**FINANCE AND RISK ANALYTICS**

**GROUP ASSIGNMENT**

**ON**

**“PORTFOLIO OPTIMIZATION”**

**PGP-BABI-HYD**

**SUBMISSION BY: GROUP 1**

**MEMBERS:**

**K Gopala Krishna Prasanth**

**Naveen Kumar Sambangi**

**Ramya Boodidha**

**Swetha Jegannathan**

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**1. INTRODUCTION**

**OBJECTIVE:**

As an equity fund manager, for a client who wants a portfolio for 1Crore, portfolios with minimum risk, maximum return, various combination in between has to be provided.

**CRITERIA FOR INVESTMENT:**

* Investment should be made only in blue-chip shares of Large-Cap companies
* Investment should be done only in 5 shares
* Maximum exposure in a single share should not exceed 30%

**DATA SET:**

* 2 years share price data of 10 companies are taken from BSE India website
* Time Period of share price data: 1-Jan-2017 to 31-Dec-2018
* 10 companies considered are as follows:

|  |  |
| --- | --- |
| **NAME OF THE COMPANY** | **SECTOR** |
| BAJAJ AUTO (Bajaj Auto Ltd) | Automobile |
| BHARTIARTL (Bharti Airtel Ltd) | Telecom |
| GODREJCP (Godrej consumer products Ltd) | Consumer Non-cyclicals |
| HDFCBANK (hdfc bank) | Finance |
| MRF (mrf Ltd) | Tyres and allied |
| NTPC (ntpc Ltd) | Utilities |
| RELIANCE (Reliance industries Ltd) | Energy |
| SUNPHARMA (Sun pharmaceutical industries Ltd) | Healthcare |
| TCS (Tata consultancy services Ltd) | Technology |
| ULTRACEMCO (Ultratech cement Ltd) | Basic materials |

**2. GRAPHS FOR CLOSING PRICE OVER TIME**

* Closing prices of shares of all the 10 companies are considered for the study, and graphs are plotted:

**OBSERVATIONS FROM THE ABOVE GRAPHS:**

* GODREJCP: There is sudden drop of close price of this share from 1953.65 (on 21-Jun-17) to 959.95 (22-Jun-17)
* RELIANCE: There is sudden drop of close price of this share from 1644.6 (on 06-Sep-17) to 818.9 (on 7-Sep-17)
* TCS: There is sudden drop of close price of this share from 3517.75 (on 30-May-18) to 1744.8 (on 31-May-18)
* Closing stock price of GODREJCP, RELIANCE, TCS show a sudden jump on certain dates, indicating a **SPLIT** in the prices of shares.
* **Therefore, closing price of shares of GODREJCP, RELIANCE, TCS has to adjusted for the split happened.**

**3. ADJUSTEMENT OF SHARE PRICES**

Following are the graphs after adjusting the share prices:

After the adjustments are made to close price to consider the split, from the adjacent graphs we can say that sudden drop of close price is not seen now.

GODREJCP A, RELIANCE A, TCS A indicate the adjusted share prices of respective companies

Note: as suggested by the faculty, the adjusted share prices for GODREJCP, RELIANCE and TCS are taken from yahoo finance website.

**4. STATISTICAL SUMMARY**

* STEP1: percentage change in closing prices for all the companies is calculated first.
* STEP2: the values obtained from step1 are used to calculate statistical parameters like mean, minimum, maximum, standard deviation, count, range, bin-size, range bins and frequency, which are as follows:







**5. HISTOGRAMS**

Range bins and frequency obtained for all the companies in the previous step are used to plot the histograms, which are as follows:

**6. VAR HISTORICAL**

For all companies, VAR historical is calculated at various confidence levels, using “percentile” function in xl.



**7. VAR PARAMETRIC**

Following are the mean and standard deviation obtained from step4:



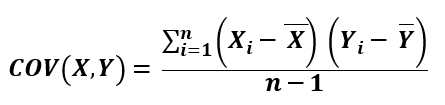
Using the above table of mean and standard deviation, VAR parametric is calculated at various confidence levels, using “NORMINV” function in xl.



**8. CO-VARIANCE MATRIX**

STEP1: EXCESS RETURNS are calculated by subtracting the percentage change in close price from the mean

STEP2: from the excess returns, Co-Variance matrix is calculated using the following mathematical formula:

[](https://education.howthemarketworks.com/wp-content/uploads/2013/09/Covariance-Formula.jpg)



**9. MINIMUM RISK PORTFOLIO**

**OBJECTIVE:** To minimise risk (in statistical terms it is: standard deviation of portfolio) of the portfolio

**CHANGING VARIABLES:** weights for each company (that is how much percentage of 1Crore to be invested in each company)

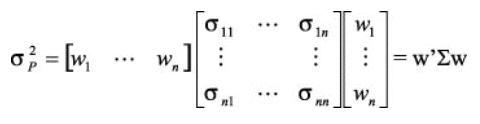
**CONSTRAINTS:**

* weights should not exceed 30% (that is 0.3), since it is given that maximum exposure of a single share is 30%
* sum of the weights should be 100% (that is 1)
* weights for the bajaj, bharti airtel, godrejcp, reliance, sunpharma are forced to be zero (note: objective of minimum risk is first achieved without using this constraint, later this constraint is applied to less weightage companies, as client wants to invest in only 5 companies)

**SOVLING METHOD:** GRG-Nonlinear

**MATHEMETICAL FORMULAE USED:**

1. variance of portfolio formula:

[](https://financetrain.com/wp-content/uploads/2010/07/var_covar_formula.gif)

1. Risk (Standard deviation) of portfolio = square-root of variance of portfolio

**RESULT:**



**10. MAXIMUM RETURN PORTFOLIO**

**OBJECTIVE:** To maximize return (in statistical terms it is: sum of weighted means) of the portfolio

**CHANGING VARIABLES:** weights for each company (that is how much percentage of 1Crore to be invested in each company)

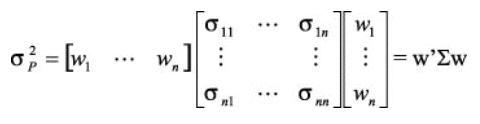
**CONSTRAINTS:**

* weights should not exceed 30% (that is 0.3), since it is given that maximum exposure of a single share is 30%
* sum of the weights should be 100% (that is 1)
* weights are non-negative

**SOVLING METHOD:** GRG-Nonlinear

**MATHEMETICAL FORMULAE USED:**

1. variance of portfolio formula:

[](https://financetrain.com/wp-content/uploads/2010/07/var_covar_formula.gif)

1. Risk (Standard deviation) of portfolio = square-root of variance of portfolio

**RESULT:**

|  |  |
| --- | --- |
| **MAXIMUM RETURN PORTFOLIO** | |
| **Firm** | **Amount to invest (as % of 1Crore)** |
| **GODREJCP A** | 30.00% |
| **HDFCBANK** | 30.00% |
| **RELIANCE A** | 30.00% |
| **TCS A** | 10.00% |
| **Risk of portfolio** | 0.91% |
| **Return of portfolio** | **0.128%** |
| **Sharpe ratio of portfolio** | 14.09% |

**11. MAXIMUM SHARPE RATIO PORTFOLIO**

**OBJECTIVE:** To maximize sharpe ratio (ratio of return and risk) of the portfolio. This objective addresses the requirement of a client who wants an optimised portfolio of taking risk and return into consideration. In other terms, a trade off is found between the minimised risk and maximized return.

**CHANGING VARIABLES:** weights for each company (that is how much percentage of 1Crore to be invested in each company)

**CONSTRAINTS:**

* weights should not exceed 30% (that is 0.3), since it is given that maximum exposure of a single share is 30%
* sum of the weights should be 100% (that is 1)
* weights are non-negative

**SOVLING METHOD:** GRG-Nonlinear

**RESULT:**

|  |  |
| --- | --- |
| **MAXIMUM SHARPE RATIO PORTFOLIO** | |
| **Firm** | **Amount to invest (as % of 1Crore)** |
| **HDFCBANK** | 50.17% |
| **TCS A** | 20.39% |
| **RELIANCE A** | 19.73% |
| **GODREJCP A** | 4.97% |
| **MRF** | 4.74% |
| **Risk of portfolio** | 0.74% |
| **Return of portfolio** | 0.123% |
| **Sharpe ratio of portfolio** | **16.69%** |

**12. OTHER PORTFOLIOS IN BETWEEN MINIMUM RISK AND MAXIMUM RETURN**

**OBJECTIVE:** to form portfolios in between minimum risk and maximum return

|  |  |  |
| --- | --- | --- |
| **portfolio** | **risk** | **return** |
| minimum risk portfolio | 0.670% | 0.072% |
| maximum return portfolio | 0.910% | 0.128% |

**Following portfolios are to be formed, whose return lie between 0.072% and 0.128%:**

1) Portfolio with return of 0.086%

2) Portfolio with return of 0.1%

3) Portfolio with return of 0.114%

**That is for the above 3 portfolios, corresponding risk has to be evaluated.**

**PORTFOLIO 1: Portfolio with return of 0.086%**

**OBJECTIVE:** To provide a return of 0.086%

**CHANGING VARIABLES:** weights for each company (that is how much percentage of 1Crore to be invested in each company)

**CONSTRAINTS:**

* weights should not exceed 30% (that is 0.3), since it is given that maximum exposure of a single share is 30%
* sum of the weights should be 100% (that is 1)
* weights are non-negative
* Some of the weights will be forced to zero (initially solver is done without this constraint and later this constraint is added for less weightage companies, since client wants to invest only in 5 companies)

**SOVLING METHOD:** GRG-Nonlinear

**RESULT:**

|  |  |
| --- | --- |
| **PORTFOLIO 1:** |  |
| **Firm** | **Amount to invest (as % of 1Crore)** |
| **MRF** | 25.85% |
| **ULTRACEMCO** | 24.08% |
| **TCS A** | 18.19% |
| **GODREJCP A** | 17.21% |
| **HDFCBANK** | 14.67% |
|  |  |
| **Risk of portfolio** | **0.787%** |
| **Return of portfolio** | **0.086%** |
| **Sharpe ratio of portfolio** | 10.923% |

**PORTFOLIO 2: Portfolio with return of 0.1%**

**OBJECTIVE:** To provide a return of 0.1%

**CHANGING VARIABLES:** weights for each company (that is how much percentage of 1Crore to be invested in each company)

**CONSTRAINTS:**

* weights should not exceed 30% (that is 0.3), since it is given that maximum exposure of a single share is 30%
* sum of the weights should be 100% (that is 1)
* weights are non-negative
* Some of the weights will be forced to zero (initially solver is done without this constraint and later this constraint is added for less weightage companies, since client wants to invest only in 5 companies)

**SOVLING METHOD:** GRG-Nonlinear

**RESULT:**

|  |  |
| --- | --- |
| **PORTFOLIO 2:** |  |
| **Firm** | **Amount to invest (as % of 1Crore)** |
| **GODREJCP A** | 24.49% |
| **MRF** | 22.93% |
| **ULTRACEMCO** | 18.73% |
| **RELIANCE A** | 16.93% |
| **HDFCBANK** | 16.92% |
|  |  |
| **Risk of portfolio** | **0.870%** |
| **Return of portfolio** | **0.100%** |
| **Sharpe ratio of portfolio** | 11.495% |

**PORTFOLIO 3: Portfolio with return of 0.114%**

**OBJECTIVE:** To provide a return of 0.114%

**CHANGING VARIABLES:** weights for each company (that is how much percentage of 1Crore to be invested in each company)

**CONSTRAINTS:**

* weights should not exceed 30% (that is 0.3), since it is given that maximum exposure of a single share is 30%
* sum of the weights should be 100% (that is 1)
* weights are non-negative
* Some of the weights will be forced to zero (initially solver is done without this constraint and later this constraint is added for less weightage companies, since client wants to invest only in 5 companies)

**SOVLING METHOD:** GRG-Nonlinear

**RESULT:**

|  |  |
| --- | --- |
| **PORTFOLIO 3:** |  |
| **Firm** | **Amount to invest (as % of 1Crore)** |
| **RELIANCE A** | 30.00% |
| **GODREJCP A** | 27.56% |
| **HDFCBANK** | 15.69% |
| **MRF** | 15.37% |
| **ULTRACEMCO** | 11.37% |
|  |  |
| **Risk of portfolio** | **0.927%** |
| **Return of portfolio** | **0.114%** |
| **Sharpe ratio of portfolio** | 12.304% |

**SUMMARY OF 3 PORTFOLIOS IN BETWEEN MINIMUM RISK AND MAXIMUM RETURN:**





**13. RESULTS OF 6 PORTFOLIO OPTIONS**



**Other combination portfolios between minimum risk and maximum return:**



**14. EXECUTIVE SUMMARY FOR CLIENT**

* A total of 6 different portfolios with diverse characteristics are provided:

Minimum risk portfolio

Maximum return portfolio

Maximum sharpe ratio portfolio (trade-off between return and risk)

Other 3 portfolio combinations between minimum risk and maximum return

* Depending on the requirement and interest, client can choose any of the above 6 portfolios to invest
* If the investment in shares has to be done in such a way that it results in a minimum risk, then client can choose MINUMUM RISK PORTFOLIO to invest in the following 5 firms:
* **30 Lakhs in HDFCBANK, 23.2 Lakhs in NTPC, 22.2 Lakhs in TCS, 14.3 Lakhs in MRF, 10.3 Lakhs in ULTRACEMCO**
* **Investments in this portfolio can be done at a minimum risk of 0.67%**
* If investment in shares has to be done in such a way that it results in maximum returns, then client can choose MAXIMUM RETURN PORTFOLIO to invest in the following 5 firms**:**
* **30 Lakhs each in GODREJCP, HDFCBANK, RELIANCE and remaining 10 Lakhs in TCS**
* **Investments in this portfolio will give a maximum return of 0.128%**
* If a client wants to get possible maximum return at the expense of possible minimum risk, then an optimised portfolio which does a trade-off between return and risk will meet the client requirement. In such a case, client can choose MAXIMUM SHARPE RATIO portfolio (sharpe ratio takes care of both risk and return) to invest in the following 5 firms:
* **50 Lakhs in HDFCBANK, 20 Lakhs in RELIANCE, 20.4 Lakhs in TCS, 5 Lakhs in GODREJCP, 4.7 Lakhs in MRF**
* **Investments in this portfolio will give a return of 0.123% at the expense of 0.74% risk, with a maximum sharpe ratio of 16.69%**
* If a client wants to get a return of 0.086% with a risk of 0.787%, then portfolio1 is the correct choice:
* **25.9 Lakhs in MRF, 24 Lakhs in ULTRACEMCO, 18 Lakhs in TCS, 17.21 Lakhs in GODREJCP, 14.67 Lakhs in HDFCBANK**
* If a client wants to get a return of 0.1% with a risk of 0.87%, then portfolio2 is the correct choice:
* **24.5 Lakhs in GODREJCP, 23 Lakhs in MRF, 18.7 Lakhs in ULTRACEMCO, 17 Lakhs in RELIANCE, 17Lakhs in HDFCBANK**
* If a client wants to get a return of 0.114% with a risk of 0.927%, then portfolio3 is the correct choice:
* **30 Lakhs in RELIANCE, 27.5 Lakhs in GODREJCP, 15.7 Lakhs in HDFCBANK, 15.3 Lakhs in MRF, 11.3Lakhs in ULTRACEMCO**