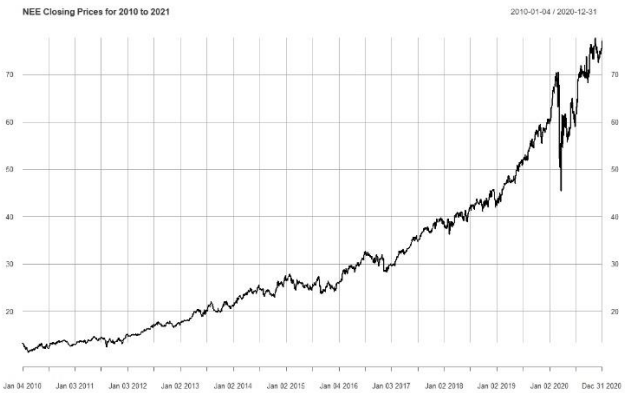


Fig. 5. Next Era stock prices for 2010-2021

Fig.6. TC Energy Corp. Stock prices for 2010-2021

We will further examine our securities by plotting their closing prices for the year 2020-2021. All the securities have been impacted by the pandemic. We can also infer that not all the securities within the same sector were impacted equally. However, it is still not clear which sector was affected most. Fig 13. & Fig. 14. Show us the return on investments and investment values for all securities for the year 2020. Based on Fig.13, Vertex Pharma has the best return on investments for 2020 and was least impacted by covid. We will dig further into this theory by exploring the data further.

Bollinger bands and simple moving averages for target and J&J show that J&J had a higher mean for the year 2020, and maybe the healthcare sector was less impacted by covid. However, this is not enough proof to support this theory. We will calculate returns by merging our securities in the portfolio for the year 2020, the results of which are shown in Fig. 17. Thus, based on our data, Target had the best returns and TC Energy corporation had the worst return for the year 2020-2021.

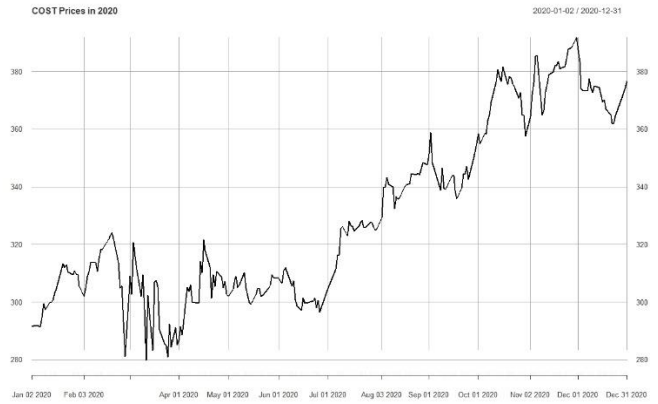


Fig. 7. COSTCO Stock prices in 2020

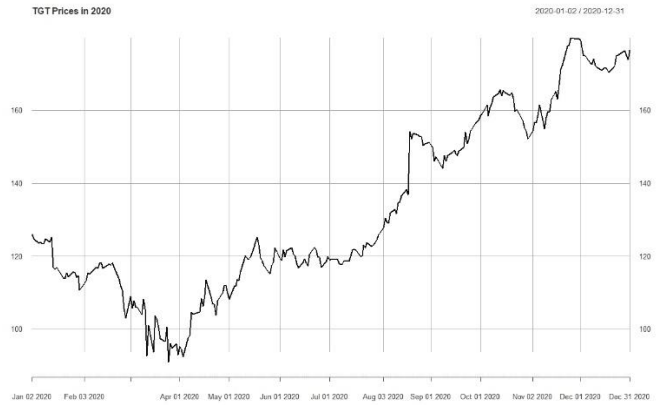


Fig. 8. Target Stock prices in 2020

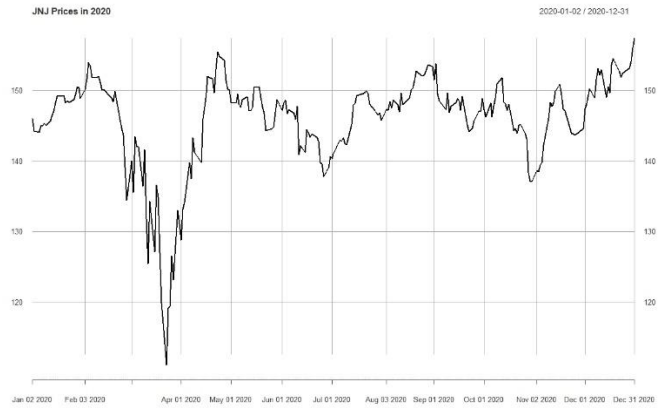


Fig. 9. Johnson & Johnson Stock prices in 2020

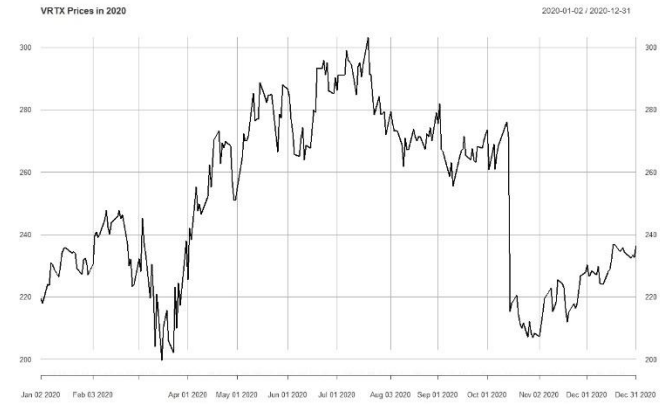


Fig. 10. Vertex Stock prices in 2020

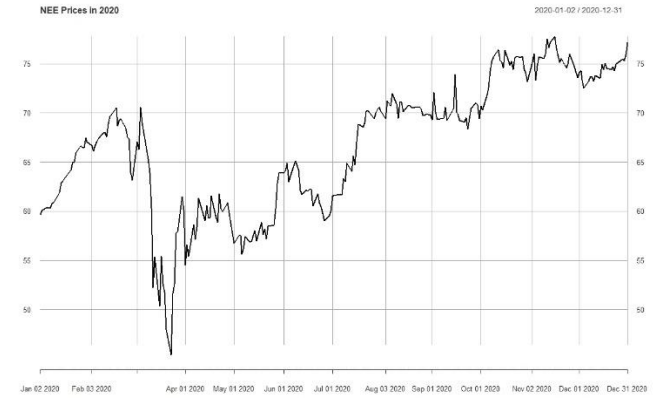


Fig. 11. NextEra Stock prices in 2020

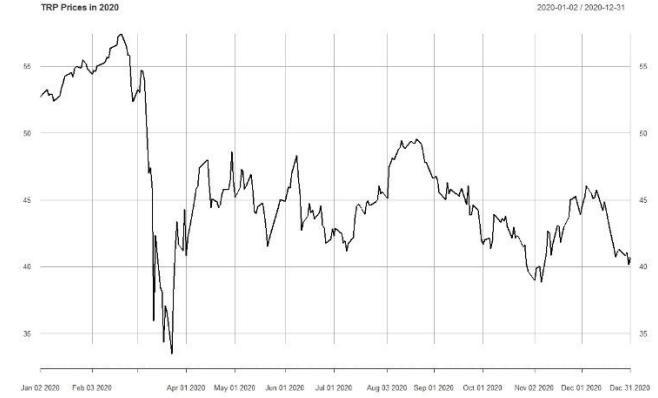


Fig. 12. TC Energy Corp. Stock prices in 2020

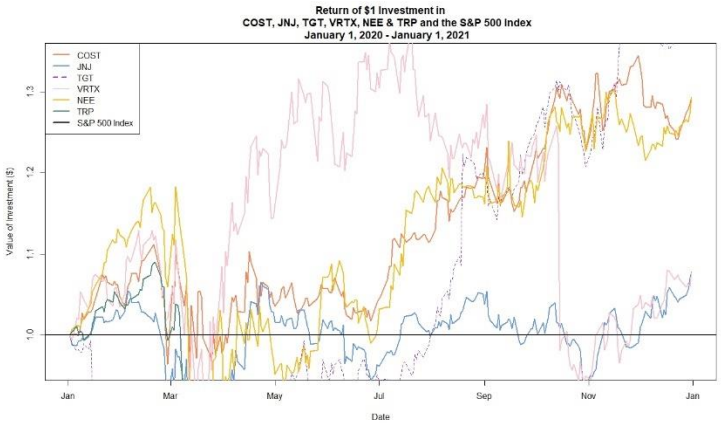


Fig. 13. Return on Investments for all securities in 2020

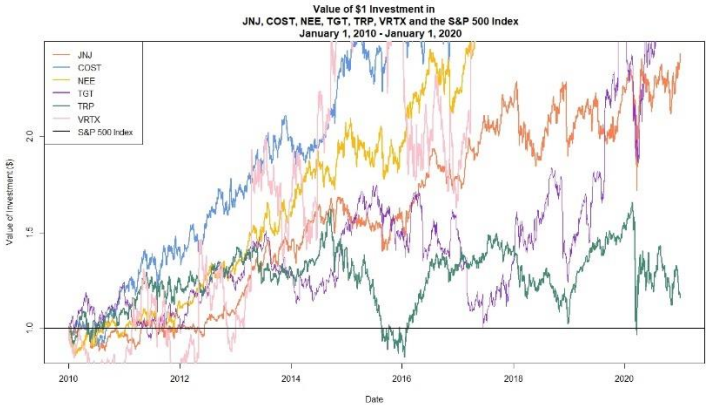


Fig. 14. Value of Investments for all securities in 2020

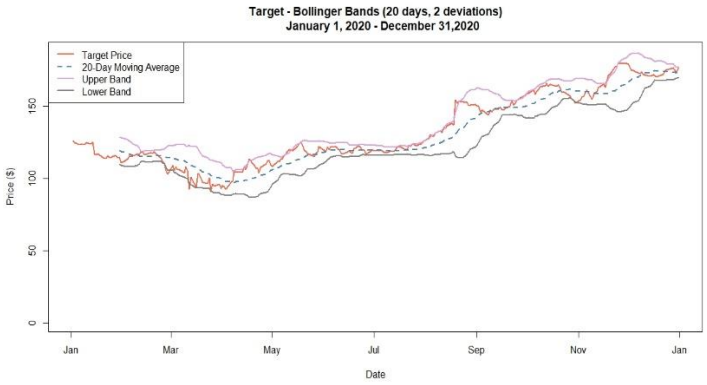


Fig. 15. Target Bollinger Bands

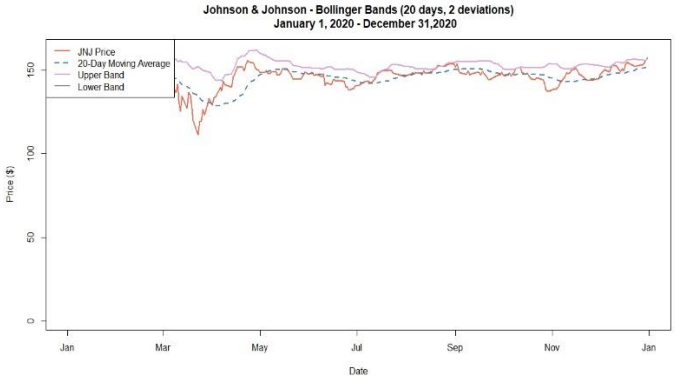


Fig. 16. J&J Bollinger Bands

	COST	JNJ	TGT	VRTX	NEE	TRP
2020-12-31	29.26	7.8167	40.025	7.6965	29.327	-22.732

Fig. 17. Returns for the year 2020 for all securities.

B. Rebalanced equal weighted and value weighted portfolio.

We will look at the Weights for a value weighted portfolio for each quarter by subsetting our data to only the year 2020-2021. Results are shown in Fig. 18

date	COST.wgt	JNJ.wgt	TGT.wgt	VRTX.wgt	NEE.wgt	TRP.wgt
2020-01-04	0.20671	0.25113	0.21757	0.042866	0.18392	0.097812

date	COST.wgt	JNJ.wgt	TGT.wgt	VRTX.wgt	NEE.wgt	TRP.wgt
2020-04-01	0.22503	0.24673	0.1788	0.053655	0.20469	0.091093

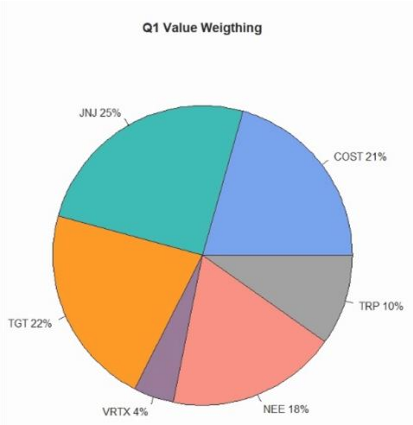
date	COST.wgt	JNJ.wgt	TGT.wgt	VRTX.wgt	NEE.wgt	TRP.wgt
2020-07-01	0.22121	0.2391	0.20972	0.060712	0.18807	0.081182

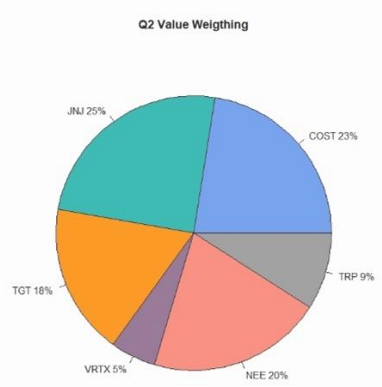
date	COST.wgt	JNJ.wgt	TGT.wgt	VRTX.wgt	NEE.wgt	TRP.wgt
2020-10-01	0.2302	0.21355	0.24202	0.050857	0.19302	0.070355

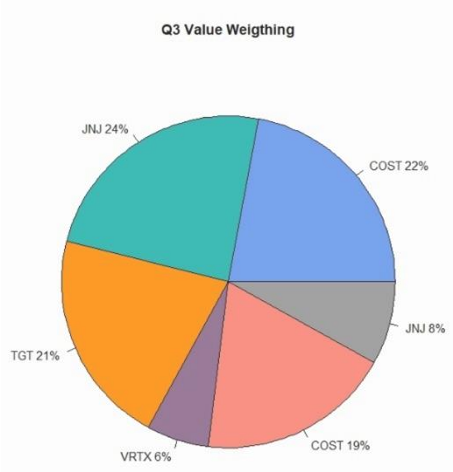
Fig.18. Q1, Q2, Q3 & Q4 weights for Value Weighted Portfolio

C. Weight pie charts for each quarter for VW portfolio

Using the weights for value weighted portfolio, weight pie charts for each quarter are created in Fig. 19 below.







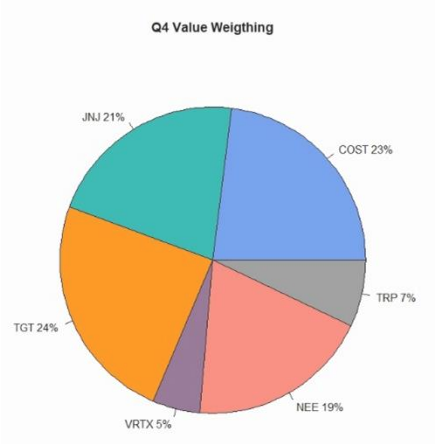


Fig. 19. VW Pie Charts for each quarter in 2020

D. Comparing EW and VW portfolios

A comparison of Equal weighted vs. Value weighted portfolio is shown in Fig. 19. Value weighted portfolio has a better result.

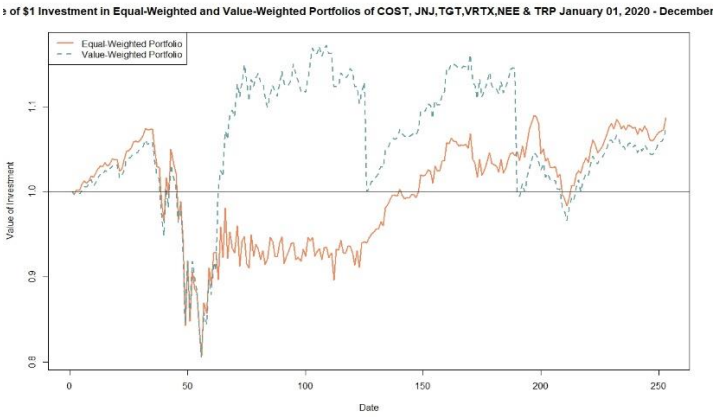


Fig. 20. Value of $1 Investment in EQ & VW Portfolios for all securities from Jan 1, 2020 to December 31, 2020

E. Variance – Covariance matrix (VCOV)

Using our data, a variance-covariance matrix is created, the result of which is in Fig. 21.

	TGT	COST	VRTX	JNJ	NEE	TRP
TGT	0.064358	0.023125	0.021070	0.014143	0.014411	0.015400
COST	0.023125	0.036907	0.019675	0.015369	0.014633	0.013305
VRTX	0.021070	0.019675	0.229937	0.024444	0.019551	0.023894
JNJ	0.014143	0.015369	0.024444	0.028839	0.016180	0.015418
NEE	0.014411	0.014633	0.019551	0.016180	0.039358	0.020505
TRP	0.015400	0.013305	0.023894	0.015418	0.020505	0.057492

Fig. 21. VCOV matrix of all securities.

F. Value at Risk and Estimated Shortfalls

The Estimated Shortfalls (ES) plot of the data is shown below in Fig. 22.

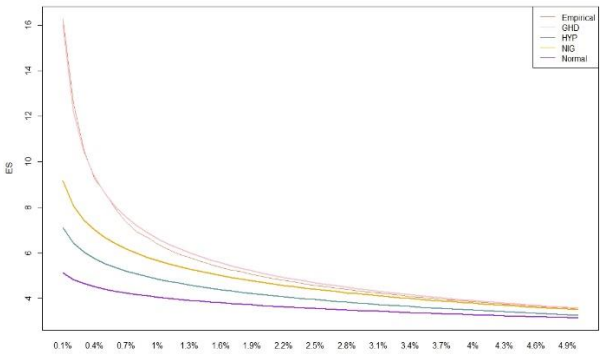


Fig. 22. Estimated Shortfalls plot of Generalized Hyperbolic Distribution, Hyperbolic Distribution, Normal Inverse Gaussian Distribution and Normal Distribution of our portfolio.

G. Extreme Value Theory – Block Maxima Approach

Per our analysis thus far, it is evident that Target had the best returns in the year 2020, and TC Energy corp. had the worst. Therefore, we will proceed with our analysis using only the data for these two securities. Using data for Target, we will create a histogram of the security's returns, losses, maximum biannual losses and diagnostic plots using the Block Maxima method.

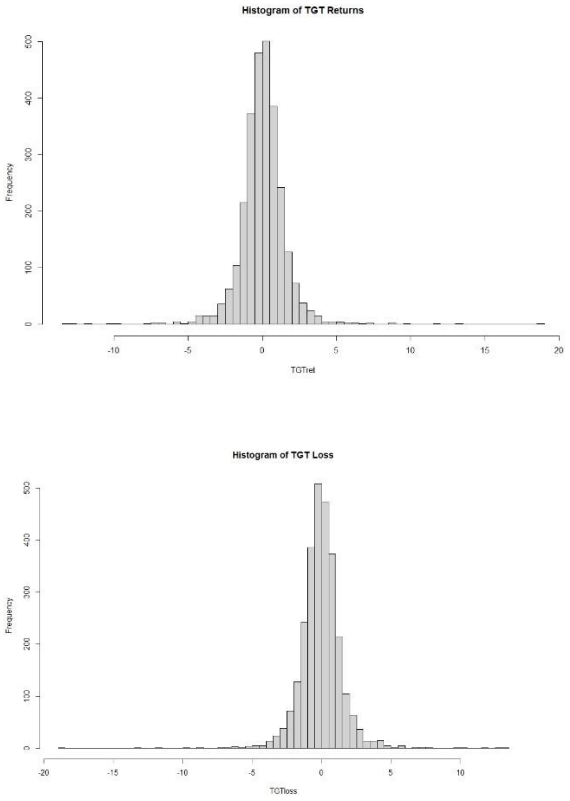


Fig. 23. Histograms of Target returns and losses

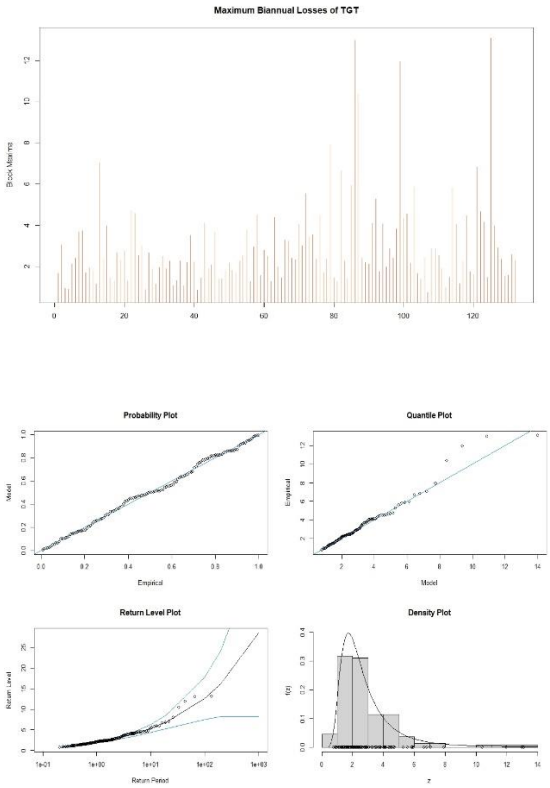


Fig. 24. Maximum Biannual losses and diagnostic plots for Target.

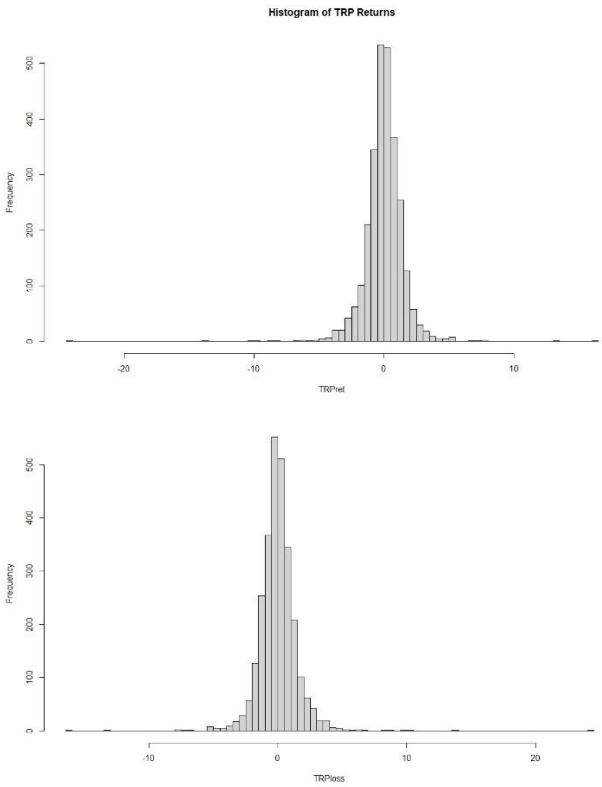


Fig. 25. Histograms of Returns and losses for TC Energy Corp.

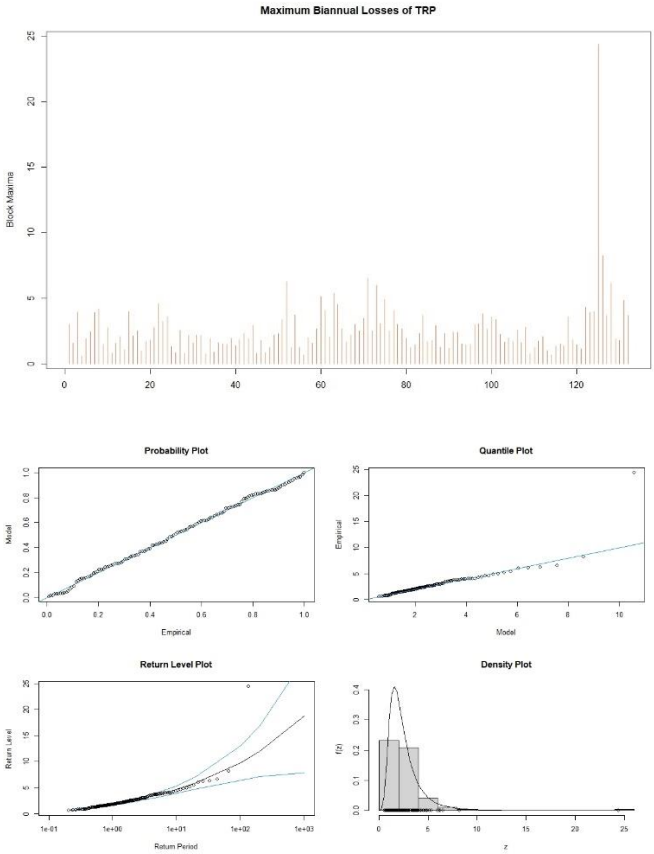
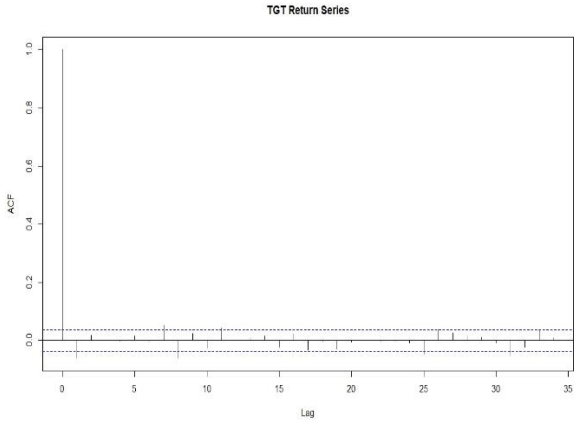


Fig. 26. Maximum biannual losses and diagnostic plots for TC Energy Corp. using Block Maxima

H. Volatility Clustering using ARCH and GARCH models



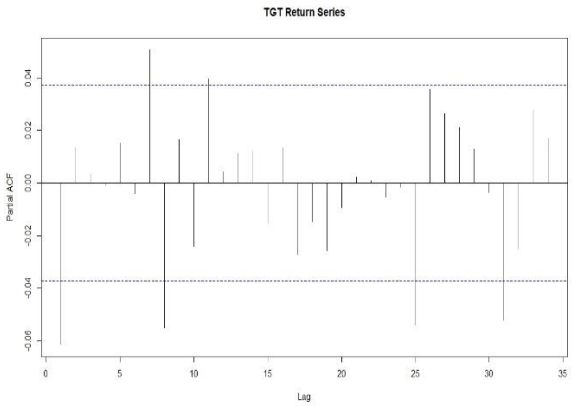


Fig. 27. Target Autocorrelation and Partial Autocorrelation

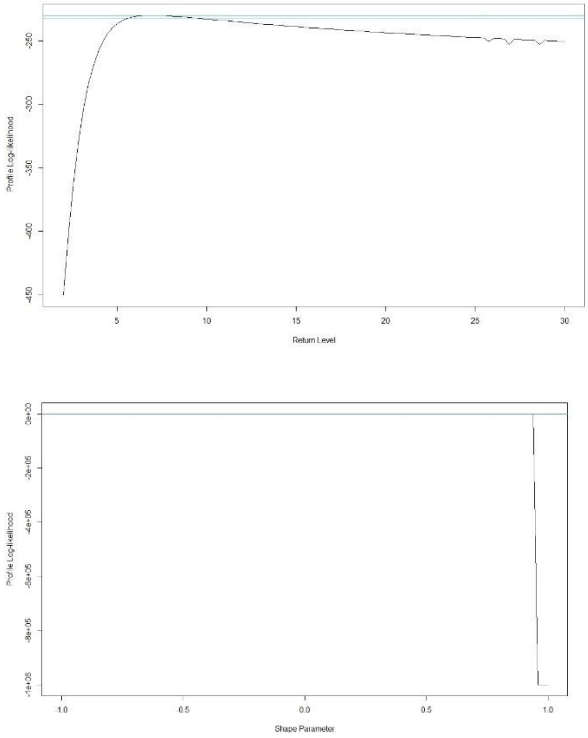
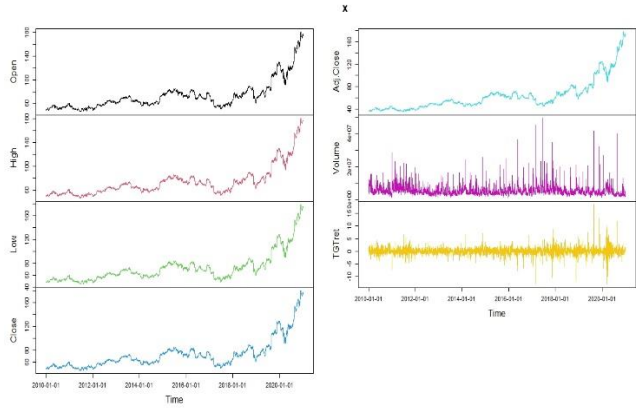


Fig. 28. Target Return Level and Shape Parameter



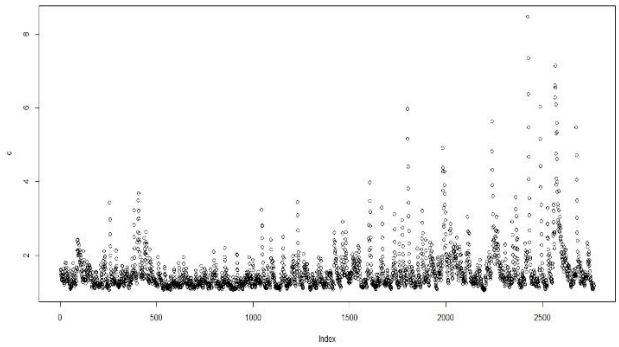


Fig. 29. Target Time Series Plots and Volatility Clustering

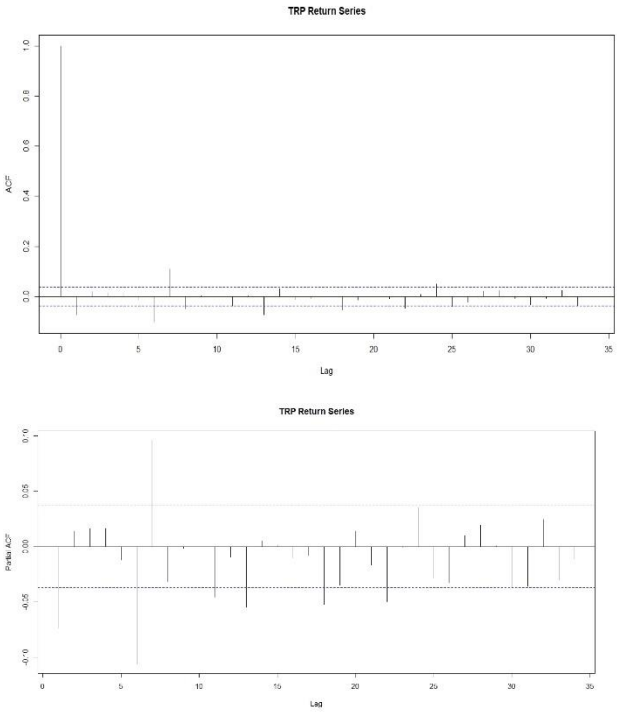


Fig. 30. TRP Autocorrelation and Partial Autocorrelation

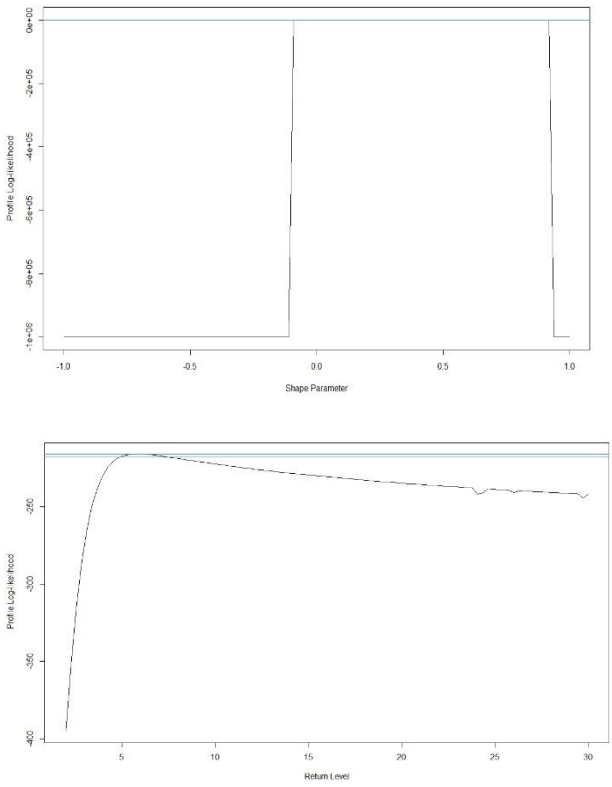


Fig. 31. TRP Return Level and Shape Parameter

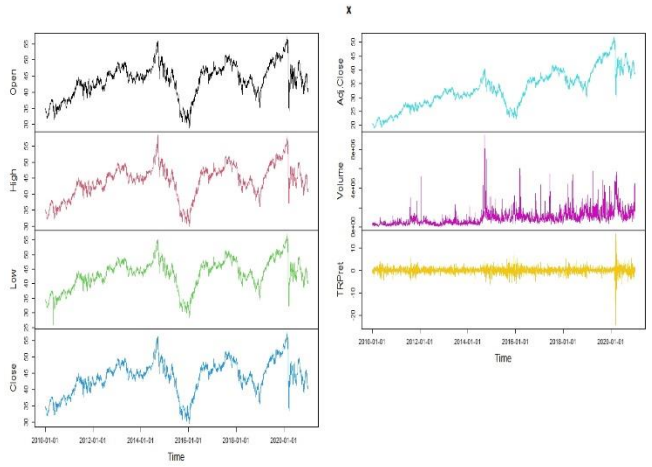


Fig. 32. TRP Time Series Plots and Volatility Clustering

I. Mean Variance Optimization

First, the tangency portfolio will be calculated using the average returns for each security within the portfolio.

TABLE II.

AVERAGE RETURN FOR EACH SECURITY

	Avg.Ret
NEE	0.139919
TGT	0.157073
TRP	0.197452
JNJ	0.096538
COST	0.154889
VRTX	0.255192

The maximum average return for each security is Vertex Pharmaceuticals, which is 0.255.

The weight for each security in the target portfolio, along with SD and Sharpe ratio is shown in table III..

TABLE III.

RETURN, SHARPE RATIO AND STANDARD DEVIATION IN TANGENCY

PORTFOLIO WITH TARGET WEIGHTS

	target.ret	target.sd	wgt.NEE	wgt.TGT	wgt.TRP	wgt.JNJ	wgt.COST	wgt.VRTX	Sharpe
60	0.19109	0.55235	0.08714	0.16579	0.23989	1.3545e-18	0.23867	0.26851	0.34585

An efficient portfolio has been defined as a portfolio which has the higher return compared to the minimum variance portfolio for a given risk level, this efficient portfolio lets us identify which portfolio is acceptable and better than the minimum variance portfolio. The result of the Mean Variance Efficient Frontier is displayed in the Mean Variance Efficient Frontier plot (Fig. 33)

Within the plot, the Triangle indicates the minimum variance portfolio on the frontier. The solid circle indicates the Tangency portfolio.

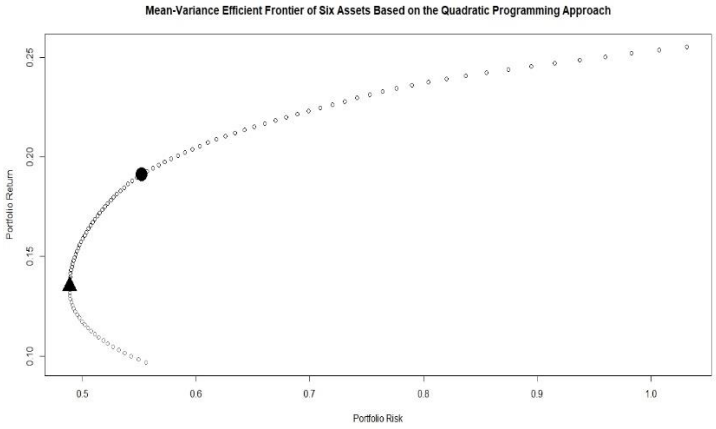


Fig. 33. Mean-Variance Efficient Frontier of Six Assets Based on the Quadratic Programming Approach

III. Model Description

As stated before, the program R has been used for this report and analysis. Some of the methods and functions used in this analysis are matrix algebra method for portfolio returns, quantmod package and functions, Gaussian and historical expected shortfall, Generalized hyperbolic distribution (GHD) and its special cases namely the hyperbolic (HYP) and normal inverse Gaussian (NIG) distributions, Extreme Value Method, Block Maxima Approach, autoregressive conditional heteroscedasticity (ARCH) , Generalized ARCH, volatility clustering, predict function using the ARIMA model, Markovitz Mean Variance Optimization.

IV. Output Analysis

Each output has been analyzed in the project plan itself and results have been inferred.

V. Simulated Results

The output of every model is the simulated result of functions used in the R program.

VI. Recommended Modifications

We could recommend an investor to divide their securities by weights according to the value weighted portfolio and refer to table III for best weights for every security in their portfolio to minimize risk and maximize returns.

VII. Conclusion

(1) Did the pandemic impact the performance of the selected securities, and if so, were all the sectors affected equally? (2) The proper weight of each security in the portfolio to reduce risks and maximize profits during peak COVID-19.

For the first question “Did the pandemic impact the performance of the selected securities, and if so, were all the sectors equally affected”, we conclude that covid did indeed have a big impact on each security and every sector. However, not all the securities within the same sector were equally affected. Furthermore, no one sector was more affected than the other. For instance, both securities from the healthcare sector were affected, but there was a vast difference in them. Each security has displayed a different pattern for the year 2020- 2021.

For the second question, **“**What would be the proper weight of each security in the portfolio to reduce risks and maximize profits during peak COVID-19”, Mean Variance Optimization

method was used (see table III). Per this result, more weight should be put on TC Energy Corporation, Costco, and Vertex Pharmaceuticals, all of which are from different sectors.

VIII. Appendices