IBA Institute of Business Administration Karachi

Leadership and Ideas for Tomorrow

Project 2: Portfolio Analysis [PKGS, PPP, BPL]

Programming for Finance — FIN 460

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ALLOCATION OF CERTAIN WEIGHTAGE TO STOCKS

The portfolio analyzed in this report contains stocks Pakistan Paper Products Limited (PPP), Packages Limited (PKGS) and Burshane Private Limited (BPL) that are listed on the Pakistan Stock Exchange (PSX). The portfolio weights are divided as following for the initial analysis:

PKGS	50%
PPP	30%
BPL	20%

These weights were allocated based on stock's individual performance as described and discussed in the individual reports in detail. This includes the historical performance of all the respective stocks. It was discovered that PKGS has been performing the best in the stock market, which is the reason why it has the highest weightage in the portfolio. PKGS is then followed by PPP and BPL with 30% and 20% of the weights respectively. Even though BPL's historical performance has been worst, it is still allocated 20% of weight to ensure some level of diversity in the portfolio.

This weightage is very different from the optimal allocation of stocks to the portfolio which is and analyzed discussed further in the optimal allocation section of analysis in the report.

HISTORICAL PERFORMANCE OF THE PORTFOLIO

Historical performance of our portfolio consisting of PKGS, PPP and BPL stocks was assessed using the historical compounded cumulative returns of the portfolio over the years. Historical compounded cumulative returns are a measure of the growth of an investment over a period of time. They are calculated by taking the compounded returns from each period and adding them together to determine the overall return for the entire period.

As it can be seen from the graph above, the portfolio had the lowest returns in 2012 after which there was a steep increase in returns until it reached the highest returns during the year of 2017. Lately the portfolio returns are on a consistent decline after a significant peak in 2021.

This signifies that the portfolio performed its best during the year of 2017 and worst during 2012. Lately, the portfolio performance has been on a gradual decline in the past few months. Right now, the portfolio gives the returns of about 300%.

ANALYSIS

PORTFOLIO VAR

First Approach (Historical Approach)

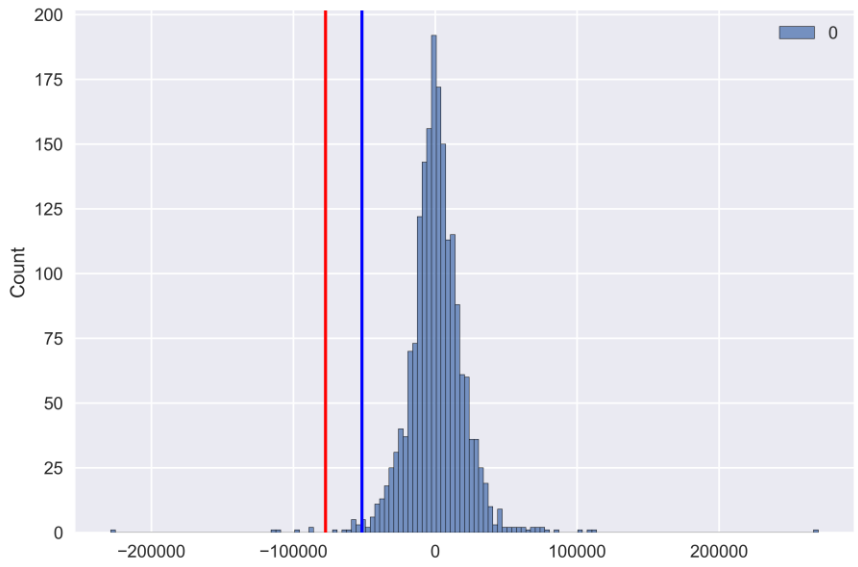
VAR is a measure of the risk of loss for an investment or portfolio. It represents the maximum amount of loss that is expected to occur with a certain level of confidence (in this case, 99%).

CVAR is similar to VAR, but instead of just providing the maximum expected loss, it gives the average loss over all scenarios where the loss exceeds the VAR.

The value at risk (VAR) is calculated by sorting the daily profit and loss (PnL) values and taking the value at the tail (1 - conf) position. The conditional value at risk (CVAR) is calculated by taking the mean of all PnL values that are less than or equal to the VAR.

The value at risk (VAR) of -51666.468 means that with 99% confidence, the portfolio is expected to lose at most an amount of Rs. -51666.468 when a total of Rs. 1 million is invested in it. In other words, there is a 1% probability that the portfolio will lose more than this amount.

The conditional value at risk (CVAR) of -77320.08 means that among all scenarios where the loss exceeds the VAR, the average loss is Rs. -77320.08 when Rs. 1 million is invested in the portfolio. In other words, if the portfolio experiences a loss that exceeds the VAR, the expected loss is -77320.08.



Both the VAR and CVAR values are negative because the PnL values are sorted in ascending order, and the VAR and CVAR are taken from the lower tail of the distribution. This means

that the VAR and CVAR represent the expected losses for the portfolio. This is why both VAR anc CVAR are at the left side of the distribution in the graph. (Blue vertical line is Var and Red is CVAR)

The VAR is generally considered to be a more conservative measure of risk, because it only considers the worst-case scenario (maximum expected loss). On the other hand, the CVAR takes into account the average loss over all scenarios where the loss exceeds the VAR, which makes it a more comprehensive measure of risk.

We have tried all 4 approaches or VAR on our portfolio. The values and graphs from all approaches indicate the same thing with same investments and CI. But however, in each case the values are different. The values are as follows:

Historical Approach		Model based		Monte carlo		Forecasted loss	
Var	-51,666.5	Var	-48,271.6	Var	-48,303.2	Var	-112,026
Cvar	-77,320.1	Cvar	-55,303	Cvar	-55,339.6	Cvar	-112,132

Second Approach (Model Building Approach)

The model-building approach to calculating value at risk (VaR) and conditional value at risk (CVaR) is a statistical method that uses assumptions about the distribution of returns for an investment or portfolio to estimate the risk of loss. The parametric or variance-covariance approach is one specific method within the model-building approach.

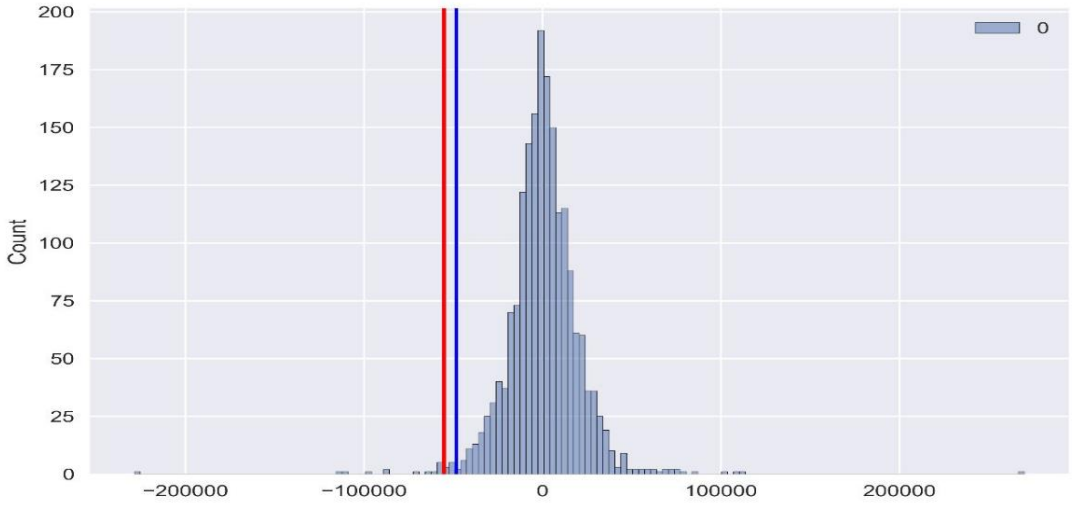
In the parametric approach, the returns of the investment or portfolio are assumed to follow a specific probability distribution, such as the normal distribution or the t-distribution. The parameters of the distribution (such as the mean and standard deviation) are estimated using historical data or other methods, and the VaR and CvaR are calculated based on the assumptions of the distribution.

The historical approach to calculating VaR and CvaR, on the other hand, does not make any assumptions about the distribution of returns. Instead, it uses historical data to estimate the risk of loss by calculating the losses that have occurred over a certain time period in the past.

One advantage of the model-building approach is that it allows for the incorporation of more information about the distribution of returns, such as skewness and kurtosis. However, this approach may be less reliable if the assumptions about the distribution of returns are not accurate.

The historical approach is generally considered to be more conservative, because it is based on actual historical data rather than assumptions about the distribution of returns. However, it may be less accurate in situations where the distribution of returns has changed significantly from the historical period.

The graphs and values for both approaches are different. The graph for model-based approach is:

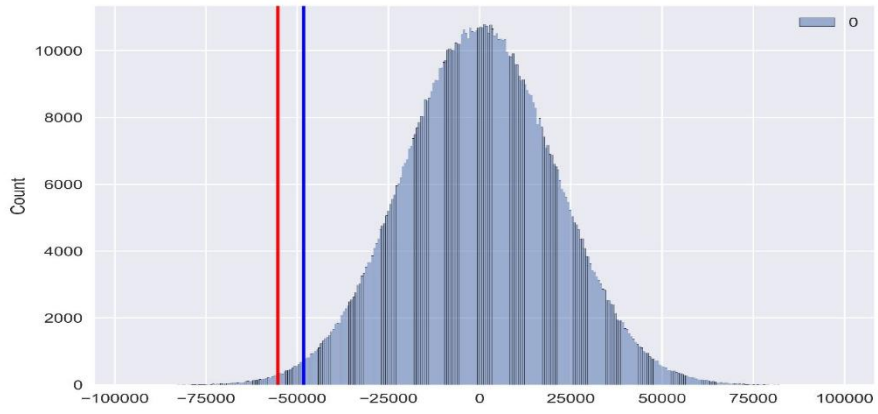


Third Approach (Monte-Carlo Approach)

Monte Carlo simulation is a method of statistical sampling that involves generating random samples from a probability distribution to estimate statistical properties or quantities of interest. In the context of calculating value at risk (VaR) and conditional value at risk (CvaR), Monte Carlo simulation can be used to generate random scenarios for the returns of an investment or portfolio, and then use these scenarios to estimate the risk of loss.

We generated 1000000 of random stock return scenarios (iterations), with same investments and confidence interval as above, using a multivariate normal distribution with the variance-covariance matrix as the input. The purpose of this step is to simulate different possible outcomes for the portfolio under different market conditions.

The graph under this approach is:

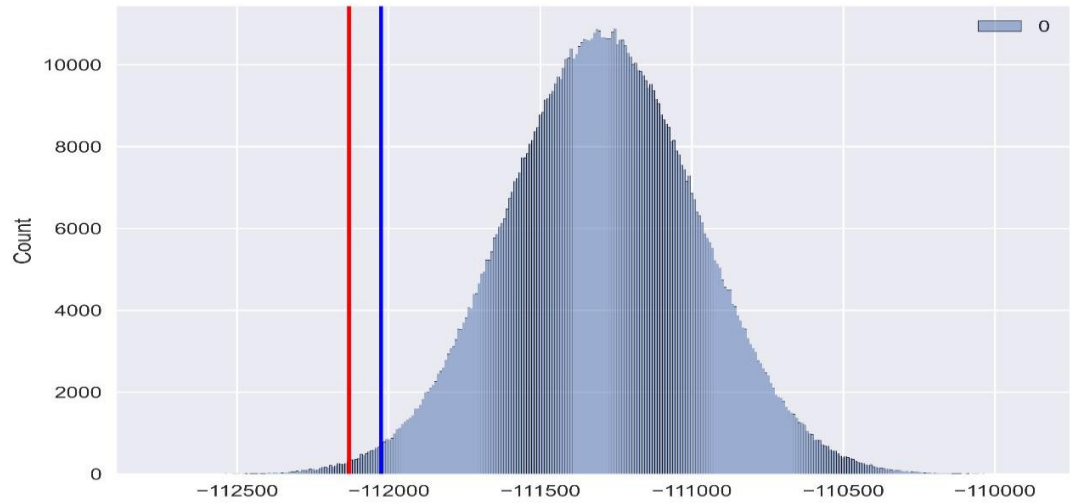


Fourth Approach (Forecasted Loss Approach)

The forecasted loss approach is a forward-looking method that uses statistical models to forecast future losses. The forecasted loss approach involves using statistical models to forecast future losses based on historical data and other relevant information. It also takes into account changes in market conditions and other factors that may affect the risk of a portfolio.

The historical approach is generally considered to be less accurate than the forecasted loss approach, as it does not take into account changes in market conditions or other factors that may affect the risk of a portfolio. This approach also gave the highest values for both VAR and CVAR than the other three.

The graph showing forecasted loss approach VAR and Cvar is below.



COPULAS

In finance, a copula is a mathematical function that describes the dependence structure between two or more random variables. Copulas are often used in modeling the joint distribution of multi-dimensional datasets, particularly when the variables in the dataset may have different marginal distributions but are connected through some underlying dependence structure.

Copulas in finance can be used to model the joint probability of default for a portfolio of stocks. The Probability of Default of each stock in the portfolio is modeled as a random variable, and the copula describes the dependence structure between the PDs of the different stocks. By modeling the dependence structure between the PDs of the stocks in a portfolio, it is possible to estimate the joint PD of the portfolio, which can be used to calculate other risk measures.

The joint probability is calculated using the "pobs" function of the copula model and the pseudo-observations of the log returns. The output came out to be 0.25, 0.5, and 0.75.

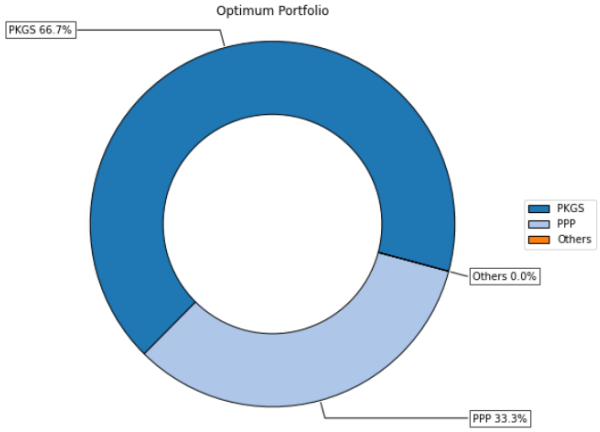
The output values of 0.25, 0.5, and 0.75 represent the joint probability that the log returns of the three stocks will fall below the benchmark of -0.01 at the same time. The joint probability can be interpreted as the probability that the three stocks will all experience negative log returns at the same time, which shows that the portfolio has significant credit risk.

In this case, the output values of 0.25, 0.5, and 0.75 indicate that there is a relatively high probability that the three stocks will all experience negative log returns at the same time.

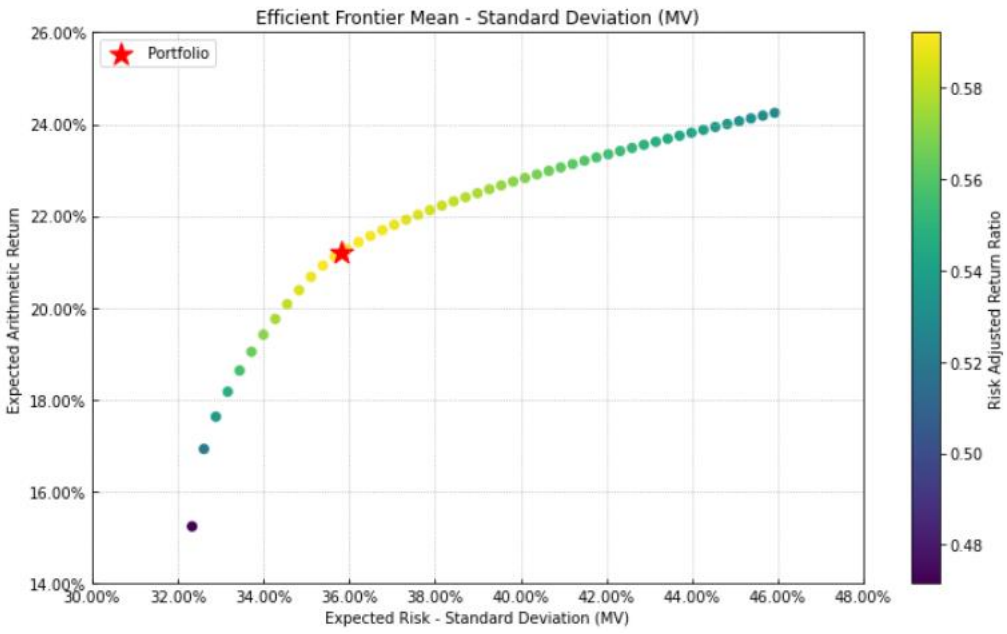
OPTIMAL ALLOCATION

The chosen risk model for the portfolio formation in Python through riskfolio library is MV (standard deviation). The optimal portfolio would include the following weights of each stock that can be seen in the Table below and the pie chart.

	weights
BPL	3.159886e-11
PKGS	6.674925e-01
PPP	3.325075e-01

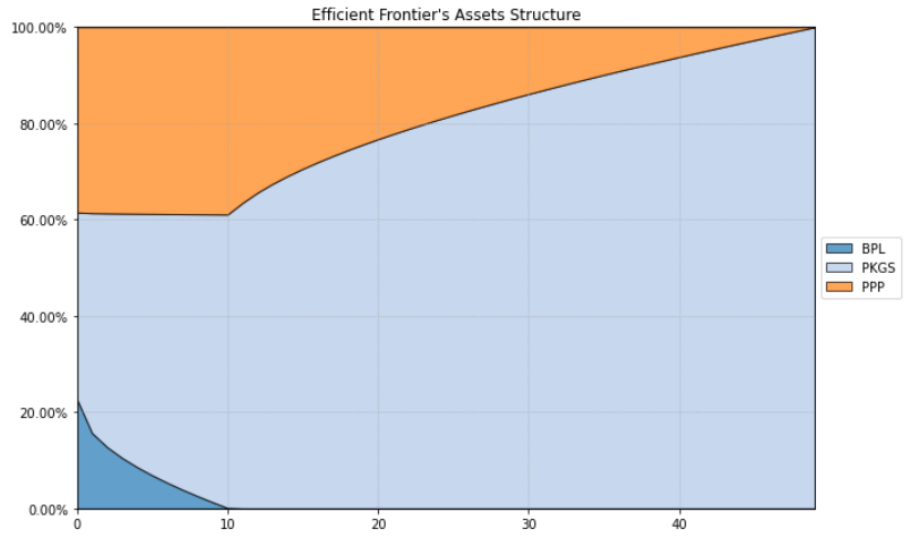


The figure above shows the optimum portfolio weightage which includes 66.7% of PKGS stocks and 33.3% of PPP stocks. BPL is not a part of the optimal portfolio as it's weight is nearly negligible as it can be seen in the table above.



The graph above shows the risks and returns of the 50 different efficient portfolios. It is a plot of the efficient frontier, with the x-axis representing the expected return and the y-axis representing the expected risk of the portfolio. The plotted points on the graph represent different portfolios with different weightages of the stocks (as shown in the Figure below). The first portfolio has the least risk and the least return and the 50th portfolio contains the highest risk and also the highest return. The red star represents the optimal portfolio that has around 21.25% return and 35.8% risk.

The figure below shows the weightage of BPL, PKGS and PPP stocks in all 50 portfolios of the efficient frontier's assets structure. It can be seen that the BPL stock is only found in 10 of the portfolios which is very low. Highest number of BPL stocks can be found when the return and the risk of the portfolio is low however at 50th portfolio the only stock found is PKGS which gives the maximum risk and maximum return.



The Jupyter report on the portfolio on the next page gives a summary of the optimal portfolio showing various performance metrics. The report includes the return of the portfolio, different risk measures based on the returns and drawdowns, historical returns of the portfolio, the optimal portfolio composition, risk contribution per stock and portfolio returns histogram with the risk models and their respective returns.

Riskfolio-Lib Report

	Values	(Return - MAR)/Risk
Profitability and Other Inputs		
Mean Return (1)	21.2182%	
Compound Annual Growth Rate (CAGR)	6.1963%	
Minimum Acceptable Return (MAR) (1)	0.0000%	
Significance Level	5.0000%	
Risk Measures based on Returns		
Standard Deviation (2)	35.8277%	0.592229
Mean Absolute Deviation (MAD) (2)	24.0435%	0.882492
Semi Standard Deviation (2)	24.6638%	0.860297
First Lower Partial Moment (FLPM) (2)	11.3385%	1.871336
Second Lower Partial Moment (SLPM) (2)	24.0222%	0.883273
Value at Risk (VaR) (2)	48.4017%	0.438377
Conditional Value at Risk (CVaR) (2)	75.8116%	0.279880
Entropic Value at Risk (EVaR) (2)	190.7334%	0.111245
Worst Realization (2)	376.6613%	0.056332
Skewness	0.33453	
Kurtosis	19.42987	
Risk Measures based on Drawdowns (3)		
Ulcer Index (UCI)	24.7471%	0.857402
Average Drawdown (ADD)	18.0786%	1.173663
Drawdown at Risk (DaR)	51.8272%	0.409402
Conditional Drawdown at Risk (CDaR)	61.3108%	0.346076
Entropic Drawdown at Risk (EDaR)	69.7177%	0.304344
Max Drawdown (MDD)	91.9891%	0.230660

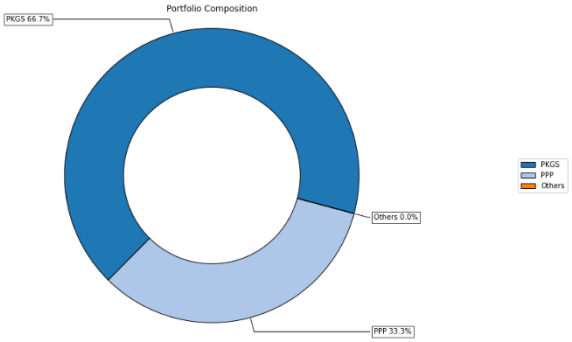
(1) Annualized, multiplied by 252

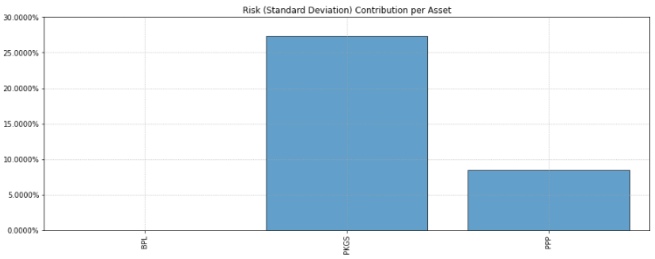
(2) Annualized, multiplied by √252

(3) Based on uncompounded cumulated returns

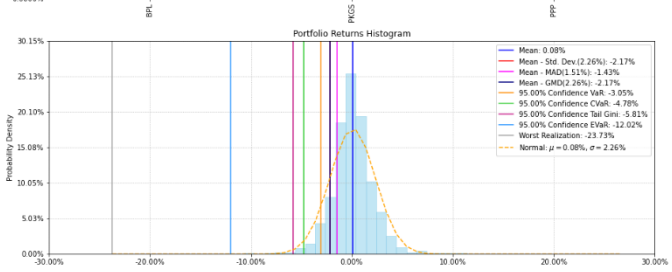
The table on the left shows the major values of the portfolio including returns, CAGR and values of the different risk models.

The line graph on the left shows the historical compounded returns of the portfolio for the last 10 years.

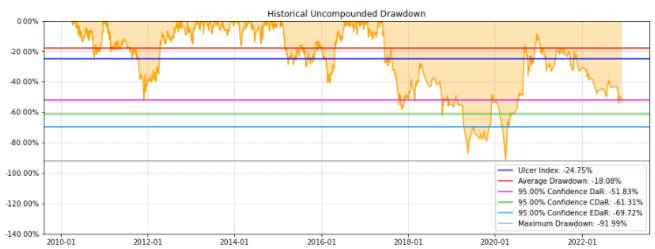




The bar chart on the left shows that PKGS has the highest contribution of risk (standard deviation) in the portfolio.



The histogram on the left represents the normal distribution of the portfolio returns with its respective Std. deviations and cVar values.

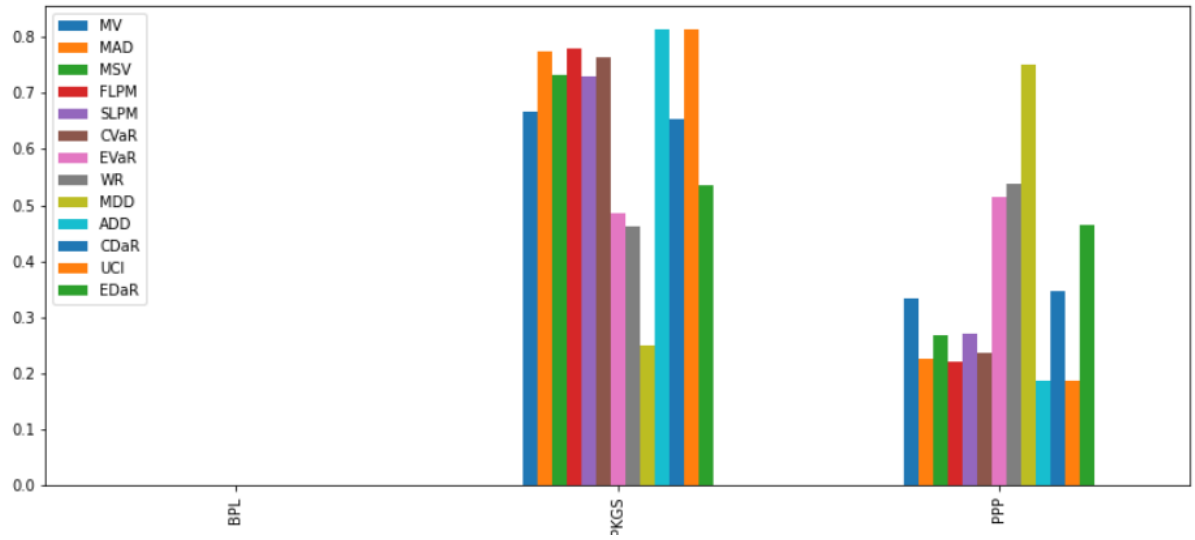


MV: standard deviation	WR: worst relative drawdown
MAD: mean absolute deviation	MDD: maximum drawdown
MSV: mean semi-variance	ADD: average drawdown
FLPM: first lower partial moment	CDaR: cumulative drawdown at risk
SLPM: second lower partial moment	UCI: upside capture index
CVaR: conditional value at risk	EDaR: expected drawdown at risk
EVaR: expected value at risk	

The table below shows the weightage of each of our stocks in the optimal portfolios for different risk models. The abbreviations in the table below are explained in the table above.

	MV	MAD	MSV	FLPM	SLPM	CVaR	EVaR	WR	MDD	ADD	CDaR	UCI	EDaR
BPL	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
PKGS	66.75%	77.34%	73.12%	77.86%	72.98%	76.21%	48.63%	46.21%	25.03%	81.40%	65.33%	81.40%	53.46%
PPP	33.25%	22.66%	26.88%	22.14%	27.02%	23.79%	51.37%	53.79%	74.97%	18.60%	34.67%	18.60%	46.54%

The table above is plotted in the graph below. It is to be noted that BPL stock is not a part in the optimal portfolio of any of the risk models. And PKGS stock dominated the portfolio in all the risk models except at expected value at risk, worst relative drawdown and maximum drawdown.



RECOMMENDATION

This portfolio containing PKGS, PPP and BPL stocks is not recommended to the investors for a number of reasons discussed below.

The joint probability of default, as discussed in the analysis section of the report is high, which means that the all the stocks in the portfolio can easily default together under certain circumstances. This is an alarming situation for the portfolio as this establishes the minimal nature or absence of diversification in the portfolio.

The VaR and cVaR values are also very high for the portfolio. If we consider the historical approach of calculating VaR and cVaR of our portfolio for the discussion here, there is a 1% probability that the portfolio will incur a loss of more than Rs. -51666.468 with the investment of Rs. 1 million.

The optimal allocation of our portfolio recommended 66.7% of the weightage for PKGS, 33.3% of the weightage for PPP and 0% of the weightage for BPL. This makes the portfolio undesirable since the investment stays in the same industry sector and does not ensure diversification in the portfolio in case of changes in market. Investment of more than 25% in a single sector is an unwise decision that results in concentration risk. The optimal allocation recommends 100% of investment in the paper and board industry which makes this portfolio undesirable to the investors.

If this portfolio is to be invested in, it would be recommended that the weights allocated should be similar to the weights allocated initially in the report rather than the optimal allocation of the stocks to ensure some level of diversification in the portfolio.