



**BSE**  
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# PORTFOLIO OPTIMIZATION

**SAPM (FIN F313) SUMMER**

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**GROUP-11**

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# Introduction to Portfolio Optimization

## WHY DO WE OPTIMIZE A PORTFOLIO?

Portfolio Management is created to offer an insight into the evaluation and analysis of a wide range of financial securities. This is done to develop unique techniques for designing an optimal portfolio and understand the theory and practice related to equity and debt markets. The reviewed topics include portfolio theory, asset pricing models, market efficiency, fundamental and technical analysis, portfolio management, introduction to debt markets, and fund performance evaluation. These fundamental concepts that are significant for good investment analysis, management of individuals and institutional examination. These concepts helpful for those who aim for personal financial advising in an institution or an individual capacity. All in all the financial ecosystem involves the investors' investment decisions and the firms' financing decisions. With this knowledge, we study the risk and return concepts that form the core of understanding financial decisions.

Modern portfolio theory deals with forming efficient portfolios using a risk-return relationship effectively maximizing the return per unit of risk. We derive a functional relationship between risk and return. This relationship could be used to price any financial security traded in the market. This forms a base for the investors' expectations, and to the firms, it forms a base to understand investors' expectations.

## Stock selection

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Below are the stocks we have considered while making the portfolio the reason we selected these particular stocks is that they are the market leaders in their specific fields and have a huge market capitalization. The portfolio is significantly diversified having companies from various sectors. We have taken into consideration the opinions of Rusmik OZA( Kotak securities), Vineeta Sharma(Narnolia Financial Advisors), and Gaurav Garg (CapitalVia Global Research) while forming the portfolio. We have also taken into consideration how the current state of the companies are, how the exports grew ( Escorts) , and how digital transformation will impact the market (as in the case with Infosys we expected market share gain), how latest buying of resources will translate to company growth(JSW Steel won the rights to iron ore mines in Odisha ) , how getting a positive response on a certain technology will give an edge over its competitors ( Glenmark Pharmaceuticals received final approval from the USFDA for Tadalafil Tablets ). While taking Aarti Industries we saw the demand increase from the consumer side post lockdown and hence chose it.

# Introduction of securities

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## 1. Coal India

Coal India Limited is an Indian government-owned coal mining and refining corporation. It is under the ownership of Ministry of Coal, Government of India headquartered in Kolkata, West Bengal, India. It is the largest coal-producer in the world and a Maharatna public sector undertaking. The company contributes around 82% to the total coal production in India. earned revenues of ₹95,435 crore (US\$13 billion) from sale of coal during the financial year 2014-2015.



**Coal India Ltd**

## 2. Infosys Limited

Infosys Limited, provides business consulting, technology, engineering and outsourcing services. Its end-to-end business solutions include consulting and systems integration comprising consulting, enterprise solutions, systems integration and advanced technologies. the 602nd largest public company in the world according to Forbes Global 2000 ranking.<sup>1</sup> The credit rating of the company is CRISIL AAA / Stable / CRISIL A1+ (rating by CRISIL).

The Infosys logo consists of the word 'Infosys' in a blue, sans-serif font, followed by a registered trademark symbol (®).

### 3. Adani Power

Adani Power Ltd, is an Indian power and energy company, subsidiary of Indian conglomerate Adani Group with head office at Khodiyar in Ahmedabad, Gujarat. It is a private thermal power producer, with capacity of 12,450 MW. It also operates a mega solar plant of 40 MW at Naliya, Bitta, Kutch, Gujarat. Its current stock price is Rs 265.00 and its market cap is Rs 105,294 crores. Its revenue in the F.Y. 2021 - 2022 was Rs 31,686 crores.



### 4. JSW Steel LTD

JSW Steel Ltd is an Indian multinational steel making company based in Mumbai, and a part of the JSW Group. After the merger of ISPAT Steel, JSW Steel became India's second largest private sector steel company. Its today's share price is ₹546.00.



### 5. Escorts Limited

Escorts Limited is an Indian multinational conglomerate that operates in the sectors of agricultural machinery, construction machinery, material handling, and railway equipment. Its headquarters are located in Faridabad, Haryana. The company was launched in 1944 and has marketing operations in more than 40 countries. Its current stock price is ₹1,552.75



## 6. Glenmark Pharmaceuticals

Glenmark Pharmaceuticals Ltd is a major player in the branded generics business in growing regions such as India. Candid Cream was the company's first foray into the dermatological sector. Glenmark's groundbreaking drug development efforts are largely focused on inflammation (asthma/COPD, rheumatoid arthritis, etc. ), metabolic illnesses (diabetes, obesity, etc. ), and pain (neuropathic and inflammatory pain). Its today's share price is Rs. 364 . Its current market capitalization stands at Rs 10,763.30 Cr.



## 7. Aarti Industries

Aarti Industries is a leading Indian manufacturer of Speciality Chemicals and Pharmaceuticals with a global footprint. Chemicals manufactured by Aarti are used in the downstream manufacture of pharmaceuticals, agrochemicals, polymers, additives, surfactants, pigments, dyes, etc. The current stock price is ₹689.00 . Its market capitalization is ₹ 25,079.84 cr .



## 8. ICICI Bank

ICICI Bank Limited is an Indian multinational bank and financial services company headquartered in Vadodara. It offers a wide range of banking products and





financial services for corporate and retail customers through a variety of delivery channels and specialized subsidiaries in the areas of investment banking, life, non-life insurance, venture capital and asset management. The bank has a network of 5,275 branches and 15,589 ATMs across India and has a presence in 17 countries. Its today's share price is Rs. 678. Its current market capitalization stands at Rs 471,864.24. In the latest year, the company has reported Net Sales of Rs. 79118.27 Cr.

## 9. Reliance Industries

Reliance Industries Limited is an Indian multinational conglomerate company based out of Mumbai, India. It has diverse businesses including energy, petrochemicals, natural gas, retail, telecommunications, mass media, and textiles. It is also the highest income tax payer in the private sector in India. The company has negative free cash flows. Reliance Industries became the first Indian company to cross 100Bn\$ in revenues. Its current share price is Rs 2605.05 and its market capitalization is Rs 1,752,254.57 Crores .



## 10. ITC

ITC Limited is an Indian conglomerate company headquartered in Kolkata. ITC has a diversified presence across industries such as FMCG, hotels, software, packaging, paperboards, specialty papers and agribusiness. The company has 13 businesses in 5 segments. It exports its products in 90 countries. Its revenue in the FY 2020-2021 is Rs 48151 crores . Its current stock price is Rs 260.40 and market cap is Rs 321,267 crores





# Solving Problem Statement

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**Problem statement:** Given a set of 10 securities, construct the optimal portfolio for an investor as prescribed by Markowitz Portfolio Theory.

## MARKOWITZ PORTFOLIO THEORY

Markowitz's portfolio theory describes how risk-averse investors can construct a portfolio that minimizes risk for a given level of expected return. It says that the risk and return characteristics of an investment should not be evaluated in alone, but rather in relation to how the investment influences overall portfolio's risk and return. This theory provides the set of returns for a given risky asset that are most likely to be maximally efficient to invest in for constructing an efficient frontier. The Efficient frontier is plotted using Expected returns, risk, and covariance as inputs. This theory adds the risk-free asset and obtains the tangency portfolio by maximizing the Sharpe ratio. This tangency portfolio is held by all the investors irrespective of their risk preference and risk aversion matters only to risky assets during capital allocation.

### Limitations:

This major limitations to this are that, its unable to accurately estimate the correlation between securities in different sectors, as specifying industry makes it harder to estimate correlations and covariance. Moreover, it becomes harder to formulate the inputs as the number of securities in the portfolio rises, the inputs list seems to erupt. On the other side, these issues might be solved using the Single Index Model, which just requires the historical data for returns as the input and hence, further making the process simpler.

## Minimum Variance Portfolio:

The Minimum variance portfolio is a particular point in the investment possibility frontier where the portfolio variance is minimum. All the points below this point are called inefficient investment regions and risk-averse investors won't invest in that region and the above region is the efficient frontier where risk-averse investors consider attractive to invest in.

### When short selling is allowed

$$\text{Min } \sigma_p^2 = w' \Sigma w$$

Constraint:  $w'1 = 1$

$w$ - vector of asset weights

$\Sigma$  - variance-covariance matrix

### When short selling is not allowed

$$\text{Min } \sigma_p^2 = w' \Sigma w$$

Constraint:  $w'1 = 1, w > 0$

$w$ - vector of asset weights

$\Sigma$  - variance-covariance matrix

## Results

### 1) The following values were received on applying the minimum variance constraint

When short selling is allowed then Portfolio Return = 5.85%

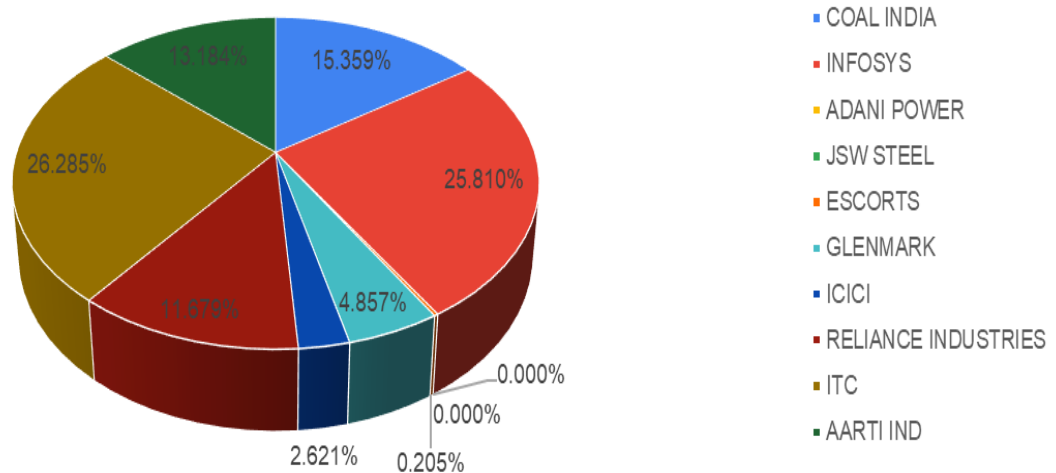
When short selling is not allowed then Portfolio Return = 5.03%

When riskless financial security (T-bill) is included and short selling is allowed = 1.39%

**(CASE-1) When short selling is not allowed**

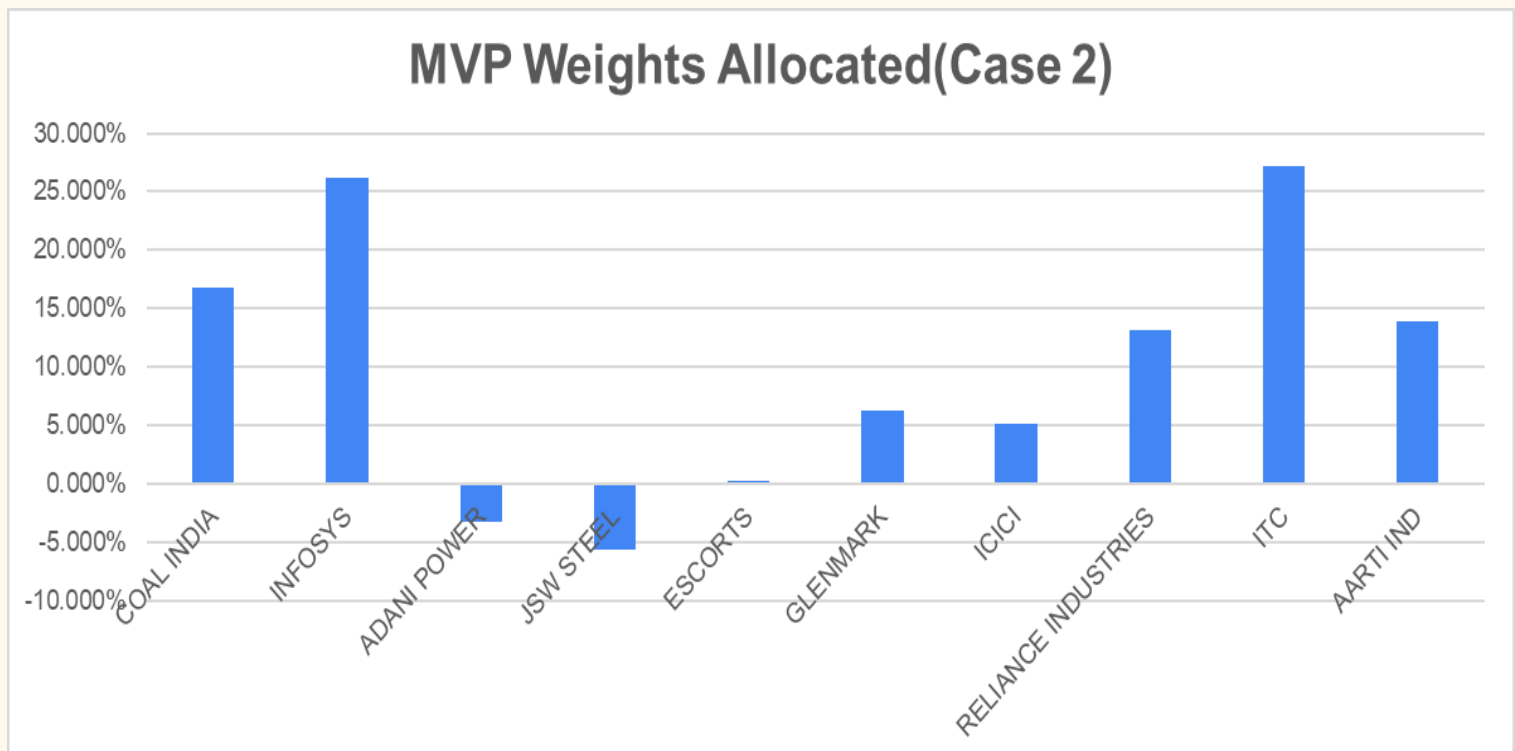
	RETURN	i	w
COAL INDIA	0.533%	100.000%	15.359%
INFOSYS	11.424%	100.000%	25.810%
ADANI POWER	21.934%	100.000%	0.000%
JSW STEEL	10.162%	100.000%	0.000%
ESCORTS	7.325%	100.000%	0.205%
GLENMARK	-4.618%	100.000%	4.857%
ICICI	8.013%	100.000%	2.621%
RELIANCE INDUSTRIES	12.366%	100.000%	11.679%
ITC	0.078%	100.000%	26.285%
AARTI IND	10.291%	100.000%	13.184%

**MVP Weights Allocated(Case 1)**



### (CASE-2) When short selling is allowed

	RETURN	i	w
COAL INDIA	0.533%	100.000%	16.812%
INFOSYS	11.424%	100.000%	26.170%
ADANI POWER	21.934%	100.000%	-3.185%
JSW STEEL	10.162%	100.000%	-5.644%
ESCORTS	7.325%	100.000%	0.226%
GLENMARK	-4.618%	100.000%	6.224%
ICICI	8.013%	100.000%	5.163%
RELIANCE INDUSTRIES	12.366%	100.000%	13.181%
ITC	0.078%	100.000%	27.181%
AARTI IND	10.291%	100.000%	13.872%

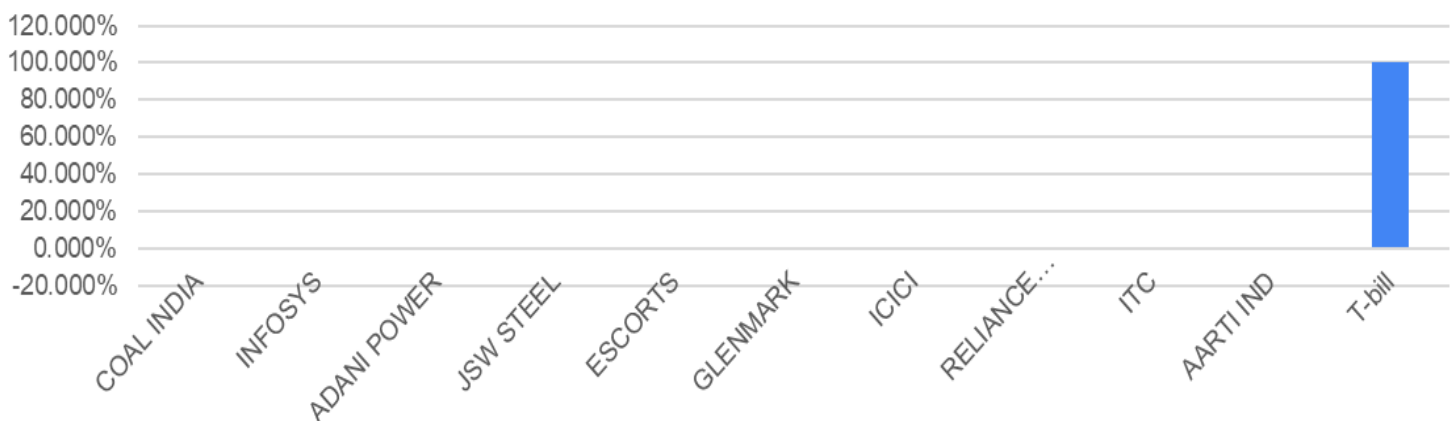


\*Note: we used bar graph instead of a use pie chart here since its difficult to show negative values on it

**(CASE-3) When riskless financial security(T-bill) is included and short selling is allowed**

	RETURN	i	w
COAL INDIA	0.533%	100.000%	0.000%
INFOSYS	11.424%	100.000%	0.000%
ADANI POWER	21.934%	100.000%	0.000%
JSW STEEL	10.162%	100.000%	0.000%
ESCORTS	7.325%	100.000%	0.000%
GLENMARK	-4.618%	100.000%	0.000%
ICICI	8.013%	100.000%	0.000%
RELIANCE INDUSTRIES	12.366%	100.000%	0.000%
ITC	0.078%	100.000%	0.000%
AARTI IND	10.291%	100.000%	0.000%
T-bill	1.385%	100.000%	100.000%

**MVP Weights Allocated(Case 3)**



## **2)The following values were recieved on finding the efficient frontiers**

### **Efficient Frontier:**

The efficient frontier is a collection of optimum portfolios that provide the best anticipated return for a given level of risk or the least risk for a given level of expected return. Portfolios that are below the efficient frontier are sub-optimal because they do not generate enough return for the amount of risk they carry. Also, portfolios that cluster to the right of the efficient frontier have a greater degree of risk for the stated rate of return, making them sub-optimal.

### **THE VARIANCE - COVARIANCE MATRIX FOR THIS PORTFOLIO:**

#### **Interpretation:**

It can be seen from the above table that out of 10 securities, the equity annualized returns of only 1 of them is negative over the selected time period, which is GLENMARK(-4.168%). The remaining 9 securities have positive returns.

## CASE-1 and CASE-2;

Var-Cov Matrix	COAL INDIA	INFOSYS	ADANI POWER	JSW STEEL	ESCORTS	GLENMARK	ICICI	RELIANCE INDUSTRIES	ITC	AARTI IND	
	COAL INDIA	1.900%	0.283%	0.925%	0.924%	0.608%	0.667%	0.611%	0.567%	0.469%	0.477%
	INFOSYS	0.283%	1.562%	0.615%	0.624%	0.547%	0.485%	0.536%	0.504%	0.292%	0.348%
	ADANI POWER	0.925%	0.615%	6.795%	1.486%	1.534%	1.288%	1.328%	1.068%	0.757%	1.005%
	JSW STEEL	0.924%	0.624%	1.486%	2.860%	1.254%	0.944%	1.270%	0.923%	0.714%	0.734%
	ESCORTS	0.608%	0.547%	1.534%	1.254%	3.139%	0.802%	1.061%	0.862%	0.631%	0.704%
	GLENMARK	0.667%	0.485%	1.288%	0.944%	0.802%	2.814%	0.591%	0.526%	0.511%	0.677%
	ICICI	0.611%	0.536%	1.328%	1.270%	1.061%	0.591%	2.392%	0.820%	0.589%	0.686%
	RELIANCE INDUSTRIES	0.567%	0.504%	1.068%	0.923%	0.862%	0.526%	0.820%	1.864%	0.445%	0.504%
	ITC	0.469%	0.292%	0.757%	0.714%	0.631%	0.511%	0.589%	0.445%	1.415%	0.409%
AARTI IND	0.477%	0.348%	1.005%	0.734%	0.704%	0.677%	0.686%	0.504%	0.409%	2.163%	

### CASE-3;

[illegible]

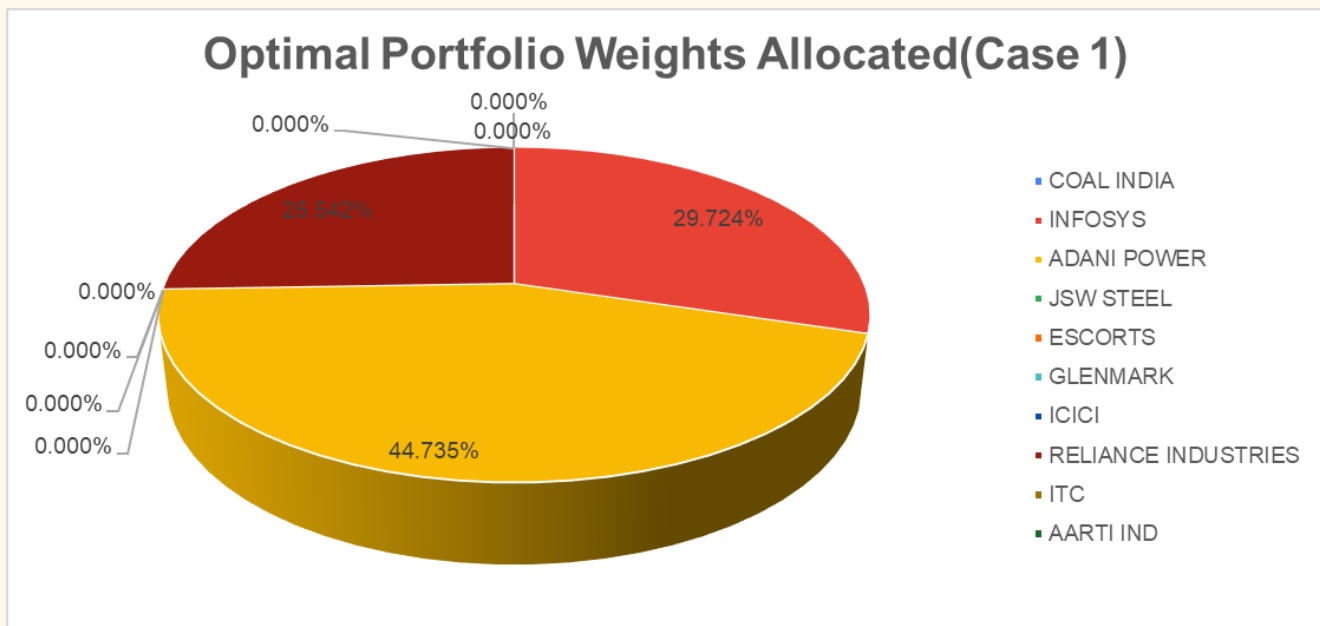


### 3)The following values were recieved on mazimizing Utility:

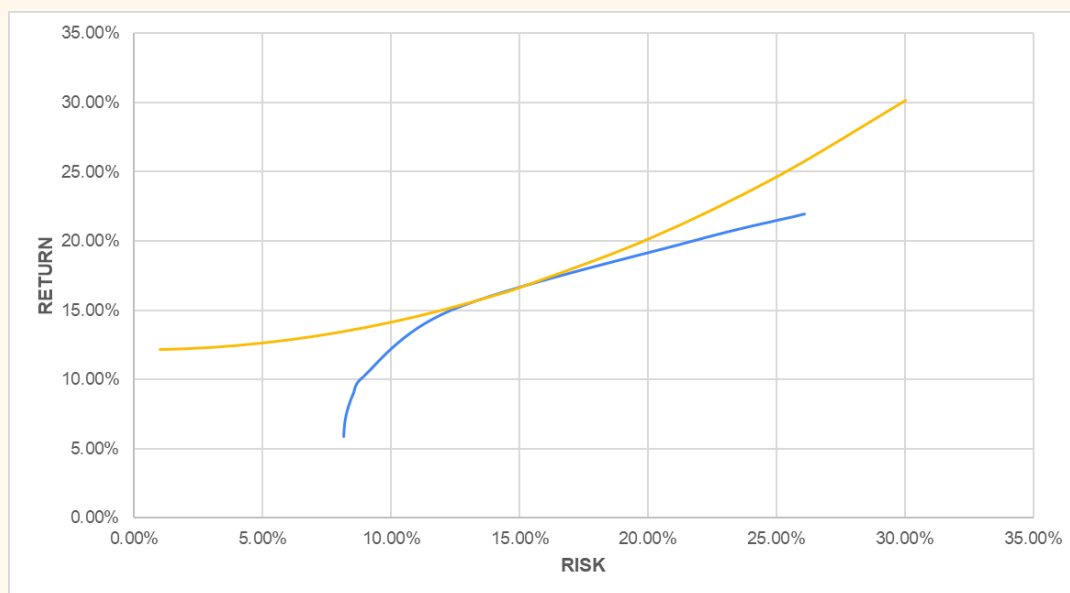
(CASE-1) When short selling is not allowed by maximizing utility.

Solution:

	RETURN	i	w
COAL INDIA	0.533%	1	0.000%
INFOSYS	11.424%	1	29.724%
ADANI POWER	21.934%	1	44.735%
JSW STEEL	10.162%	1	0.000%
ESCORTS	7.325%	1	0.000%
GLENMARK	-4.618%	1	0.000%
ICICI	8.013%	1	0.000%
RELIANCE INDUSTRIES	12.366%	1	25.542%
ITC	0.078%	1	0.000%
AARTI IND	10.291%	1	0.000%



<b>EXPECTED RETURN OF PORTFOLIO</b>	16.37%
<b>VARIANCE OF PORTFOLIO</b>	2.10%
<b>STDEV</b>	14.50%
<b>SUM OF WEIGHTS</b>	100.00%
<b>A(Degree of Risk Aversion)</b>	4
<b>UTILITY</b>	12.16%
<b>Diversification Ratio</b>	6.894499446

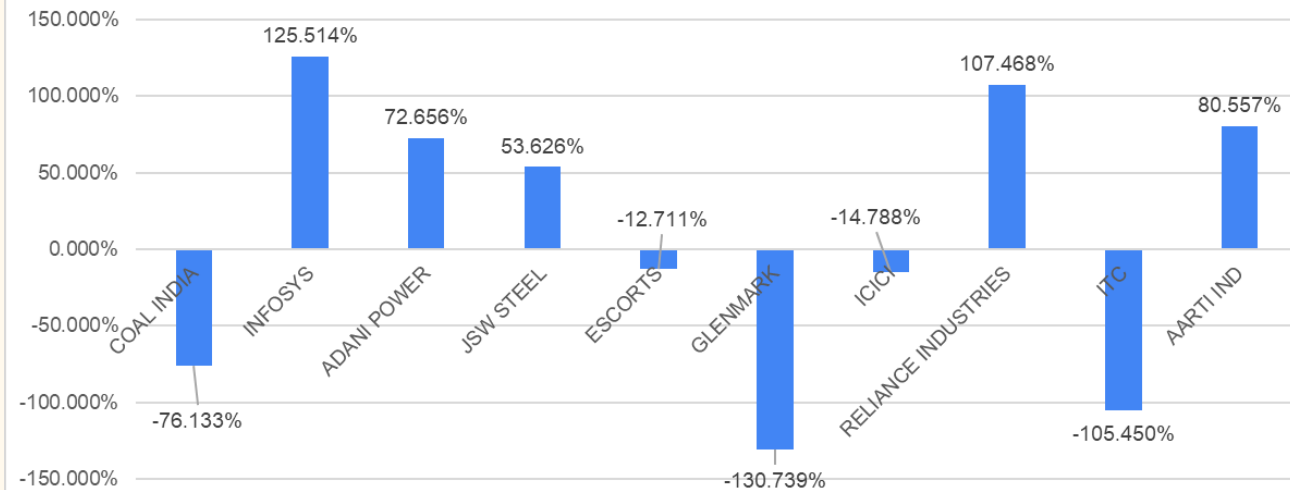


**(CASE-2) When short selling is allowed by maximizing utility.**

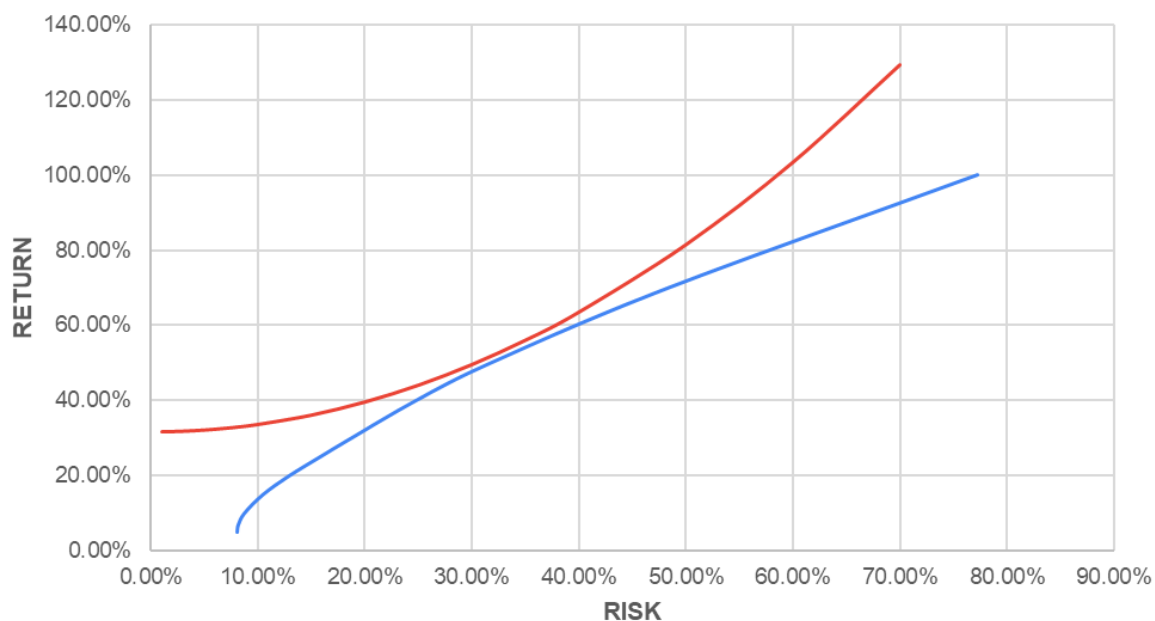
**Solution:**

	<b>RETURN</b>	<b>i</b>	<b>w</b>
<b>COAL INDIA</b>	0.533%	1	-76.133%
<b>INFOSYS</b>	11.424%	1	125.514%
<b>ADANI POWER</b>	21.934%	1	72.656%
<b>JSW STEEL</b>	10.162%	1	53.626%
<b>ESCORTS</b>	7.325%	1	-12.711%
<b>GLENMARK</b>	-4.618%	1	-130.739%
<b>ICICI</b>	8.013%	1	-14.788%
<b>RELIANCE INDUSTRIES</b>	12.366%	1	107.468%
<b>ITC</b>	0.078%	1	-105.450%
<b>AARTI IND</b>	10.291%	1	80.557%

### Optimal Portfolio Weights Allocated(Case 2)



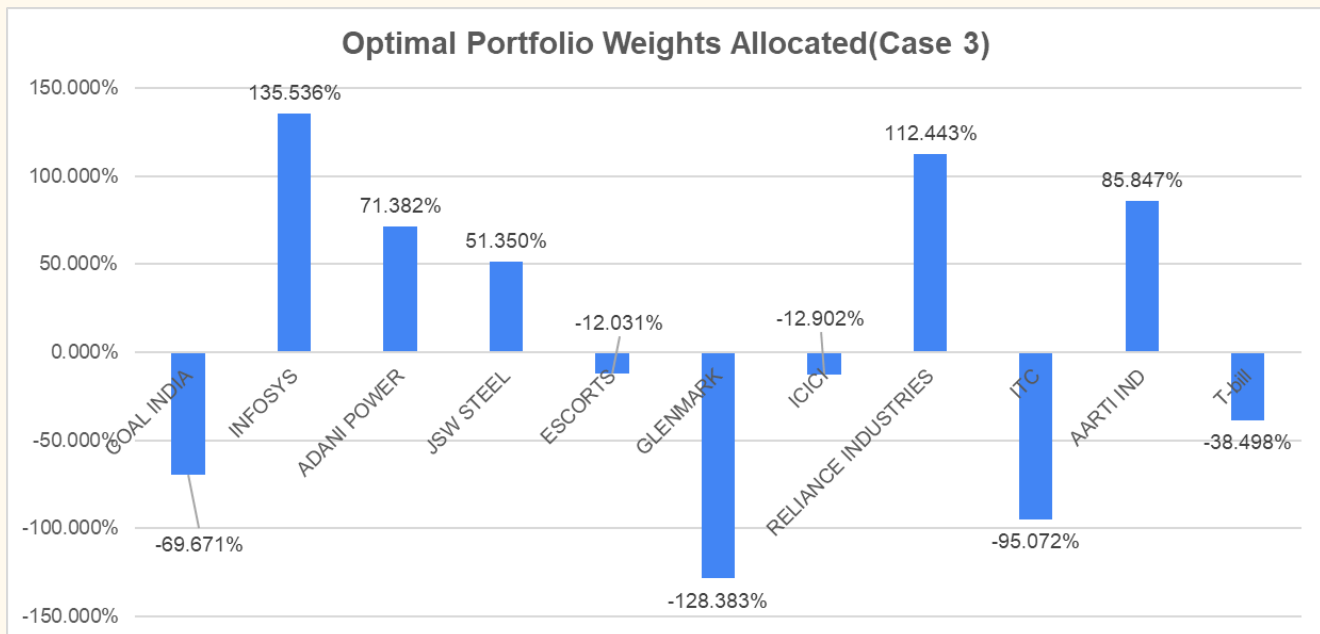
<b>EXPECTED RETURN OF PORTFOLIO</b>	60.74%
<b>VARIANCE OF PORTFOLIO</b>	14.59%
<b>STDEV</b>	38.19%
<b>SUM OF WEIGHTS</b>	100.00%
<b>A(Degree of Risk Aversion)</b>	4
<b>UTILITY</b>	31.57%
<b>Diversification Ratio</b>	2.618345053



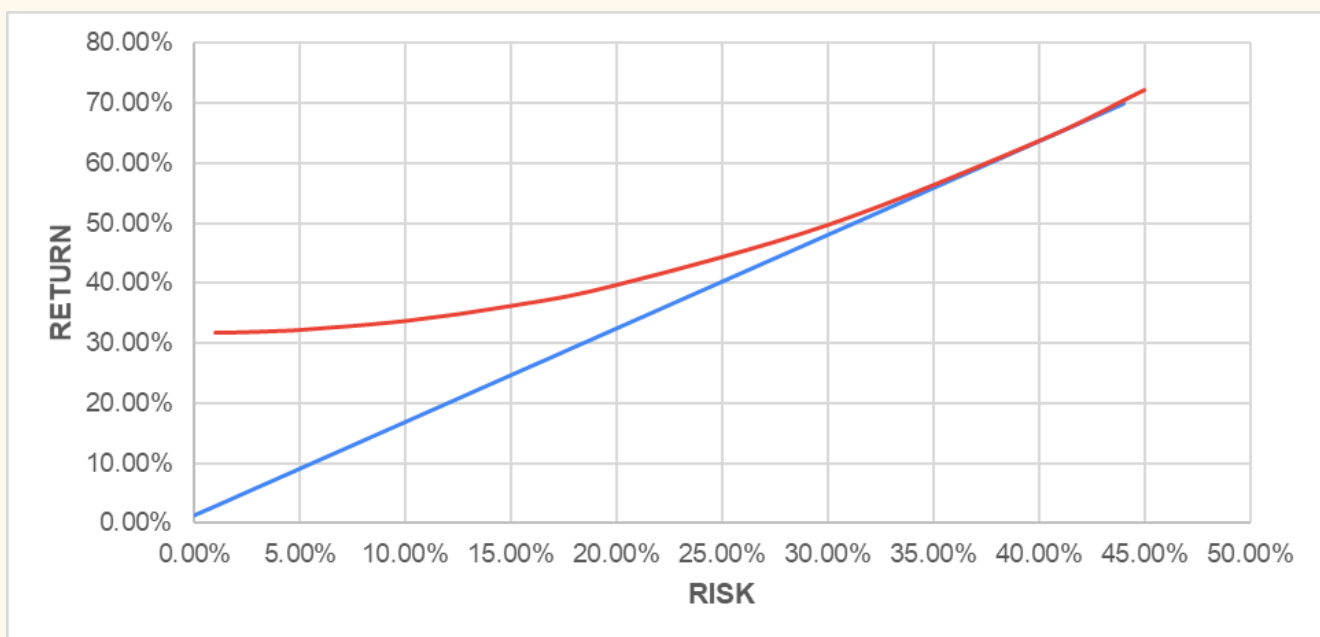
**(CASE-3) When riskless financial security(T-bill) is included and short selling is allowed by maximizing utility.**

**Solution:**

	RETURN	i	w
COAL INDIA	0.533%	1	-69.671%
INFOSYS	11.424%	1	135.536%
ADANI POWER	21.934%	1	71.382%
JSW STEEL	10.162%	1	51.350%
ESCORTS	7.325%	1	-12.031%
GLENMARK	-4.618%	1	-128.383%
ICICI	8.013%	1	-12.902%
RELIANCE INDUSTRIES	12.366%	1	112.443%
ITC	0.078%	1	-95.072%
AARTI IND	10.291%	1	85.847%
T-bill	1.385%	1	-38.498%



<b>EXPECTED RETURN OF PORTFOLIO</b>	62.13%
<b>VARIANCE OF PORTFOLIO</b>	15.19%
<b>STDEV</b>	38.97%
<b>SUM OF WEIGHTS</b>	100.00%
<b>A(Degree of Risk Aversion)</b>	4
<b>UTILITY</b>	31.76%
<b>Diversification Ratio</b>	2.566059027



## TANGENCY PORTFOLIO:

The Tangency portfolio is the one given by the point, where the capital allocation line is tangent to the efficient frontier, and henceforth it gives the best risk to return ratio. It can be obtained by maximizing the adjusted returns or the Sharpe ratio.

### Interpretation:

In tangency portfolio our objective is to maximize the risk adjusted return i.e., maximize the Sharpe ratio. For that reason, when short selling is allowed, the weights are given as such to maximize the Sharpe ratio or maximize the slope of CAL.

**We get the point of tangency by equating the slope of the efficient frontier to the slope of the utility curve, which has a return of 62.088%.**

### Motives behind choosing these securities.

The motiver behind the selection of these particular stocks is that they are the market leaders in their specific fields and have a huge market capitalization. The portfolio is well-diversified, including companies from various sectors. We have taken the opinions of Rusmik OZA( Kotak securities), Vineeta Sharma(Narnolia Financial Advisors), and Gaurav Garg (CapitalVia Global Research) while forming the portfolio. We have also taken into account how the current state of the companies are, how they have reduced their cost ratios (SBI LIFE), how the exports grew ( Escorts) , and how digital transformation will impact the market (as in the case with Infosys we expected market share gain), how latest buying of resources will translate to company growth(JSW Steel won the rights to iron ore mines in Odisha ) , how getting a positive response on a certain technology will give an edge over its competitors ( Glenmark Pharmaceuticals received final approval from the USFDA for Tadalafil Tablets ). While taking Aarti Industries we saw the demand increase from the consumer side post lockdown and hence chose it. We could have further increased the diversification by including small-cap stocks and had a better return.

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