MARKOWITZ THEORY AND PORTFOLIO MANAGEMENT

Project-2 Group 20

TABLE OF CONTENTS

01 DEFINING THE UNIVERSE

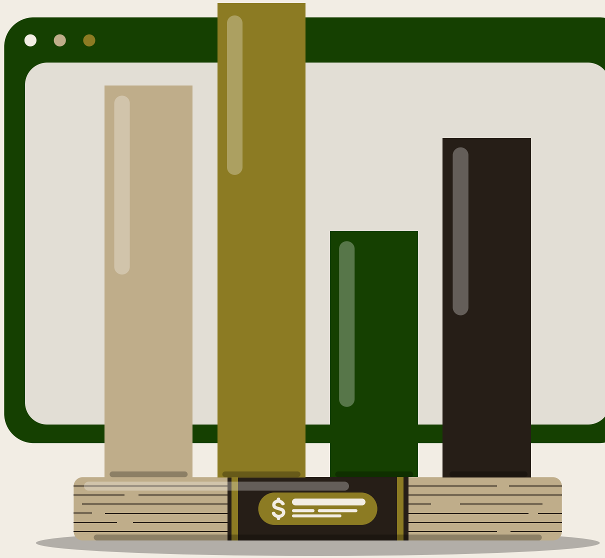
02 MARKOWITZ BULLET FOR RISKY ASSETS

03 BUILDING EFFICIENT FRONTIER

04 MAXIMISING RETURNS

01

DEFINING THE UNIVERSE OF RISKY ASSETS



INTRODUCTION

First we pick **10 risky assets from NSE**, namely: "RELIANCE.NS", "COALINDIA.NS", "KOTAKBANK.NS", "BAJAJ-AUTO.NS", "ITC.NS", "BAJAJFINSV.NS", "ADANIENT.NS", "INDUSINDBK.NS", "HEROMOTOCO.NS", "TATASTEEL.NS". This was done in order to have a **diverse portfolio** and to test how markowitz theory holds for Indian economy as a whole The data which we considered was from **30 October 2022 to 30th January 2024.**

ANALYSING ASSETS INDIVIDUALLY

We first analysed each of the 10 risky assets individually by looking at their individual returns (mean) and risks(variance). Further, we built a covariance matrix which acts as a building block for implementation of markowitz portfolio.

Ticker	ADANIENT.NS	BAJAJ-AUTO.NS	BAJAJFINSV.NS	COALINDIA.NS	HEROMOTOCO.NS	INDUSINDBK.NS	ITC.NS	KOTAKBANK.NS	RELIANCE.NS	TATASTEEL.NS
Ticker										
DANIENT.NS	0.001947	0.000060	0.000157	0.000098	0.000094	0.000114	-0.000032	0.000075	0.000145	0.000093
AJ-AUTO.NS	0.000060	0.000189	0.000030	0.000021	0.000075	0.000034	0.000023	0.000015	0.000018	0.000036
JAJFINSV.NS	0.000157	0.000030	0.000193	0.000043	0.000039	0.000092	0.000014	0.000033	0.000048	0.000053
ALINDIA.NS	0.000098	0.000021	0.000043	0.000251	0.000041	0.000061	0.000025	0.000040	0.000049	0.000076
OMOTOCO.NS	0.000094	0.000075	0.000039	0.000041	0.000208	0.000033	0.000016	0.000025	0.000037	0.000052
USINDBK.NS	0.000114	0.000034	0.000092	0.000061	0.000033	0.000260	0.000028	0.000043	0.000063	0.000054
ITC.NS	-0.000032	0.000023	0.000014	0.000025	0.000016	0.000028	0.000119	0.000026	0.000033	0.000038
TAKBANK.NS	0.000075	0.000015	0.000033	0.000040	0.000025	0.000043	0.000026	0.000113	0.000039	0.000026
LIANCE.NS	0.000145	0.000018	0.000048	0.000049	0.000037	0.000063	0.000033	0.000039	0.000141	0.000065
TASTEEL.NS	0.000093	0.000036	0.000053	0.000076	0.000052	0.000054	0.000038	0.000026	0.000065	0.000223

Fig 3: Covariance matrix for the assets

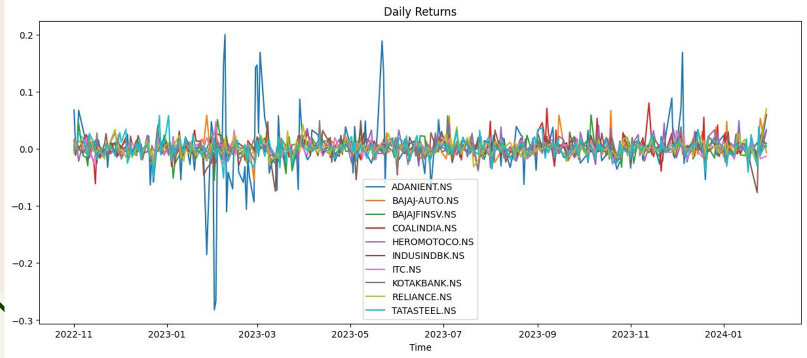
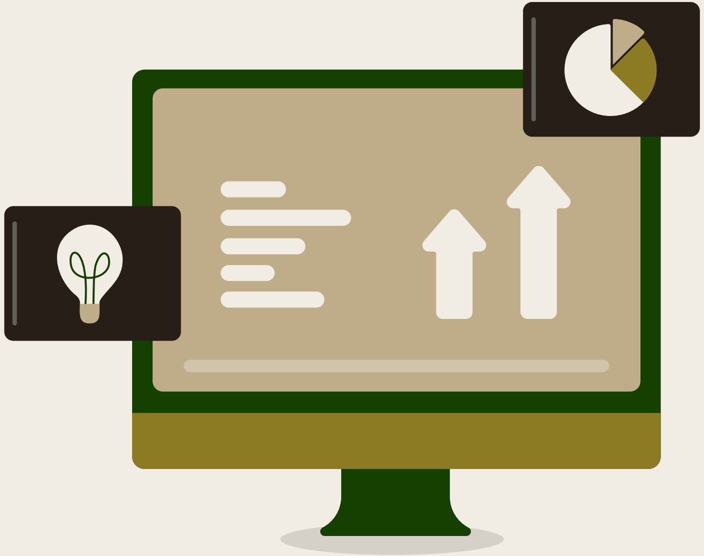


Fig 1: Daily returns of assets

Ticker	
ADANIENT.NS	0.000717
BAJAJ-AUTO.NS	0.002443
BAJAJFINSV.NS	-0.000003
COALINDIA.NS	0.001812
HEROMOTOCO.NS	0.001864
INDUSINDBK.NS	0.001075
ITC.NS	0.000889
KOTAKBANK.NS	-0.000082
RELIANCE.NS	0.000746
TATASTEEL.NS	0.001039

Fig 2: Average returns of the assets



02

MARKOWITZ BULLET FOR RISKY ASSETS

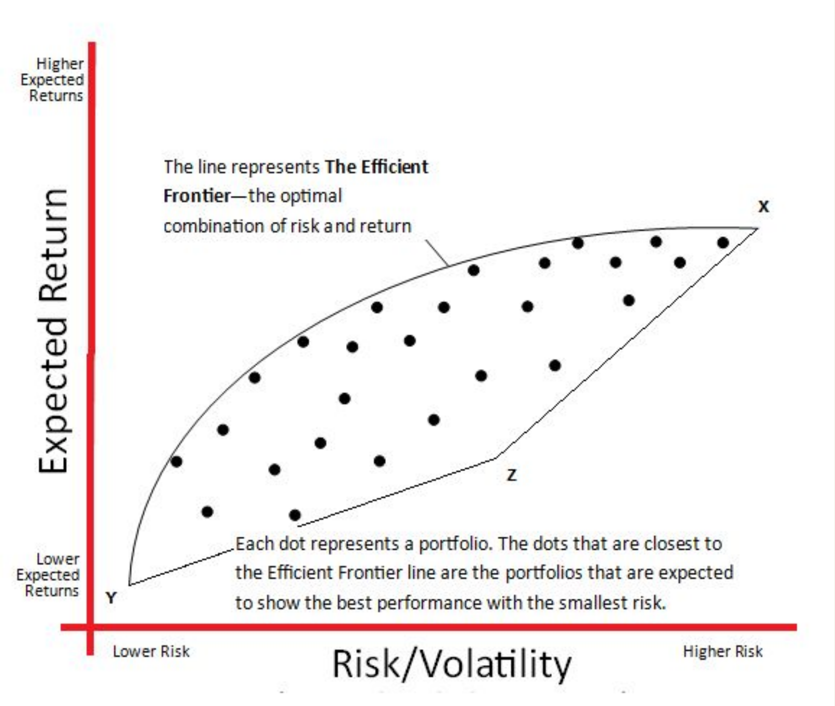


Fig 4: Explaining markowitz theory

MARKOWITZ THEORY

- Proposed by Harry Markowitz and talks about correlation between risks and returns of different assets in the portfolio.
- Talks about how for same assets some portfolios are dominant while others are dominated.
- Gives us an approach to minimise risk for a portfolio of given assets.

Markowitz bullet as a collection of Portfolios

Next, we randomly picked 100,000 weights, each summing up to 1 and corresponding to different portfolio. Now we plotted expected risks and returns for each of these portfolio's, which gave us a bullet like visualisation also known as markowitz bullet.

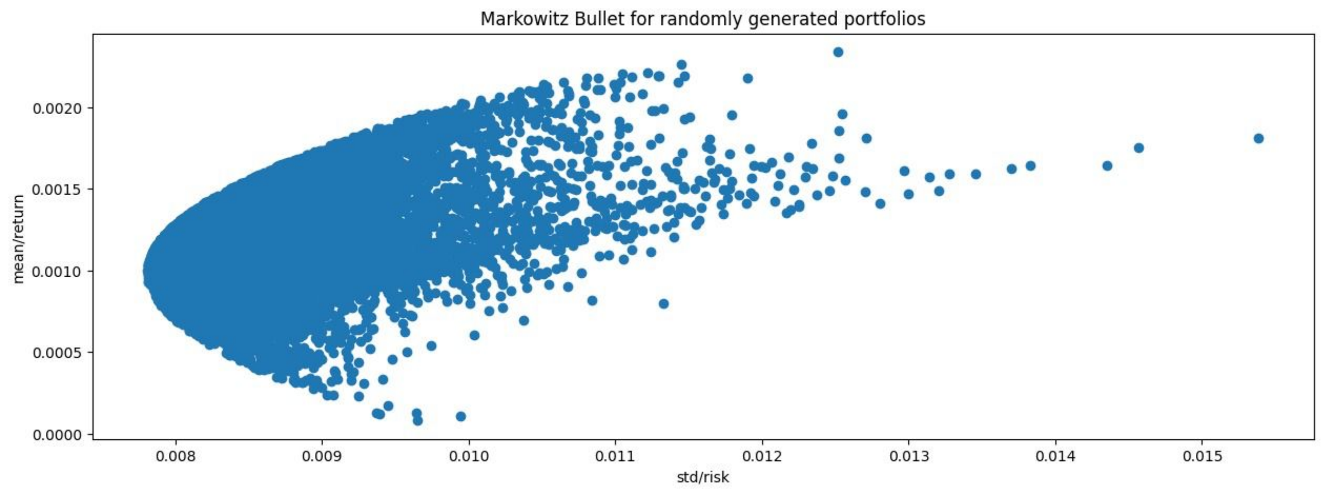
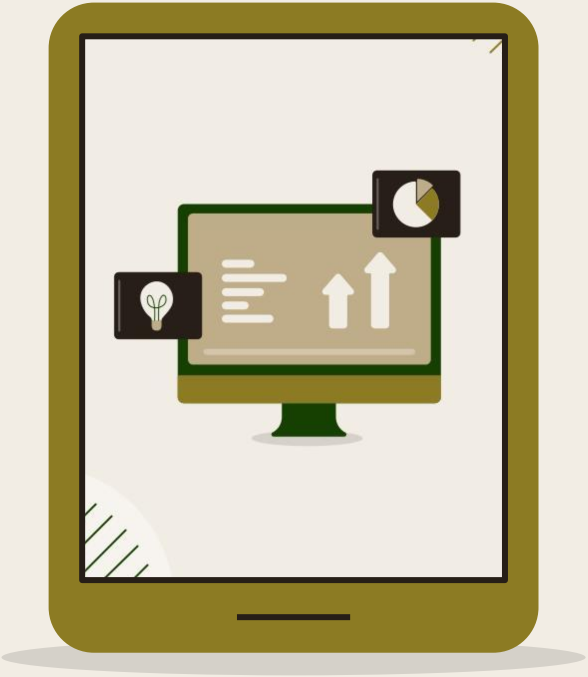


Fig 5: Visualising Markowitz Bullet for our Risky assets



03

GETTING MARKOWITZ EFFICIENT FRONTIER

DOMINANT/ DOMINATED PORTFOLIO

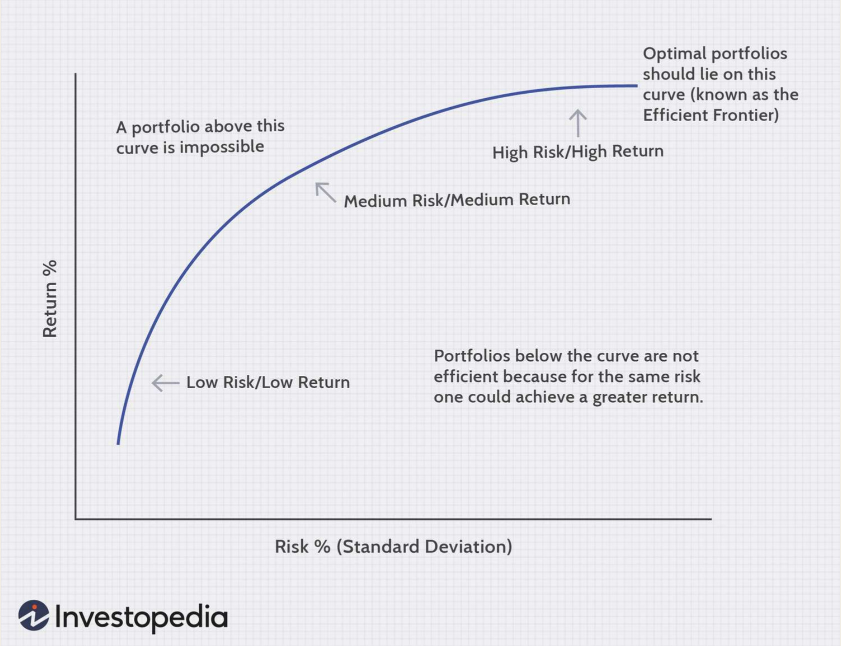


Fig 6: The idea behind an 'Efficient' frontier

Following the Markowitz Theory, we get the following mean-standard deviation plot and the Markowitz efficient frontier. Now from the plots we can draw the following observations from the perspective of an investor. Every rational investor will choose an efficient portfolio, always preferring a dominating portfolio to a dominated one. However, different investors may select different portfolios on the efficient frontiers, drawn below, depending on their individual preferences. Give two efficient portfolios with mu1 <= mu2 and sigma1 <= sigma2, a cautious person may prefer that with lower risk sigma1 and lower expected return mu1, while others may choose a portfolio with higher risk simga2, regarding the higher expected return mu2 as compensation for increased risk.

THE OPTIMIZATION PROBLEM

Now we try to find an efficient frontier for each of these risks which different portfolios have. Which is, if we pick any portfolio on efficient frontier, there is no portfolio with less risk and same return or same risk and more
return. For this we make an optimization problem to maximize the returns corresponding to each sigma (risk) with constraint that sum of weights is 1. This gives us markowitz efficient
frontier.

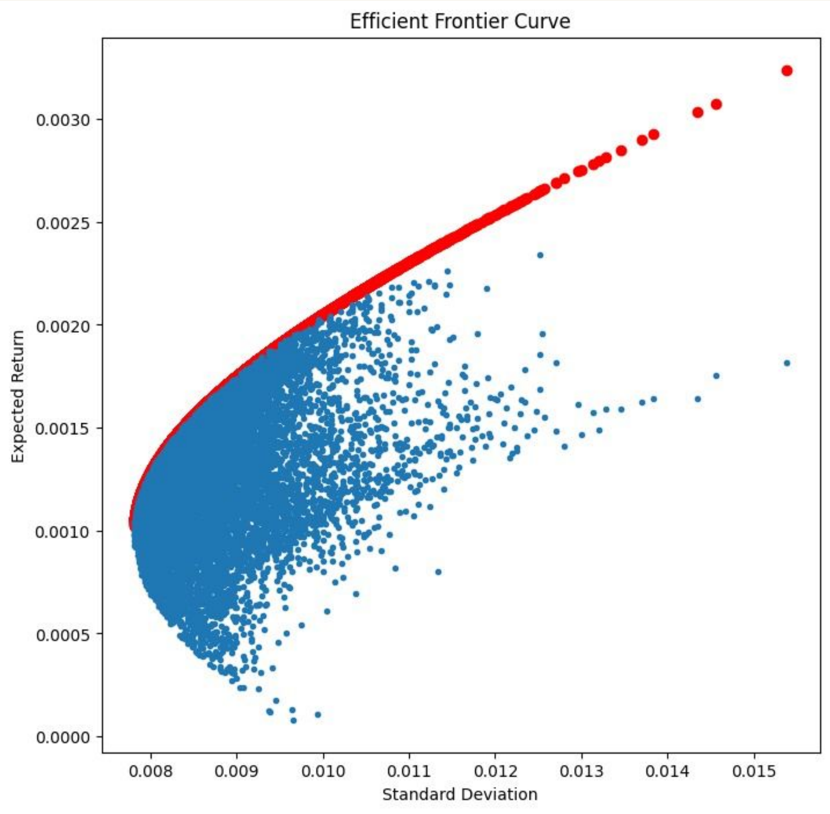
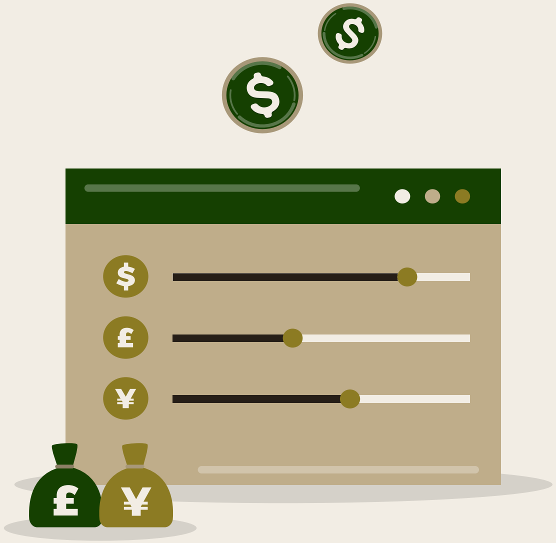


Fig 7: The efficient frontier for our markowitz bullet



04

MAXIMISING RETURN FOR DIFFERENT RISKS

Maximal Returns for given Risk

Here, we have a graph showing the Markowitz efficient frontier and the two chosen points of given risk.

We observe that maximal returns for the given two values of risk, lie on the efficient frontier.

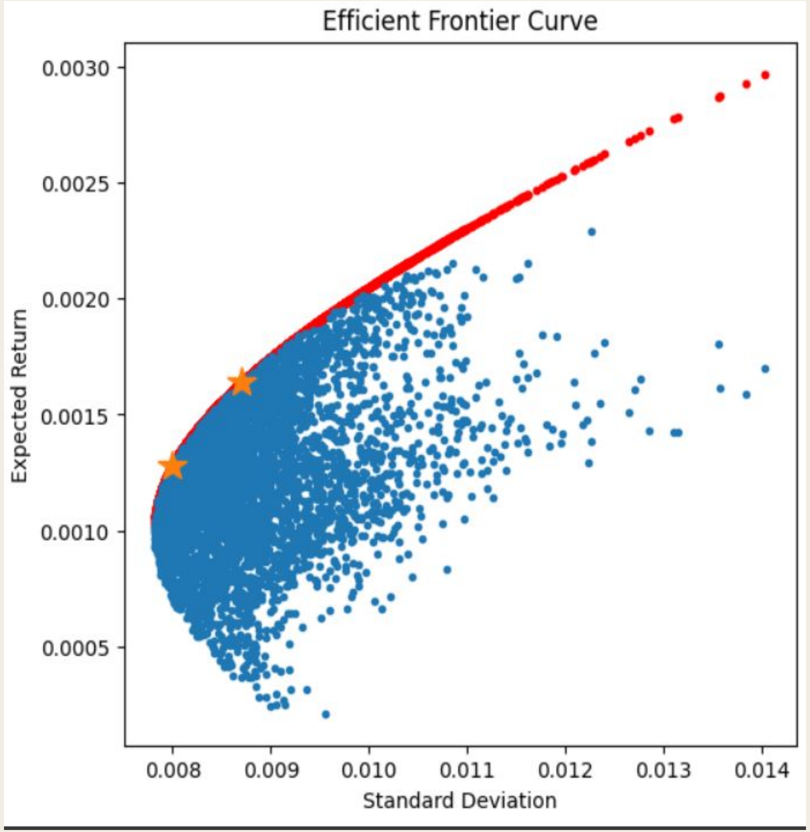


Fig 8: Choosing two points on efficient frontier

Obtained Optimal Weights

The optimal weights obtained for the given values of risk to get the maximal returns are as shown.

Also for the chosen value of risk, the obtained returns values are indicated by the image.

```
frontier_weights_new
```

```
[array([-0.00472967,  0.51872405, -0.21414085,  0.29216718,  0.22449012,
         0.12391457,  0.23648945, -0.2828412 ,  0.11541018, -0.00948382]),
 array([-0.00485035,  0.51087547, -0.20755893,  0.28732779,  0.22148608,
         0.12159843,  0.2366288 , -0.2722212 ,  0.11543178, -0.00871786])]
```

```
chosen_sigmas_new
```

```
[0.008879495740478246, 0.007873960994702411]
```

```
frontier_returns_new
```

```
[0.001706412397377907, 0.0011600649137047492]
```

Fig 9: Obtained optimal weights and returns.

REAL LIFE APPLICATIONS AND LIMITATIONS

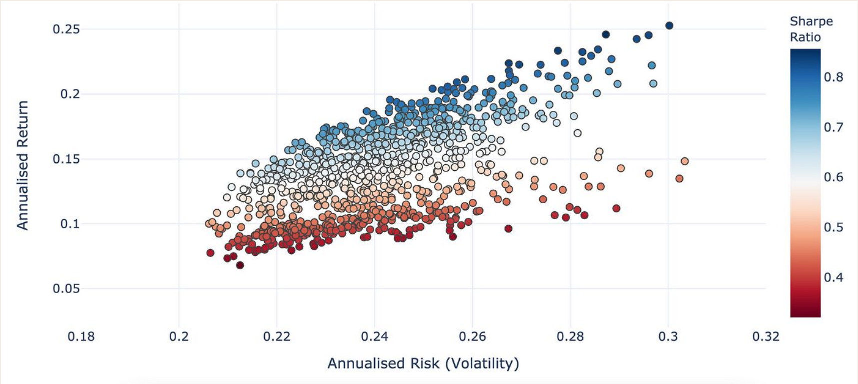


Fig 10: Example of how markowitz theory can be used to quantify good/bad investments.

Markowitz theory only takes into account historical returns and volatility and may not always be accurate for future predictions, also it works out as an optimization problem to maximise returns for a given risk. However, this may not be very practical in real market conditions as this neglects other factors like transaction costs and liquidity constraints, which are crucial in real-world investment decisions.

Despite its limitation, it still provides a quantitative metric by managing risk and return to assess our investments and is widely used, even today.

THANK YOU