

Portfolio Risk Management

- Cassandra Asset Management

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**A copula-based simulation model for big tech
and defensive portfolios risk management**

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December 16, 2018.

Research Paper :

**A copula-based simulation for big tech and
defensive portfolios risk management.**

By :

**Pinyi.Wu, Shiqi.Dong, Xiaowen.Man,
Yifan.Yang**

Published on December 16, 2018

Objective

1. Making portfolio on the basis of α and β values using Nifty 50 Index and Treasury bills.
2. Comparison of 3 Portfolios : Aggressive, Defensive, Rising Giants on the basis of their returns.
3. Optimisation of portfolio and generalization.

Analysis

General

↓
Plot

↓
Correlation

Technical

↓
Beta

↓
Alpha

Copula

↓
Fitting

↓
**Checking best
fit distribution**

Portfolio

↓
GARCH(1,1)

↓
Drawdowns

↓
**Cumulative
returns**

↓
Optimisation

↓
Comparison

↓
**Real life
example**

Selected Stocks

- **Reliance (Oil & Gas)**
- **Tata Consultancy Services (IT)**
- **HDFC Bank (Finance)**
- **Bajaj Finservice Ltd (Finance NBFC)**
- **Sun Pharma (Pharmaceutical)**
- **Indian Oil Corporation Ltd (Oil & Gas)**
- **Rajesh Export (Precious Metals)**
- **Hindustan Uniliver (FMCG)**
- **Laurus Labs Ltd (Pharma)**
- **Finolex Industries Ltd (Plastics & Pipe)**
- **Suprajit Engineering Ltd (Auto Parts)**
- **Sonata Software Ltd (IT Services & Consulting)**

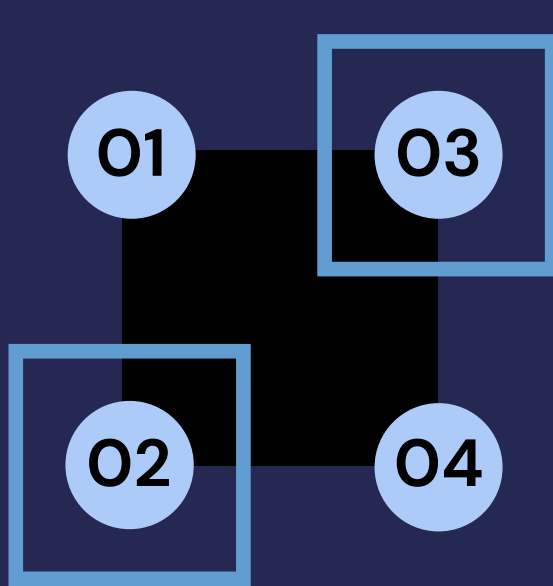
Financial Risks

Market Risk

Market risk is what happens when there is a substantial change in the particular marketplace in which a company competes.

Liquidity Risk

Liquidity risk refers to how easily a company can convert its assets into cash if it needs funds; it also refers to its daily cash flow.



Credit Risk

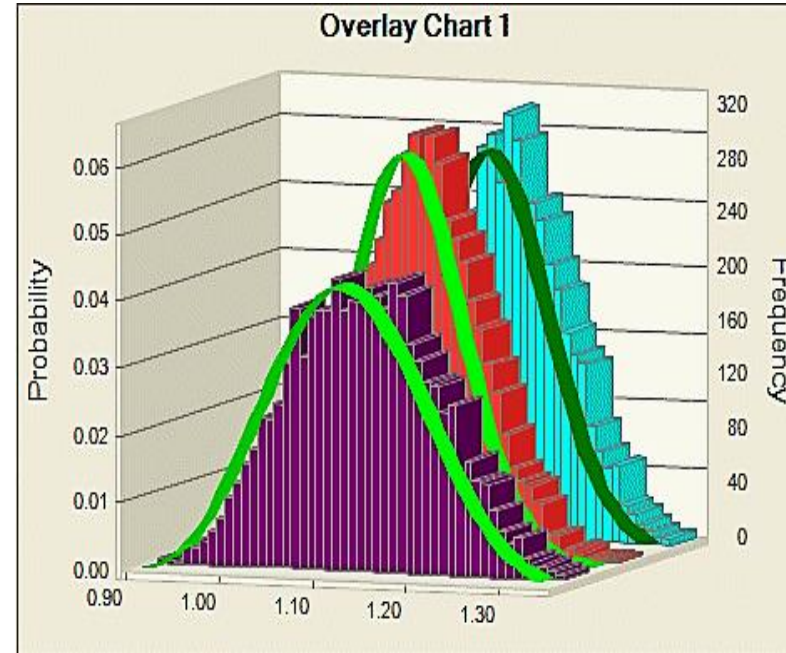
Credit risk is when companies give their customers a line of credit; also, a company's risk of not having enough funds to pay its bills.

Operational Risk

Operational risks emerge as a result of a company's regular business activities and include fraud, lawsuits, and personnel issues.

Copula

- Copulas were identified as the functions that join or couple Multivariate distribution functions to their uniform one-dimensional marginal distribution functions.
- Copula is a new methodology that measures dependence between random variables and also is used in the study of characteristics of financial markets, portfolio aggregation, and risk analysis.

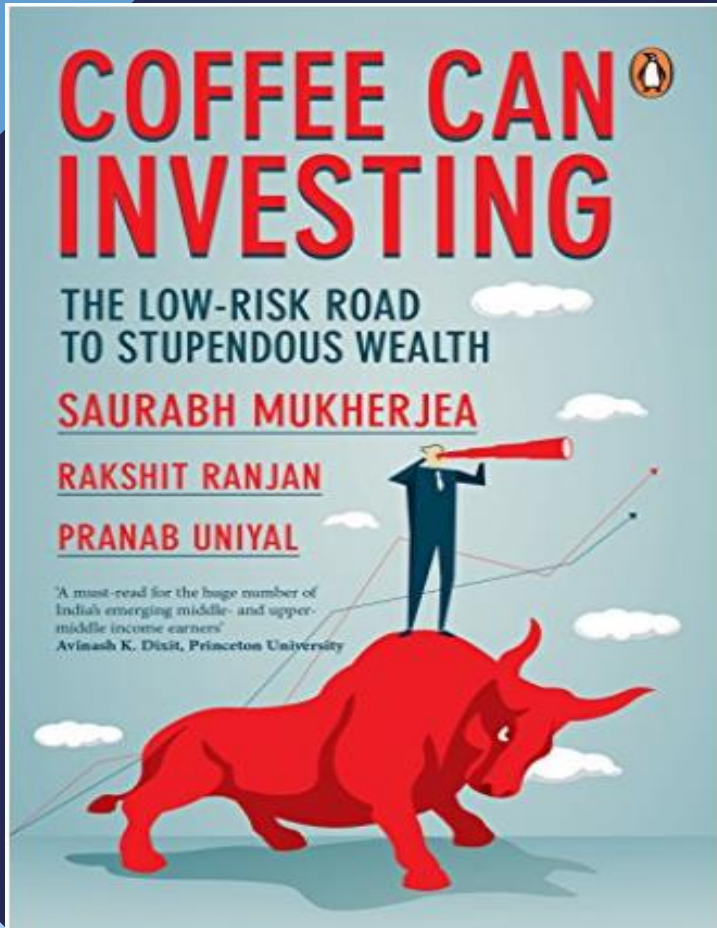


Value At Risk

- **Value-at-risk (VaR) is a powerful tool that can assess market risk in real-time, which provides important suggestions when making decisions in trading and hedging.**
- **Although VaR has good performance in market risk management and was adopted as standard risk analysis in the financial area.**
- **VaR (Variance - Covariance method) = $-(\mu + Z\alpha * \sigma)$**



**How to Use Value
at Risk (VaR) to Manage
Your Assets**



- Coffee can investing refers to the “buy and forget” approach to investing in the stock Market . It is a low-risk method to create enormous wealth by buying a particular stock quantity at a specific price and then holding them for at least ten years to generate high returns.
- Primarily, coffee can investing is a long-term investment strategy suitable for passive investors with an investment horizon of more than a decade.

Selection Criteria of Stocks for Rising Giants Portfolio



Market Capitalization > 4000 Cr

Free Cash Flow > 250 Cr (last 5 years)

ROE \geq 15% (last 5 years)

ROCE \geq 15% (last 5 years)

Low Debt / Equity \leq 0.5

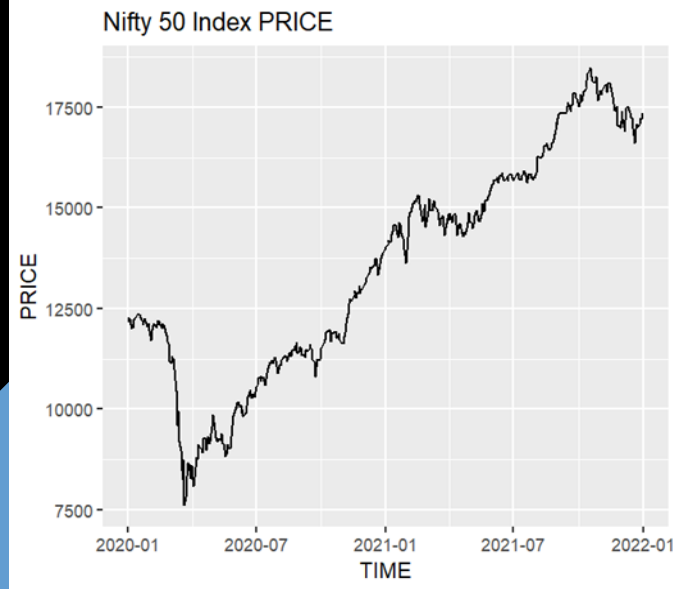
MOAT

Data Snapshot

	A	B	C	D	E	F
1	Date	Open	High	Low	Close	Volume
2	01-01-2020	1275	1280.4	1271	1279.05	44876
3	02-01-2020	1278	1287.9	1277.5	1286.65	41084
4	03-01-2020	1289	1289	1263	1268.1	1100857
5	06-01-2020	1265.8	1265.8	1236	1241.15	574250
6	07-01-2020	1258.3	1271.75	1252.2	1260.85	594878
7	08-01-2020	1250	1261.3	1240	1257.05	2299367
8	09-01-2020	1263	1275.8	1263	1270.8	143800
9	10-01-2020	1283	1286.9	1275.4	1283.2	147090
10	13-01-2020	1285	1296.6	1277.3	1287.25	4046429
11	14-01-2020	1293.5	1293.5	1278	1289.45	4766929
12	15-01-2020	1289.45	1289.45	1274.05	1284.05	178511
13	16-01-2020	1283	1291.2	1279.4	1287.6	339085
14	17-01-2020	1285	1285	1271.95	1277.85	185105
15	20-01-2020	1302.75	1303.8	1252.8	1254.9	259242
16	21-01-2020	1255	1255	1239	1244.15	177060
17	22-01-2020	1249	1255.45	1235	1240.35	489687
18	23-01-2020	1242	1246.65	1231.85	1245	130687
19	24-01-2020	1247.7	1254	1239.5	1244.15	346362
20	27-01-2020	1237	1237.95	1211.5	1212.9	437154
21	28-01-2020	1225.9	1227.45	1213.25	1222.85	162574
22	29-01-2020	1227	1242	1222.85	1235.95	446105
23	30-01-2020	1236	1239.35	1217.45	1227.1	261904
24	31-01-2020	1234.9	1237.8	1220.55	1225.7	102936
25	03-02-2020	1199.1	1199.1	1178	1193	206699
26	04-02-2020	1210	1233.7	1199	1229.25	211614
27	05-02-2020	1235	1248	1227.4	1244.2	237226
28	06-02-2020	1248	1248.3	1237.45	1239.85	191275
29	07-02-2020	1242.15	1246.7	1232	1241.9	106272
	hdfcbank					

Nifty 50

The NIFTY 50 is a benchmark index that represents the weighted average of 50 of the largest Indian companies listed on the National Stock Exchange.



$$\beta = \frac{Cov_{i,m}}{\sigma_m^2} = \frac{(R_i - \bar{R}_i)(R_m - \bar{R}_m)}{(R_m - \bar{R}_m)^2}$$

Beta Values

Beta coefficient (β), a widely used method to evaluate risk, it is employed to measure the risk volatility concerning the required return of a specific asset compared to the volatility of the average of the overall market portfolio.

Beta Comparison

AGGRESSIVE PORTFOLIO :

RELIANCE	TATA CONSULTANCY SERVICES	HDFC BANK	BAJAJ FINSERVICE LTD	PORTFOLIO BETA
1.103569	0.7246668	1.099369	1.345164	1.0681922

DEFENSIVE PORTFOLIO :

SUN PHARMA	INDIAN OIL CORPORATION LTD	RAJESH EXPORT	HINDUSTAN UNILIVER	PORTFOLIO BETA
0.6665866	0.7678764	0.2969597	0.5629717	0.5735986

RISING GIANTS PORTFOLIO :

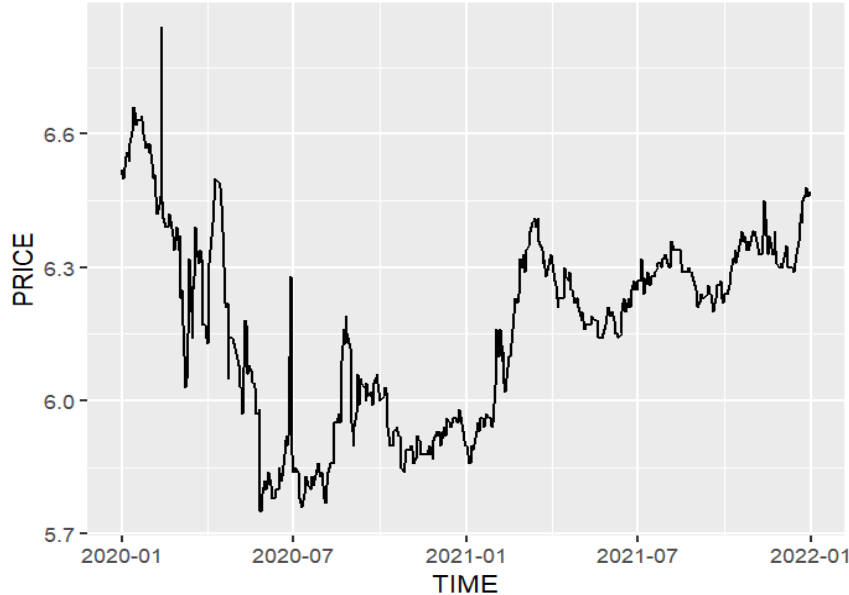
LAURUS LABS LTD	FINOLEX INDUSTRIES LTD	SUPRAJIT ENGINEERING LTD	SONATA SOFTWARE LTD	PORTFOLIO BETA
0.3359925	0.2053599	0.2442656	0.2459112	0.257865425

Treasury Bills

A Treasury Bill is a form of bond.
A bond is a securitized loan made by an investor to a borrower who is usually a corporation or a government entity.

Mean of closing prices (R_f) = 6.159333

10 T Bill



$$r = R_f + \beta(R_m - R_f) + \alpha$$
$$\alpha = r - R_f - \beta(R_m - R_f)$$

Alpha Values

Alpha is defined as the excess return on an investment relative to the return on a Benchmark. It is expressed as a percentage that illustrates how an investment performed relative to a benchmark index.

Alpha Comparision

AGGRESSIVE PORTFOLIO :

RELIANCE	TATA CONSULTANCY SERVICES	HDFC BANK	BAJAJ FINSERVICE LTD	PORTFOLIO ALPHA
0.6382074	-1.695211	0.6116484	2.126411	0.42033885

DEFENSIVE PORTFOLIO :

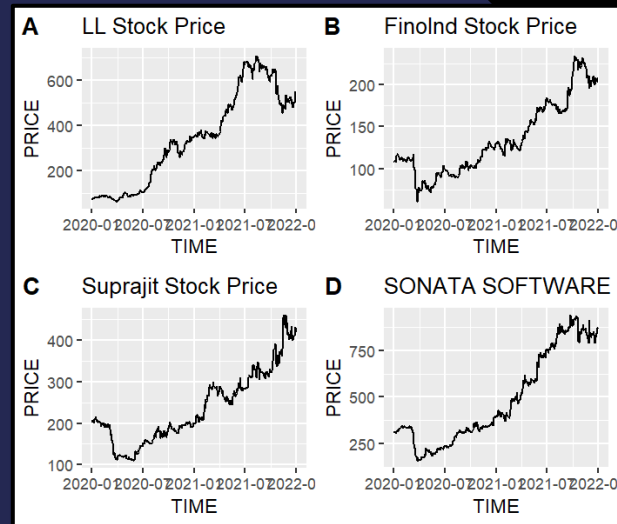
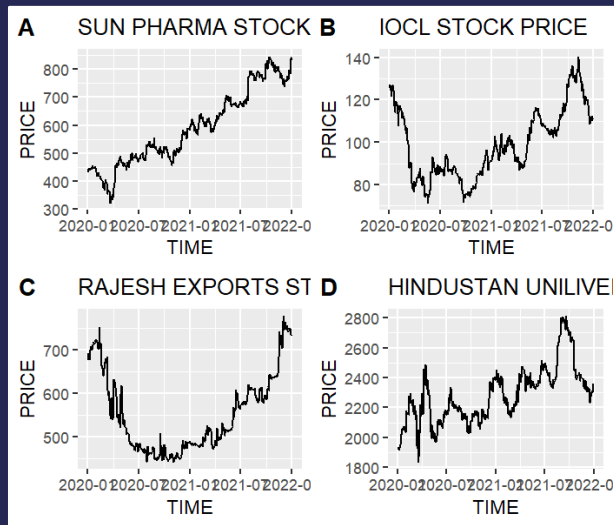
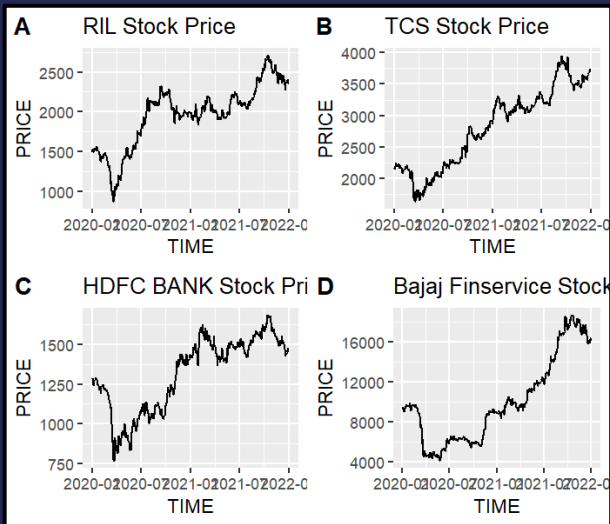
SUN PHARMA	INDIAN OIL CORPORATION LTD	RAJESH EXPORT	HINDUSTAN UNILIVER	PORTFOLIO ALPHA
-2.0526	-4.330115	-2.691717	-1.430409	-2.74456025

RISING GIANTS PORTFOLIO :

LAURUS LABS LTD	FINOLEX INDUSTRIES LTD	SUPRAJIT ENGINEERING LTD	SONATA SOFTWARE LTD	PORTFOLIO ALPHA
4.046554	3.892948	4.653132	4.445368	4.2595005

Plotting Data

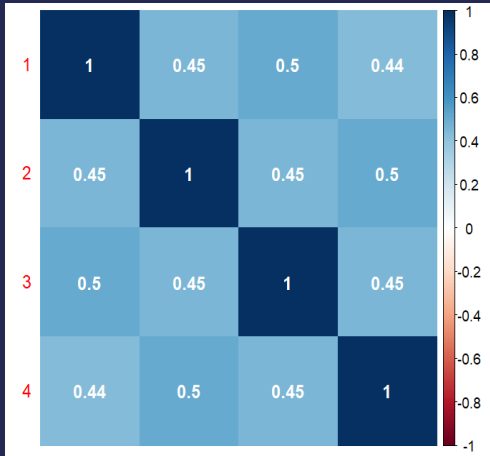
Defensive Portfolio



Aggressive Portfolio

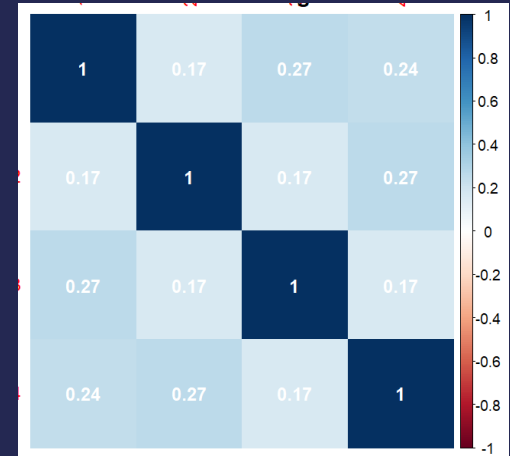
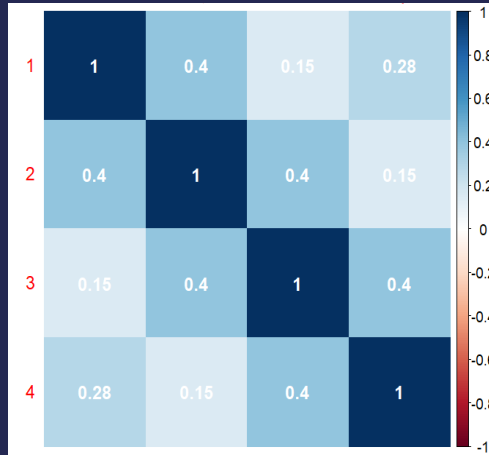
Rising Giants Portfolio

Correlation Matrix



Aggressive Portfolio

Defensive Portfolio



Rising Giants Portfolio

Log Return

Log returns effectively capture the compounding effect.

The compounding of returns of stocks can be easily understood by assuming the normal distribution

$$r_i = \ln\left(\frac{p_i}{p_{i-1}}\right)$$

Portfolio Return

The simple net return of a portfolio consisting of N assets is a weighted average of the simple net returns of the assets involved, where the weight on each asset is the percentage of the portfolio's value invested in that asset.

$$\mathbf{r}_{p,t} \approx \sum_{i=1}^N w_i \mathbf{r}_{it}$$

Fitting Of Models

T- Copula Model

The t copula is defined as a model to represent the dependence structure reserved in a multivariate t distribution.

Under t-copula, the return of the portfolios is:

$$R(V) = \sum_{j=1}^d w_i e^{c_i G_j^{-1}(F(T))}$$

Under normal copula, the return of the portfolios is:

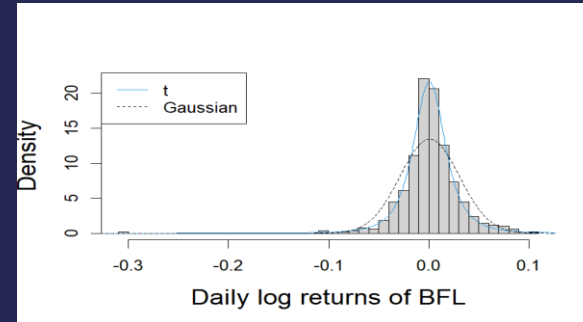
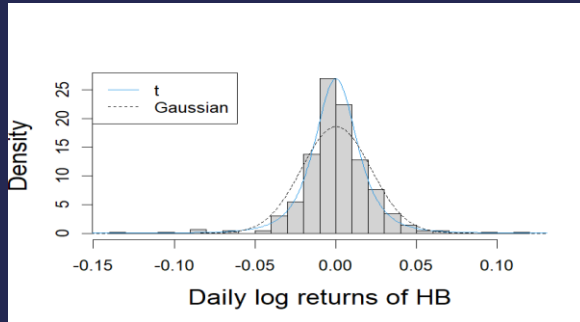
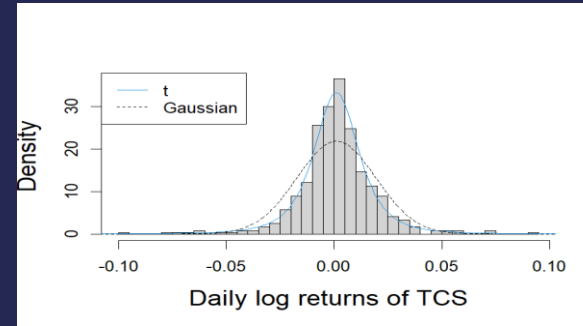
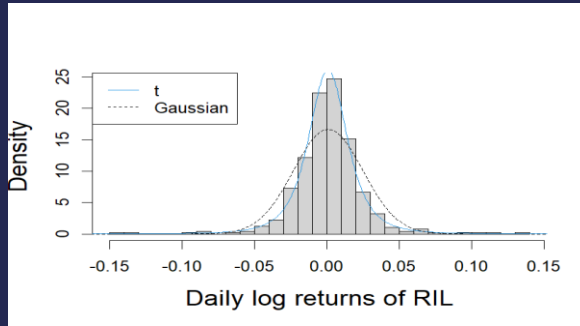
$$R(Z) = \sum_{j=1}^d w_j e^{G_j^{-1}(\phi(\tilde{Z}_j))}$$

Normal Copula Model

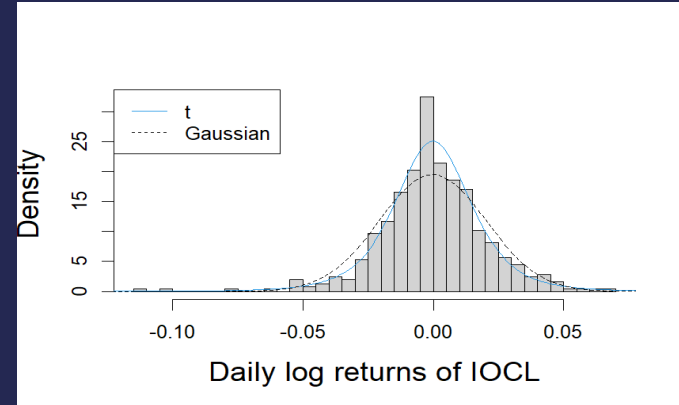
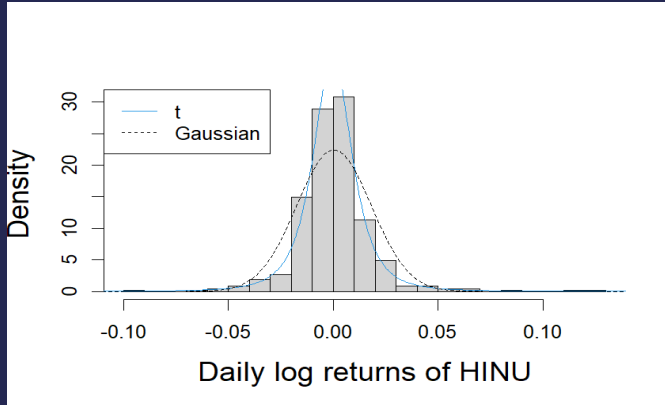
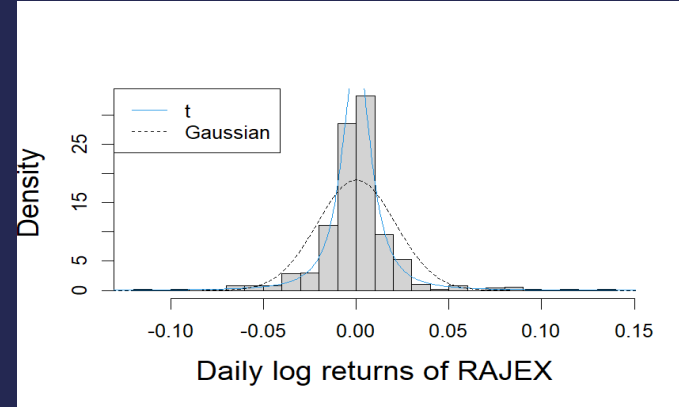
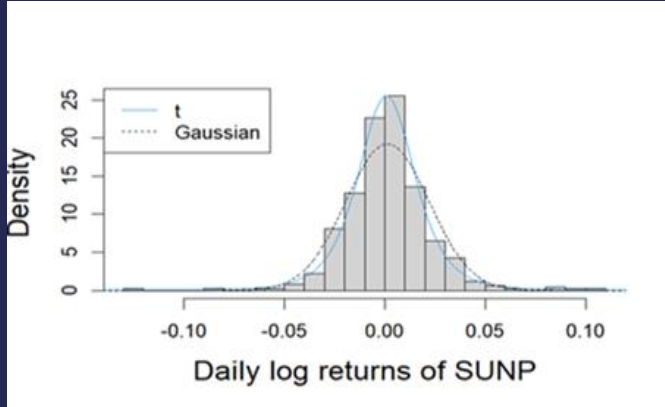
The Gaussian copula is a distribution over the unit hypercube . It is constructed from a multivariate normal distribution over. by using the probability integral transform.

Histogram & Density Plot of t & Gaussian Copula

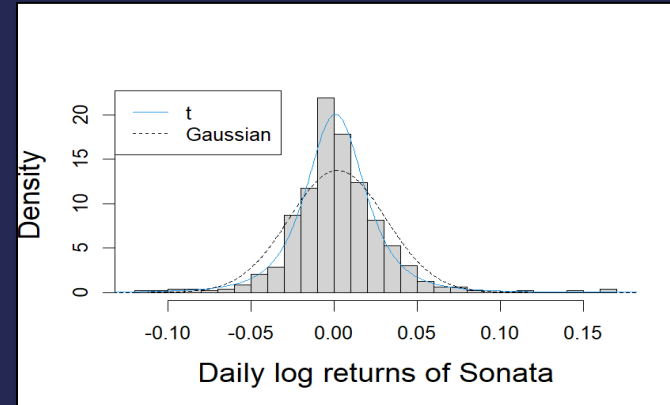
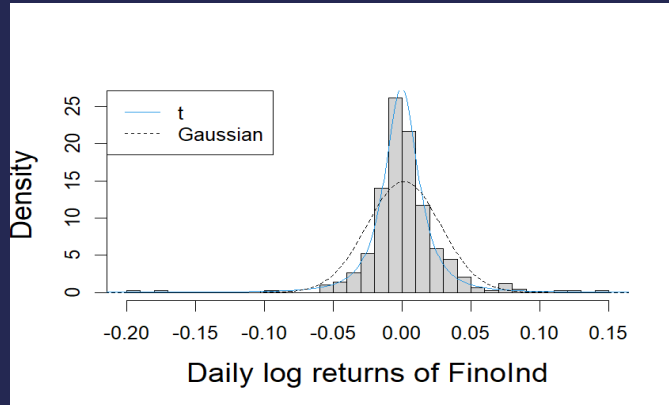
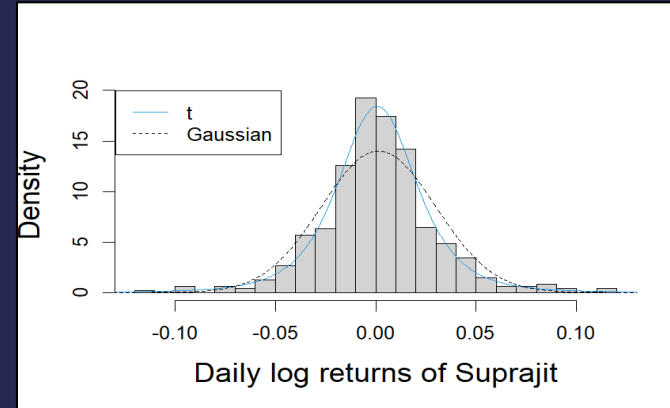
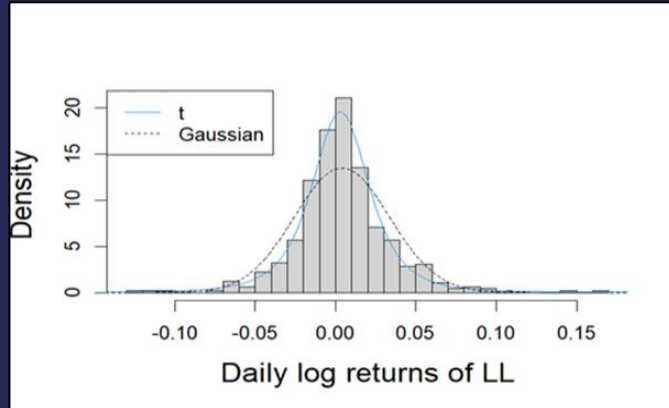
▪ Aggressive Portfolio



■ Defensive Portfolio



▪ Rising Giants Portfolio



Criteria to check best fit Copula

- The log likelihood function of the copula:

$$\text{Max} \sum_{t=1}^T \ln(F_j(x_1^t; \beta_1), \dots, F_d(x_d^t; \beta_d); \mathbf{a}), \quad j = 1, \dots, a$$

- Akaike Information Criterion (AIC):

NE : Estimated number of parameters

$$\text{AIC} = -2 \text{ Loglik} + 2 * \text{NE}$$

- Higher Value of Loglikelihood
- Lower Value of AIC

Model Comparison

Aggressive Portfolio

Normal copula

	loglikelihood	aic
RIL	1143.151	-2282.3
TCS	1275.954	-2547.91
HB	1197.235	-2390.47
BFL	1036.594	-2069.19

T- copula

	loglikelihood	aic
RIL	1224.895	-2443.79
TCS	1337.613	-2669.23
HB	1255.995	-2505.99
BFL	1120.334	-2234.67

Defensive Portfolio

Normal copula

	loglikelihood	aic
SUNP	1214.209	-2424.42
IOCL	1204.364	-2404.73
RAJEX	1289.398	-2574.8
HINU	1220.654	-2437.31

T- copula

	loglikelihood	aic
SUNP	1254.531	-2503.06
IOCL	1343.34	-2680.68
RAJEX	1383.183	-2760.37
HINU	1248.077	-2490.15

Rising Giants Portfolio

Normal copula

	loglikelihood	aic
LL	1038.733	-2073.47
Finolnd	1088.406	-2172.81
Suprajit	1057.24	-2110.48
Sonata	1047.706	-2091.41

T- copula

	loglikelihood	aic
LL	1085.525	-2165.05
Finoland	1196.033	-2386.07
Suprajit	1083.91	-2161.82
Sonata	1104.355	-2202.71

Model Comparision for Portfolios using Maximum Log Likelihood Method

▪ Aggressive Portfolio

Normal Copula	178
t Copula	210.9

▪ Defensive Portfolio

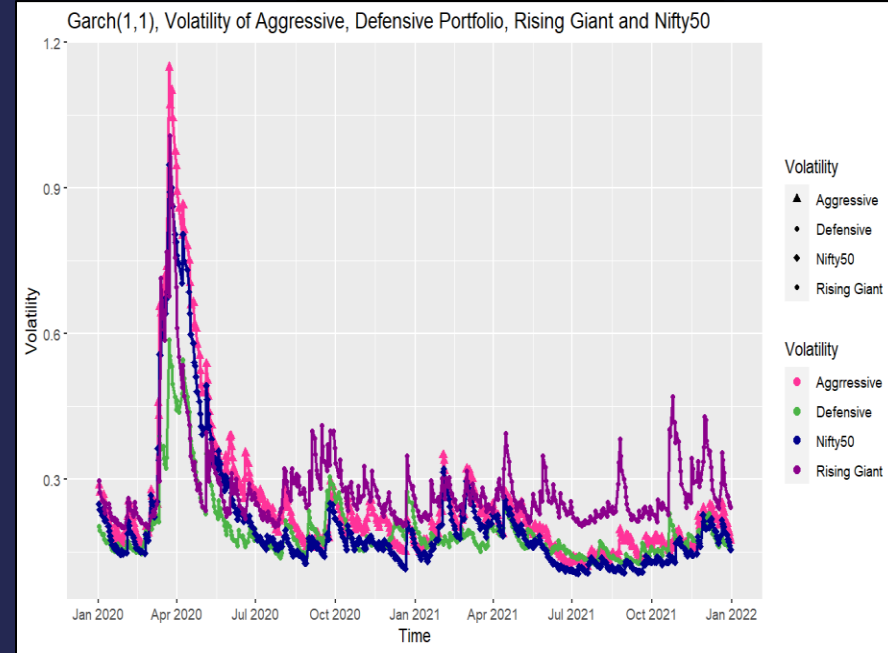
Normal Copula	57.92
t Copula	89.15

▪ Rising Giants Portfolio

Normal Copula	58.03
t Copula	73.43

Garch (1,1)

- The generalized autoregressive conditional heteroskedasticity (GARCH) process is an approach to estimating the volatility of financial markets.
- Financial institutions use the model to estimate the return volatility of stocks, bonds, and other investment vehicles.
- $\sigma_t^2 = \omega + \alpha_1 u_{t-1}^2 + \beta_1 \sigma_{t-1}^2$



Coefficients of Garch

AGGRESSIVE PORTFOLIO :

μ	omega	α_1	β_1
0.00144718117	0.00000554638	0.11990850866	0.86368096703

DEFENSIVE PORTFOLIO :

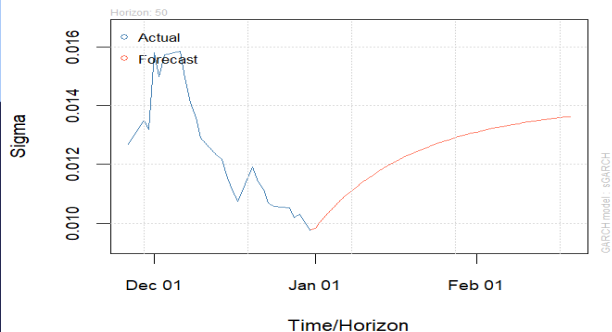
μ	omega	α_1	β_1
0.001091870170	0.000008023542	0.099980109558	0.850920243252

RISING GIANTS PORTFOLIO :

μ	omega	α_1	β_1
0.0032177594	0.0000353919	0.1455578919	0.7516487693

Forecast of Volatility

Forecast Unconditional Sigma
(n.roll = 0)

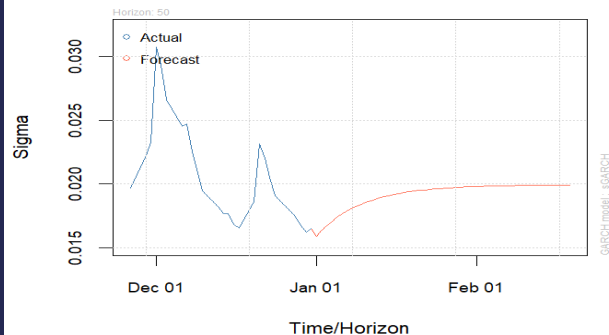


l step ahead forecast for garch (1,1)
model :

$$\sigma_h^2(l) = \omega \left[\frac{1 - (\alpha_1 + \beta_1)^{l-1}}{1 - (\alpha_1 + \beta_1)} \right] + (\alpha_1 + \beta_1)^{l-1} \sigma_h^2(1)$$

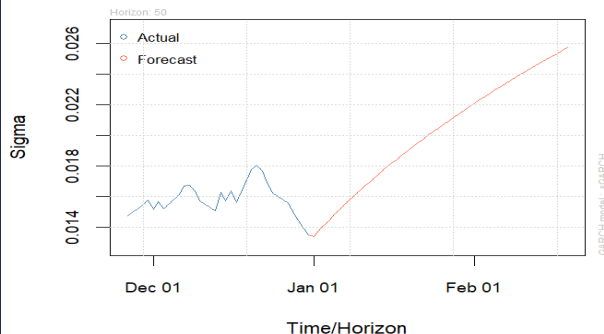
Aggressive stocks

Forecast Unconditional Sigma
(n.roll = 0)



Defensive stocks

Forecast Unconditional Sigma
(n.roll = 0)

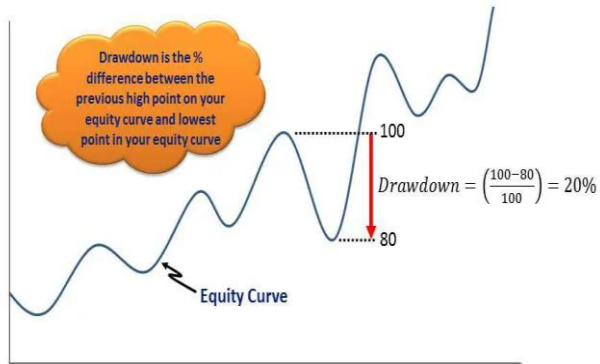


Rising Giants Portfolio

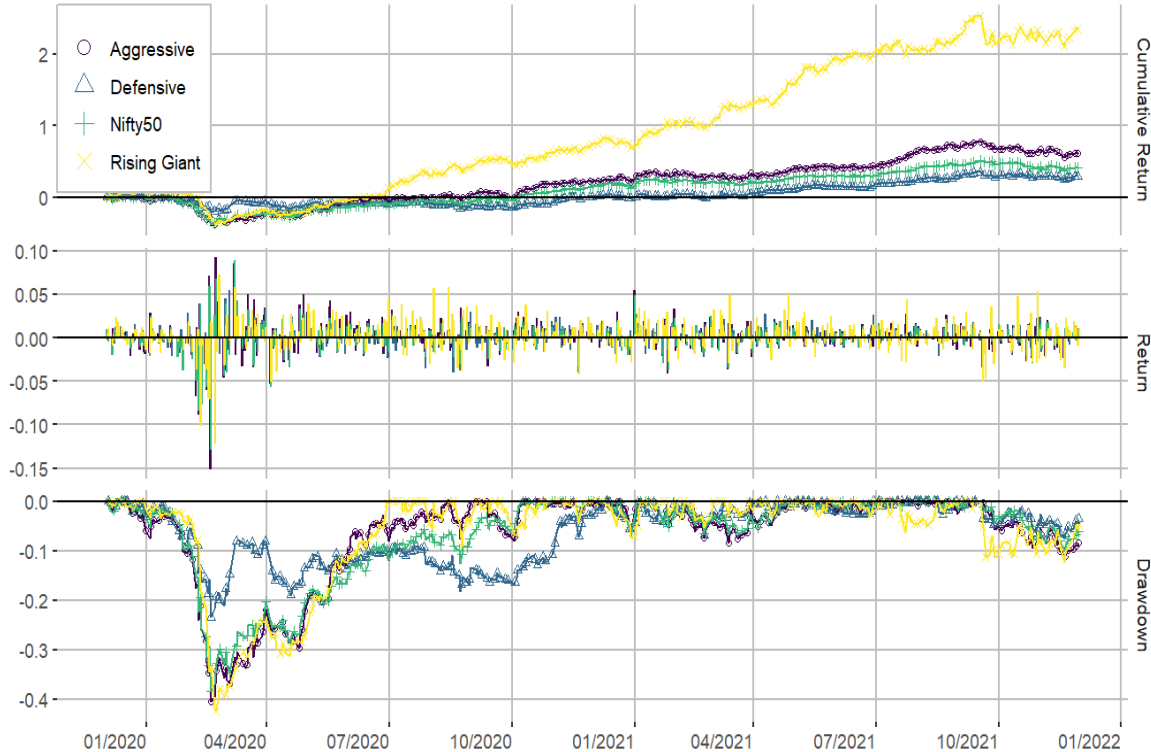
Drawdown

What is a drawdown?

Drawdown in our Equity Curve: The % drop from an equity high



Asset Aggressive Defensive Nifty50 Rising Giant Performance



Cumulative Returns

Cumulative return can be defined as the total gain or loss that an investment would generate which is irrespective of time period

$$\frac{\text{Current Price} - \text{Original Price}}{\text{Original Price}}$$

Cumulative Returns for Equal Weights





Portfolio optimization

Portfolio optimization is nothing but a process where an investor receives the right guidance with respect to selection of assets from the range of other options and in this theory projects/programs are not valued on an individual basis rather the same is valued as a part of a particular portfolio.

Optimised Weights

▪ Aggressive Portfolio

	Optimised Weights
RIL	0.22
TCS	0.32
HB	0.10
BFL	0.36

▪ Defensive Portfolio

	Optimised Weights
SUNP	0.38
IOCL	0.24
RAJEX	0.13
HINU	0.25

▪ Rising Giants Portfolio

	Optimised Weights
LL	0.32
Finoland	0.23
Suprajit	0.23
Sonata	0.22

Cumulative Returns Aggressive

2020-01-02 / 2021-12-31



Jan 02 2020 May 04 2020 Oct 01 2020 Feb 01 2021 Jun 01 2021 Oct 01 2021

Aggressive Portfolio

VaR

Equal weight – 1.3367
Optimal weight – 1.4214
Extra Return – 19.76%

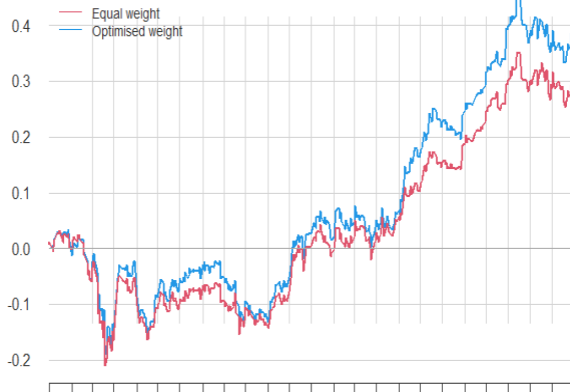
Defensive stocks

VaR

Equal weight – 1.1582
Optimal weight – 1.2351
Extra Return – 9%

Cumulative Returns Defensive

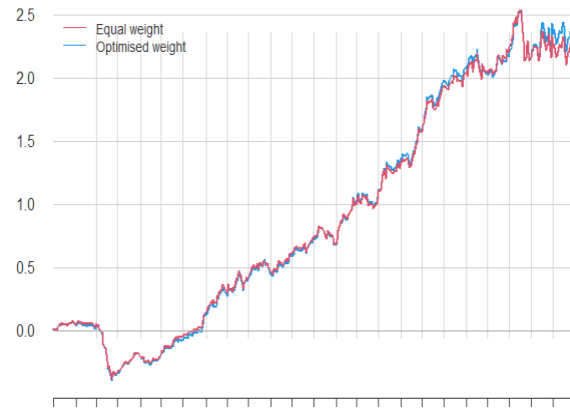
2020-01-02 / 2021-12-31



Jan 02 2020 May 04 2020 Oct 01 2020 Feb 01 2021 Jun 01 2021 Oct 01 2021

Cumulative Returns Rising Giant

2020-01-02 / 2021-12-31



Jan 02 2020 May 04 2020 Oct 01 2020 Feb 01 2021 Jun 01 2021 Oct 01 2021

Rising Giants Portfolio

VaR

Equal weight – 1.6026
Optimal weight – 1.6011
Extra Return – 8%

Cumulative Returns of Optimised Weights

2020-01-02 / 2021-12-31



Cumulative Returns for Optimised Weights

Application of the Analysis

Initial amount to invest – 1,00,000

- Equal Weights

	stock	buy price	shares	invested amt	bonus	corpus
rising giants	laurus labs	74.00	338.00	25012.00		182249.60
	sonata sftw	312.00	80.00	24960.00		70056.00
	suprajit engg	200.00	125.00	25000.00		53718.75
	finloex ind	107.85	232.00	25021.20	1160.00	239946.00
			Total	99993.20		545970.35

- Optimised Weights

	stock	buy price	shares	invested amt	bonus	corpus
rising giants	laurus labs	74.00	433.00	32042.00		233473.60
	sonata sftw	312.00	70.00	21840.00		61299.00
	suprajit engg	200.00	115.00	23000.00		49421.25
	finloex ind	107.85	214.00	23079.90	1070.00	221329.50
			Total	99961.90		565523.35

Conclusion

- By comparing the performance of portfolios, Rising Giants portfolio shows higher profitability with low volatility.
- However, in contrast, the higher volatility of aggressive portfolio directly indicates high risk and it may not imply higher return. Thus, to measure the performance of the cumulative return, Rising Giants portfolio shows great advantage when compared to the Aggressive and Defensive portfolios.
- Optimised weights are more reliable than equal weights since they produced higher returns.
- Not going the conventional way of investing in companies that have already made it big (completely) but also looking for companies that are constantly growing at a good rate/pace and can be the next TCS or next Titan or next Bajaj Finance so we should keep an eye on these Rising Giants to become next Rakesh Jhunjhunwala.

Limitations

- **Change of optimized weights with time.**
- **For Rising Giants portfolio it does not guarantee multi-bagger returns.**
- **Theoretically calculated returns can not be exactly obtained in real life.**





Future Scope

- Risk prediction using VaR.
- Backtesting of VaR.
- Implementing Coffee Can investment strategy on different stocks and monitoring them.

The background features a dark blue field with large, light blue chevron shapes pointing towards the corners. These chevrons are outlined in a slightly darker blue, creating a layered, geometric effect.

THANK YOU