Project report

on

"Portfolio Management: Asset Selection and Weight Optimization for Investment with Sectorial Preference"

For

**Bonanza
Portfolio Ltd.**

Submitted by

Aditya Chaurasiya

In

Partial Fulfilment of the Award of Degree of
Master of Operational Research

To

Department of Operational Research

Faculty of Mathematical Sciences
New Academic Block
University of Delhi
Delhi – 110007

2025

Department of Operational Research

Faculty of Mathematical Sciences
New Academic Block
University of Delhi
Delhi – 110007

Name of the student	:	Aditya Chaurasiya
Title of Project	:	Portfolio Management: Asset Selection and Weight Optimization for Investment with Sectorial Preference
Date of commencement of project	:	18th Feb, 2025
Date of submission of project	:	08th May, 2025
Name and Address of the Organization	:	Bonanza Portfolio Ltd 4353/4C Ansari Road, Drya Ganj, New Delhi - 110002
Supervisors from the faculty	:	Sr. Prof. Chandra K. Jaggi Sr. Prof. Prakash C. Jha Sr. Prof. Pankaj Gupta Sr. Prof. Preeti Wanti Srivastava Prof. K K Aggarwal Prof. Anu Gupta Aggarwal Prof. Ompal Singh Prof. Mukesh Kumar Mehlawat Prof. Sameer Anand Prof. Aditi Khanna Dr. Vandana Khaitan Dr. Abhishek Tandon Dr. Shilpi Verma Dr. Adarsh Anand Dr. Kaushal Kumar Dr. Gurjeet Kaur Dr. Jagvinder Singh

DECLARATION

I declare that the Project entitled "Portfolio Management: Asset Selection and Weight Optimization for Investment with Sectorial Preference" is my original work carried out at Bonanza Portfolio Ltd, and has been submitted in partial fulfilment for the Award of Degree of Master of Operational Research. This project report has not been submitted earlier in full or in part for any other Diploma or Degree to any other University or Institution to the best of my knowledge.

<div align="right">

Name: Aditya Chaurasiya

Master of Operational Research (Sem-IV)

Department of Operational Research

University of Delhi Delhi-110007

</div>

Prof. KK Aggarwal

Head of Department

Department of Operational Research

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Letter

To
Head of Department
Department of Operational Research
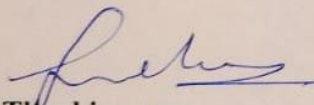Faculty of Mathematical Sciences
University of Delhi, New Delhi - 110000

Subject: Assignment of Industrial Project to Mr. Aditya Chaurasiya at BONANZA PORT FOLIO LTD.

Respected Sir/Madam,

In response to your request regarding an industrial project for Mr. Aditya Chaurasiya, a final-year student of the Master's program in Operational Research at the University of Delhi, we are pleased to confirm that he has been granted permission to undertake a project on **Portfolio Management** at our company, BONANZA PORT FOLIO LTD 4353/4C Madan Mohan Street Ansari Road Darya Ganj Helhi 110002

This projectwill be conducted over a period of two months, from **February 18, 2025, to April 30, 2025**, and will be strictly for academic purposes. Please note that no stipend will be provided during the course of the project. Additionally, we expect Mr. Aditya Chaurasiya to uphold the confidentiality and integrity of all organizational data.

We appreciate your cooperation and look forward to a productive collaboration.

Thanking you.

Best regards,

PRITI SRIVASTAVA
Branch Manager

To
The Head of Department
Department of Operational Research
Faculty of Mathematical Sciences
University of Delhi - 110007

Subject: Completion of Project by Mr. Aditya Chaurasiya at Bonanza Portfolio Ltd.
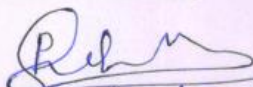
Respected Sir/Ma'am,

This is to certify that Mr. Aditya Chaurasiya, final year student of Master of Operational Research, Department of Operational. Research, University of Delhi has successfully completed his project for Bonanza Portfolio Ltd and submitted the project title "Asset Selection and Weight Optimization for Investment with Sectorial Preference".

We wish him all the best in his future endeavours.

Sincerely,

Branch Head
PRITI SRIVASTAVA

07/05/2025

Acknowledgement

This project would not have been possible without the help of many people. I would like to take this opportunity to express my deep appreciation to those who have helped me in one way or another in the completion and success of this study.

I want to pay my earnest gratitude to my professors Prof. (Dr.) Pankaj Gupta, Prof. (Dr.) Chandra K. Jaggi, Prof. (Dr.) K.K. Aggarwal, Dr. Shilpi Verma, Dr. Gurjeet Kaur, Prof. (Dr.), Dr. Abhishek Tandon, (Mrs.) Preeti Wanti Srivastava, Prof. (Dr.) P.C Jha, Prof. (Dr.) (Mrs.) Anu Gupta Aggarwal, Dr. Ompal Singh, Dr. Mukesh Kumar Mehlawat, Dr. Vandana Khaitan, Dr. Adarsh Anand, Dr. Kaushal Kumar, Dr. Sameer Anand and Dr. Jagvinder Singh for the comprehensive discussions during the tenure of my project.

During the project work, I was in constant interaction with my colleagues, who were highly supportive keeping up my enthusiasm. I am highly indebted to them.

Aditya Chaurasiya
Master of Operational Research (Semester - IV)
Department of Operational Research
University of Delhi
Delhi – 110007

Contents

1. Introduction to Operational Research

Operational Research (OR) is a discipline that employs mathematical modeling, statistical analysis, and optimization techniques to solve complex problems in decision-making under business scenarios. The primary goal of OR is to provide insights and solutions that can help organizations and businesses make better decisions, optimize processes, and increase efficiency.

OR has a rich history that dates back to the 19th century, but it wasn't until the 20th century that the field began to take shape as we know it today. During World War II, the Allies recognized the need for a more scientific approach to planning and logistics in order to improve military operations. Thus, OR emerged as a field of study, with a focus on applying mathematical models and algorithms to solve military problems.

One of the key figures in the development of OR during this time was George Dantzig, who is credited with developing the simplex algorithm for linear programming. The simplex algorithm is still widely used today in a variety of applications, including resource allocation and production planning. Other notable pioneers in OR include Harold Kuhn, who developed the Hungarian algorithm for solving the assignment problem, and Tjalling Koopmans, who made significant contributions to the field of econometrics.

In short, operational research is the study of how to make decisions efficiently. In OR, large problems are broken down into basic steps, then solved in defined steps by mathematical analysis. The steps in general are:

1. Identification of the problem
2. Constructing a mathematical problem that closely resemble the real-world scenario and constraints
3. Using a mathematical model to solve the problem
4. Testing each solution on the model and analyzing its viability in the given business scenario
5. Implementing of the solution to the actual problem

After the war, OR began to expand beyond military applications and into areas such as logistics, transportation, and manufacturing. The development of computers in the 1950s and 1960s made it

possible to tackle more complex problems, leading to the development of more sophisticated models and algorithms.
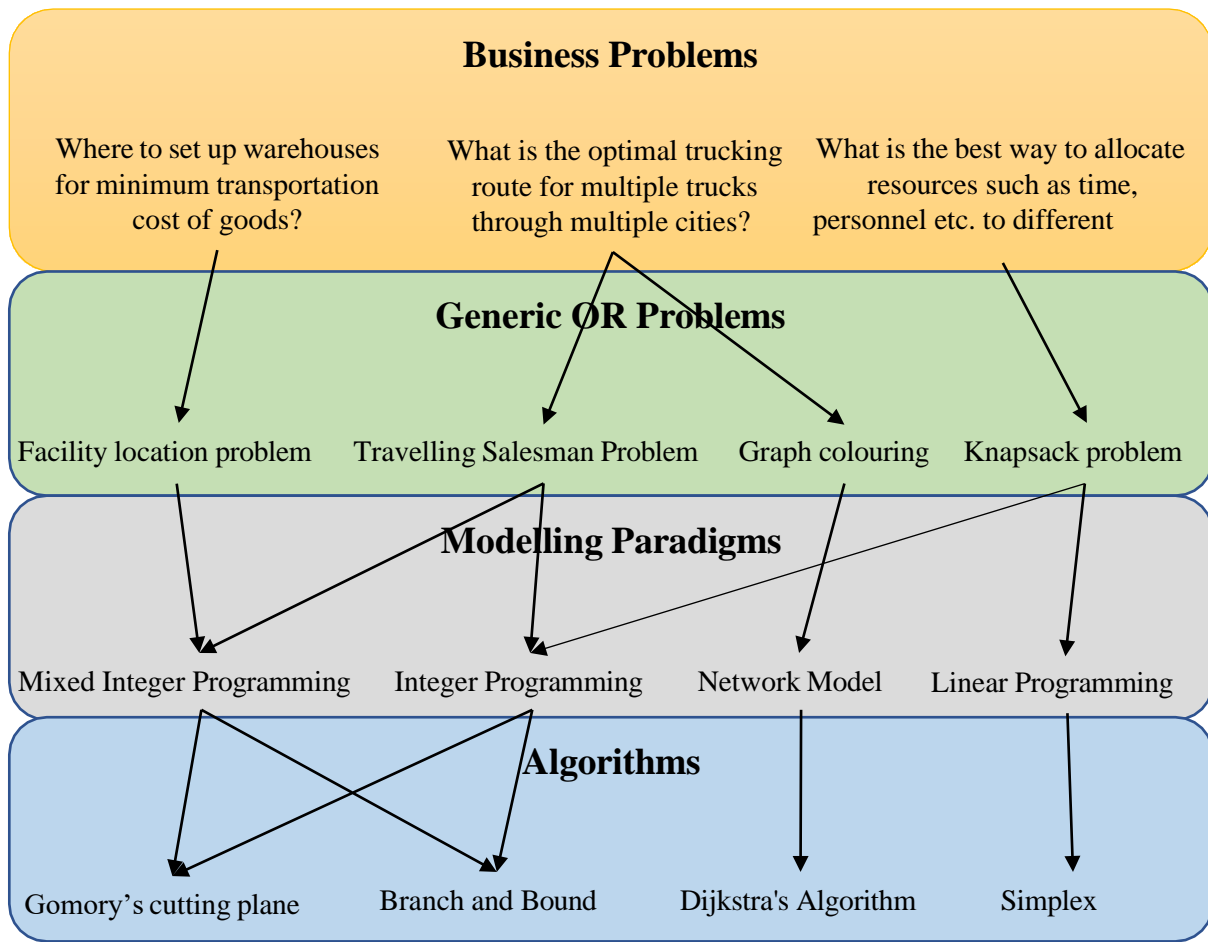
Today, some business problems addressed by OR are:

- **Critical path analysis or project planning**: Identifying those processes in a multiple dependency project consisting of many processes that influence the overall duration of the project. This can be used to analyze and optimize complex construction processes.

- **Deploying workforce for a project**: Resource allocation is the study of optimally assigning available resources to various uses. The problem can be of assigning computational power to different components of a machine to minimize total computational time, assignment of available workforce to a construction project with the objective of optimally using each workforce unit etc.

- **Finding the optimal location of facilities**: The facility location problem is the study of optimally placing facilities (factories, warehouses etc.) over a geographical area to minimize total transportation costs while considering factors like avoiding placing hazardous materials near housing, and competitors' facilities.

- **Vehicle Routing:** Optimally assigning agents to tasks. For example, suppose, that a taxi firm has three taxis (the agents) available at different locations, and three customers (the tasks) wishing to be picked up as soon as possible. For each taxi the "cost" of picking up a particular customer will depend on the time taken for the taxi to reach the pickup point. Its solution is whichever combination of taxis and customers results in the least total cost.

- **Supply chain management**: Optimally managing the flow of raw materials and products based on uncertain demand for the finished products. This includes procurement of raw materials, optimal managing of its entire flow until its produced into a finished good which is then delivered to the end customer.

- **Inventory management**: Optimally managing a stock of idle resources for an organization that has a future economic value to ensure smooth running of the organization's current and immediate future affairs.

- **Designing data networks**: Queueing theory is the study of movement of people, objects or information through a line. Its applications are in providing faster customer service, increasing traffic flow, improving order shipments from a warehouse, designing data networks and call centers etc.

- **Healthcare Management:** OR can be used in healthcare to optimize patient flow through hospitals, schedule surgeries, and manage resources. OR techniques can help healthcare organizations make better decisions that improve patient outcomes and reduce costs.

- **Determining prices of products:** Predicting demand, adjusting pricing, terms of sale etc. to maximize the revenue for the company.

- **Portfolio Optimization:** Optimal allocation of financial resources to various securities in order maximize returns while managing risk.

Business problems such as above are generally mapped into some variation or extension of **Generic Problems of OR**. These generic problems are families of problems that are easier to study and research. These problems are concise enough to be described in mathematical notations as a result of which majority of academic OR research is done in these fields. Some examples of generic OR problems are the Travelling Salesman Problem (TSP), Knapsack problem, Facility location problem etc.

These generic problems are then modelled and solved using operational research modelling paradigms and algorithms. A modelling paradigm is a set of rules and practices that represents higher level problems using lower-level mathematical notations and structures. Some examples of popular OR modelling paradigms are Linear Programming, Quadratic Programming, Network Models etc.

The problems described mathematically are solved using OR algorithms such as Simplex Method, Branch and Bound method, Djikstra's method etc.

Business Problems

Where to set up warehouses for minimum transportation cost of goods?

What is the optimal trucking route for multiple trucks through multiple cities?

What is the best way to allocate resources such as time, personnel etc. to different

Generic OR Problems

Facility location problem   Travelling Salesman Problem   Graph colouring   Knapsack problem

Modelling Paradigms

Mixed Integer Programming   Integer Programming   Network Model   Linear Programming

Algorithms

Gomory's cutting plane   Branch and Bound   Dijkstra's Algorithm   Simplex

One of the latest developments in OR is the integration of machine learning and artificial intelligence techniques. These techniques can be used to improve the accuracy and effectiveness of OR models and algorithms, and to automate decision-making processes. For example, machine learning algorithms can be used to predict demand for products or services, allowing organizations to optimize production and resource allocation. In addition, artificial intelligence algorithms can be used to automate decision-making in areas such as risk management and fraud detection.

Another area of development in OR is the use of big data and data analytics. With the proliferation of digital technologies and the internet, organizations are collecting vast amounts of data that can be used to optimize processes and make better decisions. OR practitioners are using data analytics to extract insights from this data and apply them to real-world problems. For example, in healthcare, OR practitioners are using data analytics to identify patterns in patient data that can be used to improve patient outcomes and reduce costs.

One potential area of future development in OR is the use of blockchain technology. Blockchain technology allows for the secure and transparent transfer of data and assets, making it a potentially powerful

As we look to the future, OR is likely to play an increasingly important role in a wide range of industries. As organizations continue to collect more data, OR practitioners will be needed to analyze this data and extract insights that can be used to make better decisions. In addition, as automation and artificial intelligence become more prevalent, OR practitioners will be needed to ensure that these systems are making decisions that align with an organization's goals.

2. Company Profile

Bonanza Portfolio Limited

Bonanza Portfolio Ltd. is a leading full-service financial powerhouse headquartered in India. Established in 1994, Bonanza has rapidly evolved into one of the largest financial services and broking houses in the country. Today, it stands as the fastest-growing financial institution with a robust structure comprising 10 mega group companies, offering a comprehensive suite of services across all financial verticals.

With a pan-India presence through 700+ outlets in over 600 cities, Bonanza delivers trusted expertise and cutting-edge financial solutions to a wide base of individual and institutional clients. Its services span Equity Broking, Portfolio Management Services, Mutual Fund Investments, Insurance, and top-tier Depository Services, catering to diverse financial goals and risk appetites.

Committed to technological advancement, Bonanza provides its tech-savvy clientele with an integrated and innovative platform for both online and offline trading. The company is also backed by one of the most dedicated and insightful research teams in the industry, offering market intelligence and strategic insights that drive sound investment decisions.

Bonanza's industry credibility is reinforced by affiliations with premier institutions including NSE, BSE, MCX, MCX-SX, CDSL, NSDL, ICEX, and USE, making it a name to reckon with in India's financial landscape. Whether you're a first-time investor or a seasoned trader, Bonanza offers the perfect ecosystem to take your financial journey forward with confidence.

Service and Products Offered

1. **Broking:** Bonanza offers trading facilities for equities, commodities, currencies, and derivatives, with a strong research team providing insights and analysis on various markets and sectors.

2. **Portfolio Management Services (PMS):** For high-net-worth individuals, Bonanza provides customized portfolio strategies with active monitoring and risk management.

3. **Insurance:** Bonanza offers a range of insurance products, including life insurance, health insurance, and general insurance.

4. **Depository Services:** Bonanza provides depository services through its partnership with the National Securities Depository Limited (NSDL) and Central Depository Services Limited (CDSL).

5. **Investment Advisory:** Bonanza investment advisory services provide expert guidance on investment strategies and portfolio management.

6. **Trading Platforms:** With a technologically advanced interface, Bonanza provides real-time market access, analytics, and trading tools accessible via desktop and mobile.

7. **Research Services:** Bonanza has a strong research team that provides insights and analysis on various markets and sectors, including equity research, macroeconomic research, and technical research.

Company Performance as for 2020-23:

8. THE FINANCIAL PERFORMANCE OF THE PORTFOLIO MANAGER

(Rupees in Lacs)

Year ending	31/03/2020 (Audited)	31/03/2021 (Audited)	31/03/2022 (Audited)	31/03/2023 (Audited)
Income	8385.64	12446.17	14828.45	11331.44
Expenditure	8662.25	10973.26	13178.53	10606.68
Exceptional Items	-	-	-	-
Net Profit Before Tax	-276.61	1472.91	1649.92	724.76
Prov. for Taxation	138.52	255.27	420.93	195.79
Profit After Taxation	-414.69	1217.64	1228.99	528.91

3. Objective of the Project

"To create a minimum risk portfolio of not more than 25 stocks that gives a minimum expected return with the given constraints based on sectorial preference"

Steps to achieve the objective:

1. **Understand risk-return constraints of the customer under consideration**

2. **Obtain a list of 25 'best performing stocks'**

   Data envelopment analysis will be used to compare a larger pool of stocks on multiple performance measures, followed by a pairwise *correlation analysis* to shortlist best performing stocks that are mutually least correlated.

3. **Obtain the optimal allocation of available funds to different stocks to obtain best possible risk-return measures subject to the given constraints**

   Multiple portfolio optimization *quadratic programs* will be used to obtain allocations. A *comparison* will be done between the obtained portfolios and other professionally managed portfolios to understand the performance of the obtained portfolios.

4. **Suggest the best of the obtained portfolios**

Benefit to Clients:

Bonanza Portfolio Ltd**.** takes a personalized and client-centric approach to investment advisory. Our financial experts begin by understanding the customer's financial goals, risk appetite, and investment preferences to build a well-defined investor profile. Based on this profile, we craft a investment strategy that reflects both the customer's financial objectives and market opportunities. Traditionally, Bonanza has guided clients toward investments in mutual funds, offering a curated Mutual Fund Tracker that highlights top-performing funds based on in-depth research and risk-return analysis. While the final investment decision always rests with the client, our expert insights empower them to make informed choices.

This new initiative – Smart Portfolio enhances our offering by providing clients with an additional investment option—a carefully selected narrow portfolio of individual stocks, along with the option of mutual funds. The value this project brings to the customer are:

1. **Transparency & Control:** We can see every stock, its weight, rationale, and past performance before investing. You also have full control to modify, add, or remove stocks from your portfolio.

2. **Direct Ownership of Stocks/ETFs:** Unlike mutual funds, where you own units, gives you direct ownership of the underlying stocks or ETFs in your demat account.

3. **Freedom of choice:** Depending on the risk-taking willingness of the customer and their willingness to see beyond the abstraction of mutual funds, a list of specific stocks to invest in maybe preferred by some customers.

4. **Goal-Based Investing:** It enables investors to align their portfolios with specific financial goals such as retirement, education, or wealth creation. Each investment bucket is structured around a clear objective, providing strategic direction while allowing investors to capitalize on prevailing market trends.

Drawback:

Mutual funds offer professional management and diversification, making them a safer option for investors who prefer a passive investment strategy. In contrast, Smart Portfolios provide more control and transparency, allowing investors to directly choose stocks based on their preferences, but they may come with higher risks and costs. The key drawbacks are as follows: of mutual funds.

1. **Risk:** Mutual funds, due to their diversified nature, inherently spread risk across various assets, helping to lower the overall exposure to any single stock or sector. On the other hand, Smart Portfolios, which may involve concentrated positions in certain stocks or themes, could expose investors to higher risk, especially during market volatility.

2. **Additional Cost:** While mutual funds charge management fees and expense ratios, Smart Portfolios allow investors to bypass such fees by directly owning the underlying assets. However, Smart Portfolios might incur transaction costs or brokerage fees when buying or selling stocks, which can add up over time, especially with frequent rebalancing.

3. **Rebalancing:** Investors must manually execute rebalancing recommendations, which could be cumbersome for those seeking a more hands-off, automated investment experience.

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4. Literature Review

A. Investments: What and Why
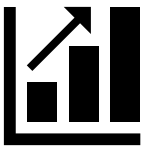
Financial investment is a way of increasing existing wealth by buying and selling financial assets of fluctuating value and bearing related risk. The value of investments is expected to grow in the long term, although without any guarantee. The rationale for this expectation of investments to grow in value is rooted in global accumulation of capital and increase in commercial productivity through competent management and innovations.

As more and more people live longer, accumulate more wealth, and have progressively higher standards of living, the need for financial security becomes vital. It is exactly for this reason; people start to look for multiple sources of incomes. Traditionally this used to mean fixed deposits at banks, which yielded a small return in exchange of no risk. But FD returns often get beaten by inflation rates as a result of which FDs start giving negative returns.

Moreover, not all investors are looking for the safest way of putting their money to work, a good majority is risk hungry, who are willing to take on risk in exchange of a higher expected rate of return from their investments. Apart from risk hungry investors, there are retirees who do not enjoy the

benefits of government pension plans; for this demography a relatively safe way of investments that yield a return greater than fixed deposits is needed.
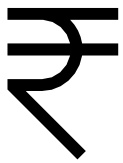
Then there are High Net Worth Individuals (HNWIs). HNWIs are individuals or families with a high net worth, which is typically defined as having investable assets (such as cash, stocks, and real estate) exceeding a certain threshold. HNWIs are often able to take advantage of investment opportunities and financial services that may not be available to the general public. They are also often targeted by wealth management firms and financial advisors who specialize in serving affluent clients. HNWIs can include entrepreneurs, executives, celebrities, and inherited wealth.

A financial investment is the purchasing of assets which are expected to generate future incomes. There are risks associated with such investments, a investment may not generate any income for a period or may actually lose value over a period.

Types of investments

Cash and Cash Instruments

Cash can be invested over any desired period, to generate interest income, in a range of highly liquid or easily redeemable instruments, from simple bank deposits, negotiable certificates of deposits, commercial paper (short term corporate debt) and Treasury bills (short term government debt) to money market funds, which actively manage cash resources across a range of domestic and foreign markets.

Stocks/Equities

A share of stock is a piece of ownership of a public or private company. By owning stock, the investor may be entitled to dividend distributions generated from the net profit of the company. As the company becomes more successful and other investors seek to buy that company's stock, it's value can also appreciate and be sold for capital gains.

The two primary types of stocks to invest in are common stock and preferred stock. Common stock often includes voting right and participation eligibility in certain matters. Preferred stock often have first claim to dividends and must be paid before common shareholders.

Bonds/Fixed-Income Securities

A bond is an investment that often demands an upfront investment, then pays a reoccurring amount over the life of the bond. Then, when the bond matures, the investor receives the capital invested into the bond back. Similar to debt, bond investments are a mechanism for certain entities to raise money. Many government entities and companies issue bonds; then, investors can contribute capital to earn a yield. The recurring payment awarded to bondholders is called a coupon payment.

Derivatives

Derivative instruments are financial assets that are derived from existing primary assets as opposed to being issued by a company or government entity. The two most popular derivatives are futures and options.

Real Estate

Real estate investments are often broadly defined as investments in physical, tangible spaces that can be utilized. Land can be built on, office buildings can be occupied, warehouses can store inventory, and residential properties can house families. Real estate investments may encompass acquiring sites, developing sites for specific uses, or purchasing ready-to-occupy operating sites.

Commodities

Commodities are often raw materials such as agriculture, energy, or metals. Investors can choose to invest in actual tangible commodities (i.e. owning a bar of gold) or can choose alternative investment products that represent digital ownership (i.e. a gold ETF).

Commodities can be an investment because they are often used as inputs to society. Consider oil, gas, or other forms of energy. During periods of economic growth, companies often have greater energy needs to ship more products or manufacture additional goods. In addition, consumers may have greater demand for energy due to travel. In this example, the price of commodities fluctuates and may yield a profit for an investor.

₿ Cryptocurrency

Cryptocurrency is a blockchain-based currency used to transact or hold digital value. Cryptocurrency companies can issue coins or tokens that may appreciate in value. These tokens can be used to transact with or pay fees to transact using specific networks.

Collectibles

A less traditional form of investing, collecting or purchasing collectibles involves acquiring rare items in anticipation of those items becoming in higher demand. Ranging from sports memorabilia to comic books, these physical items often require substantial physical preservation especially considering that older items usually carry higher value.

B. Portfolio Management

Portfolio management is the process of managing a collection of financial assets, such as stocks, bonds, and other securities, with the goal of achieving a specific investment objective. The objective may be to maximize returns, minimize risk, or achieve a combination of both.

In portfolio management, an investor or investment manager will typically analyze a range of factors, including the individual securities' risk and return characteristics, their correlation with other securities in the portfolio, and the investor's or client's risk tolerance, investment objectives, and time horizon.

Based on this analysis, the investor or investment manager will construct a portfolio of securities that is designed to meet the investment objective. The portfolio may be actively managed, with the manager buying and selling securities as market conditions change, or it may be passively managed, with the manager simply tracking a benchmark index.

Portfolio management also involves ongoing monitoring and evaluation of the portfolio's performance, as well as periodic rebalancing to ensure that the portfolio remains aligned with the investor's or client's investment objectives and risk tolerance.

In order to manage a portfolio a good understanding of the constraints and the type of investor are required.

Constraints

The management of portfolios requires an understanding of the limitations of the investor.

- **Resources**

One obvious constraint facing an investor is the amount of resources available for investing. Many investments and investment strategies will have minimum requirements.

- **Tax Status**

In order to achieve proper financial planning and investment, taxation issues must be considered by both investors and investment managers. Investors will need to assess any trade-offs between investing in tax-fee funds and fully taxable funds. For example, tax-free funds may have liquidity constraints meaning that investors will not be able to take their money out of the funds for several years without experiencing a tax penalty. The tax status of the investor also matters. Investors in a higher tax category will seek investment strategies with favorable tax treatments. Tax-exempt investors will concentrate more on pre-tax returns.

- **Liquidity Needs**

At times, an investor may wish to invest in an investment product that will allow for easy access to cash if needed. For example, the investor may be considering buying a property within the next twelve months, and will want quick access to the capital. Liquidity considerations must be factored into the decision that determines what types of investment products may be suitable for a particular client. Also, within any fund there must be the ability to respond to changing circumstances, and thus a degree of liquidity must be built into the fund. Highly liquid stocks or fixed-interest instruments can guarantee that a part of the investment portfolio will provide quick access to cash without a significant concession to price should this be required.

- **Time Horizons**

An investor with a longer time horizon for investing can invest in funds with longer-term time horizons and can most likely stand to take higher risks, as poor returns in one year will most probably be cancelled by high returns in future years before the fund expires. A fund with a very short-term horizon may not be able to take this type of risk, and hence the returns may be lower. The types of securities in which funds invest will be influenced by the time horizon constraints of the funds, and the type of funds in which an investor invests will be determined by his or her investment horizon.

- **Special Situations**

Besides the constraints already mentioned, investors may have special circumstances or requirements that influence their investment universe. For example, the number of dependents and their needs will vary from investor to investor. An investor may need to plan ahead for school or university fees for one or several children. Certain investment products will be more suited for these investors. Other investors may want only to invest in socially responsible funds, and still other investors, such as corporate insiders or political officeholders, may be legally restricted regarding their investment choices.

Types of investors

Investors are principally categorized as either retail investors, who are private individuals with savings, or institutional investors, which include banks, pension funds and insurance companies.

- **Retail Investors**

Many retail investors do not have the time, skill or access to information to assess the many investment opportunities open to them and to manage their money in the most effective manner (although, with the abundance of financial and company information now available on the Internet, more individuals are taking the control of their financial management into their own hands).

In practice, few individuals have sufficient money to build up a portfolio which diversifies risk properly. As a result, a variety of organizations, all professional intermediaries or middlemen, have developed a range of investment products and services for retail investors. These organizations range from small, independent firms of financial advisers (IFAs) who advise investors on how best to invest

their funds in return for commissions from major financial organizations, to larger institutions such as banks, life assurance companies, fund management groups and stockbrokers.

By pooling individual investors' funds in various collective investment schemes, these intermediaries can

- Offer good returns at relatively low levels of risk.
- Utilize the services of full-time, professional fund managers with access to the latest information.
- Offer economies of scale in managing and administering the funds.
- Minimize risk by investing in large, well-diversified portfolios.
- Depending on the particular product, provide a reasonable degree of liquidity, enabling the investor to buy or sell investments easily.

High net worth individuals will generally have more investment options available and can obtain specialized money management services. The professionals managing retail investor money or private client funds can offer the following services:

- **Execution only service**, which does not involve any advice or recommendations to the client but simply offers the means to buy and sell securities or assets for a commission. Very often, experienced financial investors who have the time and expertise to manage their own investment portfolios will choose this route.

- **Advisory dealing service**, which involves the stockbroker executing the business on behalf of the client, but also providing necessary advice regarding the transactions.

- **Portfolio advisory service**, whereby a stockbroker will assess the client's overall financial situation and needs and will provide advice on portfolio construction and investment strategy. However, it will be the client who gives the final word on the execution of the strategy.

- **Portfolio discretionary service**, where the stockbroker is responsible for the client's portfolio and is free to buy and sell assets on behalf of the client according to market conditions and other limitations that have been pre-arranged.

- **Institutional Investors**

Similar to retail or private clients, many institutions or corporations, large and small, can decide to outsource the management of their proprietary Treasury portfolios, company pension schemes, or client portfolios to a third party.

Institutional clients are particularly attractive to professional money management organizations, as they usually represent long-term relationships with clients who invariably possess a large volume of assets. As with private clients, the services that can be provided to institutional clients range from execution-only to full discretionary services. Institutional investors also include charities and other organizations such as certain universities, colleges and church commissioners.

C. Portfolio Theory

Portfolio theory, also known as modern portfolio theory (MPT), is a set of principles and techniques used to manage investment risk and maximize expected returns. It was first developed by economist Harry Markowitz in the 1950s and has since become a cornerstone of modern finance.
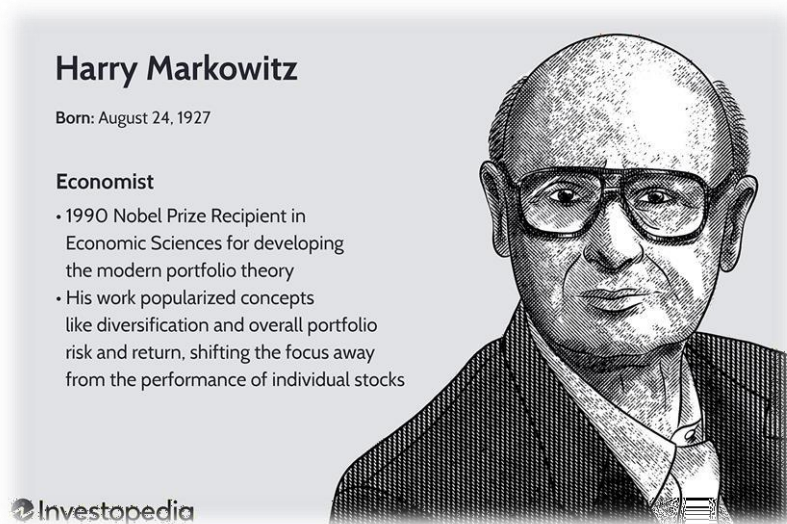
At its core, portfolio theory is based on the idea that diversification can reduce investment risk. Rather than investing all of one's money in a single security or asset class, an investor can spread their risk by investing in a variety of securities with different risk and return characteristics. By diversifying their portfolio, the investor can reduce the impact of any individual security's price movements on the overall performance of the portfolio.

Markowitz formalized this concept by introducing the concept of the efficient frontier. The efficient frontier is a graph that plots the expected return of a portfolio against its level of risk, as measured by its volatility or standard deviation. The efficient frontier represents the set of portfolios that offer the highest expected return for a given level of risk, or the lowest risk for a given level of expected return.
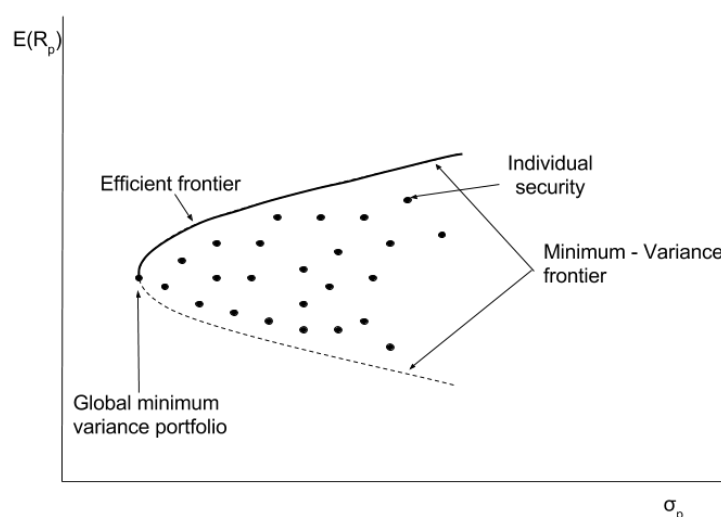
To construct a portfolio on the efficient frontier, an investor or investment manager will typically use a combination of assets that have low correlations with each other. This helps to reduce the overall risk of the portfolio without sacrificing potential returns. For example, a portfolio might include a mix of stocks, bonds, and real estate investments, with each asset class representing a different level of risk and return.

The process of constructing a portfolio on the efficient frontier is known as portfolio optimization. Portfolio optimization involves selecting the combination of assets that provides the highest expected return for a given level of risk or the lowest risk for a given level of expected return. This process requires sophisticated mathematical modelling and analysis, and is often aided by computer software.

One of the key assumptions of portfolio theory is that investors are rational and risk-averse. That is, they seek to maximize their expected return for a given level of risk, and will not take on additional risk without the expectation of additional return. While this assumption has been criticized as overly simplistic, portfolio theory remains a widely used framework for managing investment risk and constructing diversified portfolios.

In summary, portfolio theory is an important concept in modern finance that provides a framework for managing investment risk and constructing diversified portfolios. By diversifying across a range of

securities with different risk and return characteristics, investors can reduce the impact of any individual security's price movements on the overall performance of their portfolio.

Some definitions

Asset

An asset is a valuable economic entity from which future economic benefits are expected to flow to the owner of the asset. It is controlled by the owner who legally acquired it as a result of past transactions. Assets can be categorized as follows:

Physical or tangible assets**:** These are assets with a physical presence in the real world. Example: Real estate, machinery, furniture etc.

Intangible assets: These are non-monetary assets that can't be physically measured like goodwill, competitive knowledge, patents etc.

Financial or liquid assets: These include bonds, shares, mutual funds, currency etc. Gold and other precious metals are both tangible and liquid assets.

Return

An asset's return is the measure of the economic benefit the asset provides to its owner. It is measured as

$$return = \frac{Closing\ price\ for\ current\ period - Closing\ price\ for\ previous\ period + dividend\ for\ the\ currentperiod}{Closing\ price\ for\ the\ previous\ period}$$

From the above definition, it is clear that return has been expressed as percentage, hence return of an asset is actually its Rate of Return (RoR).

Risk

Risk is defined as the degree of uncertainty of the return of an asset. It signifies the probability of loss in the value of the asset. Risk can be zero; meaning that the asset is risk free. If the asset is risk free then the future value of the asset is known with certainty. The future value of a risky asset is uncertain.

Risk free assets: Bonds, Fixed deposits etc.

Risky assets: Shares, Mutual funds etc.

Types of risks:

- **Unsystematic Risk**

    Also called the diversifiable risk, this risk is unique to the company such as worker's
    conditions, sudden discoveries of deficiencies in the products of the company, outcome of
    unfavorable litigations etc.

- **Systematic Risk**

    Also called market risk, it is common to all companies in a similar economic environment. It
    is concerned with institutional banking systems, economic policies of the government etc.
    This risk is considered to be undiversifiable.

Total Risk = Unsystematic Risk + Systematic Risk

Different ways to measure risk:

i.   **Standard deviation**

Standard deviation is the most popular measure of risk for a portfolio because if it's ease of
understanding and calculation. It measures how much the returns of the portfolio vary with
respect to its mean.
However, one drawback of using variance minimizing optimization models is that it penalizes
both positive deviation from mean and negative deviation from mean. An investor is only
concerned about how less is the portfolio's return is compared to the mean while any positive
deviation from the mean is welcome.

$$\sigma_p = \sqrt{\sum(x - \bar{x})}$$

ii. Semi-variance

Semi-variance (sv), which measures the downside risk of an investment by focusing only on the negative deviations from the expected return (E). Mathematically, Semi-variance is the expected value of squared negative deviation of the actual returns (R) of the portfolio from the expected returns (E).

$$\text{Semi-variance } (sv) = \mathbb{E}([R - \mathbb{E}(R)]^-)^2$$

Where:

$$\left(R - \mathbb{E}(R)\right)^- = \begin{cases} R - \mathbb{E}(R), & \text{if } R - \mathbb{E}(R) \leq 0 \\ 0, & \text{if } R - \mathbb{E}(R) > 0 \end{cases}$$

iii. Value at Risk (VaR)

Value at risk is a very popular risk measure widely used in the financial industry. VaR describes the magnitude of likely losses a portfolio can be expected to suffer during *normal* market movements. In other terms, VaR is a value above which there is only $(1 - \alpha)$ % of losses and it represents what amount one can expect to lose with α probability.

iv. Conditional Value at Risk

Value at risk calculates the minimum loss with probability $1 - \alpha$, but it does not consider how bad the losses beyond VaR can be. An investor may need to know the magnitude of these losses in order to know whether there is a possibility of losing a 'huge' sum of money or not. CVaR quantifies this magnitude and is a measure of the expected loss corresponding to a number of worst cases depending on the chosen confidence level.
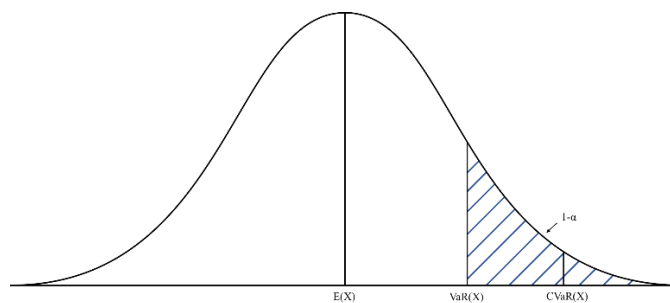
The Markowitz portfolio optimization model:

Put forward in 1952 by Harry Markowitz, the mean-variance model forms the foundation of modern portfolio theory. This model aims to find weights of different assets in a portfolio so as to minimize portfolio variance given expected return or maximize expected return given portfolio variance.

Assumptions:

Risk of a portfolio is based on the variability of returns from said portfolio.

1. An investor is risk averse.
2. An investor prefers to increase consumption.
3. Analysis is based on single period model of investment.
4. An investor either maximizes their portfolio return for a given level of risk or minimizes their risk for a given return.
5. An investor is rational in nature.

Let us define,

Number of assets: n

Vector of Returns (random variable): $x = (x_1, \ldots, x_n)$

$$\mu_i = E[x_i]$$

Vector of weights: $w = (w_1, \ldots, w_n)$

Mean Return Vector: $\mu = (\mu_1, \mu_2, \ldots, \mu_n)$

Variance-Covariance Matrix of Returns:
$$C = \begin{bmatrix} \sigma_{11} & \cdots & \sigma_{1n} \\ \vdots & \ddots & \vdots \\ \sigma_{n1} & \cdots & \sigma_{nn} \end{bmatrix}^{n \times n}$$

were, $\sigma_{i,j} = Cov(x_i, x_j)$

Portfolio return:
$$\mu = \sum_{i=1}^{n} \mu_i w_i = w^T \mu$$

Portfolio Risk (Variance): $\sigma = w^T C w$

The optimization model:

Objective function: $$Min\ w^T C w$$

s.t.

$$w^T \mu \geq \mu_0 \qquad \mu_0 \text{ is the expected return}$$

$$e^T w = 1 \qquad \text{Where, } e^T = (1,1,\dots,1)^{1 \times n}$$

D. Data Envelopment Analysis

Data Envelopment Analysis (DEA) is a linear programming-based technique used to evaluate the efficiency of decision-making units (DMUs) that consume multiple inputs and produce multiple outputs. The method was first introduced by Charnes, Cooper, and Rhodes in 1978 and has since been widely applied in various fields such as finance, operations research, economics, and healthcare.

The basic idea of DEA is to compare the efficiency of different DMUs by measuring how well they utilize their inputs to produce outputs. DEA assumes that there are multiple inputs and outputs, and each DMU uses a different combination of these inputs to produce its outputs. The efficiency score of each DMU is calculated by comparing its input-output combination to that of other DMUs in the sample.

$$Efficiency = \frac{Output}{Input}$$

DEA operates by constructing a frontier of efficient DMUs that represents the best practice in terms of input-output utilization. The efficient DMUs are those that produce the maximum number of outputs with the minimum number of inputs. DEA then evaluates the efficiency of each DMU by comparing its input-output ratio to that of the efficient DMUs. If a DMU lies on the frontier, it is considered efficient; otherwise, it is considered inefficient.

DEA is particularly useful when there is no clear definition of what constitutes an optimal input-output combination. DEA is also able to handle multiple inputs and outputs simultaneously and can handle both constant and variable returns to scale.

There are two main DEA models**:**

Input-Oriented Models

In the input-oriented model, the efficiency of a DMU is evaluated by considering the minimum proportion by which its input levels must be reduced to become efficient while maintaining the same level of outputs.

Output-Oriented Models

In the output-oriented model, the efficiency of a DMU is evaluated by considering the maximum proportion by which its output levels can be increased while maintaining the same level of inputs to become efficient.

DEA has been applied in a variety of contexts, such as evaluating the efficiency of banks, hospitals, universities, and manufacturing firms. In finance, DEA has been used to evaluate the performance of investment portfolios, mutual funds, and hedge funds. In healthcare, DEA has been used to evaluate the efficiency of hospitals and healthcare providers.

However, DEA is not without its limitations. One of the main limitations is that DEA assumes that all DMUs operate under the same set of environmental and technological conditions. In reality, different DMUs may face different constraints and opportunities that affect their efficiency. DEA also assumes that the inputs and outputs are measured accurately and that there is no measurement error or bias. Finally, DEA may not provide a unique solution, and different efficient frontiers may exist depending on the choice of inputs and outputs.

Constant Return to Scale (CRS):

Constant returns to scale (CRS) are a concept in DEA that refers to the condition were the proportional increase in input leads to a proportional increase in output. In other words, if the inputs are doubled, the outputs will also double.

In the context of DEA, a DMU is said to exhibit CRS if it maintains its relative efficiency score when its inputs and outputs are proportionally increased or decreased. This means that the DMU is operating at its optimal scale, and there are no economies of scale or diseconomies of scale in the production process.

If a DMU exhibits CRS, then it means that it is efficient and it is not possible to increase its efficiency by simply increasing its scale of operation. However, if a DMU exhibits increasing or decreasing returns to scale, then it may be possible to increase its efficiency by adjusting its scale of operation.

Variable Return to Scale (VRS):
Variable returns to scale (VRS) are a concept in DEA (Data Envelopment Analysis) that refers to the condition where the proportional increase in input does not lead to a proportional increase in output. In other words, if the inputs are doubled, the outputs will increase by less than or more than double.

In the context of DEA, a DMU is said to exhibit VRS if its relative efficiency score changes when its inputs and outputs are proportionally increased or decreased. This means that the DMU is not operating at its optimal scale, and there may be economies of scale or diseconomies of scale in the production process.

If a DMU exhibits increasing returns to scale (IRS), it means that as the scale of the operation increases, the efficiency of the DMU also increases. This suggests that the DMU is not operating at an optimal scale, and it may be able to increase its efficiency by increasing its scale of operation.

On the other hand, if a DMU exhibits decreasing returns to scale (DRS), it means that as the scale of the operation increases, the efficiency of the DMU decreases. This suggests that the DMU is operating beyond its optimal scale, and it may be able to increase its efficiency by decreasing its scale of operation.

History of application of DEA in selection of stocks:

This project is not the first time DEA has been applied to the stock market. In 2000, a study was done by Powers, McMullen to select efficient large market-cap securities. However, the paper stated that the purpose was not to select the best stocks to invest in, rather to prove the viability of DEA as a technique to assist investors in multicriteria decision making.

Chen used data envelopment analysis in 2008 to select efficient stocks on the Taiwanese stock exchange. He concluded that DEA was an effective tool for stock selection when all stocks were in the same industry. Later, in 2010 Patari, Leivo, and Honkapuro proved similar results on the Finland stock exchange.

Mathematical Programming aspects of DEA:

Let us define:

x_{im} = amount of input i used by DMU m

y_{jm} = amount of output j produced by DMU m

u_{im} = weight for input i

v_{jm} = weight for output j

I = number of inputs

J = number of outputs

N = number of DMUs

Objective Function*:*

Maximize the efficiency score E_m of DMU m:

$$\text{Maximize } E_m = \frac{\sum_{j=1}^{J} v_{jm}\, y_{jm}}{\sum_{i=1}^{I} u_{im}\, x_{im}}$$

Subject to:

For all $n = 1, 2, \ldots, N$:

$$\frac{\sum_{j=1}^{J} v_{jm}\, y_{jn}}{\sum_{i=1}^{I} u_{im}\, x_{in}} \leq 1$$

$$v_{jm} \geq 0 \quad \text{for } j = 1, \ldots, J$$

$$u_{im} \geq 0 \quad \text{for } i = 1, \ldots, I$$

The above programming problem is fractional in nature and difficult to solve. For practical applications, a linearized form of the above problem is used.

E. Quadratic Programming Problems (QPP)

Quadratic programming is a mathematical optimization technique that is widely used in various fields such as engineering, economics, and finance. It is a powerful tool for solving problems that involve finding the minimum or maximum value of a quadratic function subject to a set of linear constraints.

Quadratic programming involves optimizing a quadratic objective function subject to linear constraints. The objective function is usually represented as a quadratic equation in terms of the decision variables. The linear constraints, on the other hand, are a set of equations or inequalities that limit the values of the decision variables. The goal of quadratic programming is to find the values of the decision variables that minimize or maximize the objective function while satisfying the linear constraints.

Quadratic programming is used in a wide range of applications, including portfolio optimization, resource allocation, machine learning, etc. For example, in portfolio optimization, quadratic programming can be used to find the optimal allocation of assets in a portfolio to minimize risk while achieving a target return. In machine learning, quadratic programming can be used to train support vector machines (SVMs) and other classification models.

One of the key advantages of quadratic programming is that it can handle complex, nonlinear problems that cannot be solved by other optimization techniques. Additionally, quadratic programming can be extended to handle more complex constraints, such as non-linear and non-convex constraints.

There are several algorithms for solving quadratic programming problems such as the Lagrangian Method. However, in this project, QPPs were solved using the python package "cvxopt" which solves QPP of the following standard form:

$$\text{Minimize } \frac{1}{2}x^T Q x + q^T x$$

subject to:

$$Gx \leq h$$

$$Ax = b$$

Where:

- x is the vector of decision variables,
- Q is a symmetric positive semi-definite matrix (defining the quadratic term),
- q is a vector (defining the linear term),
- G and h define the inequality constraints,
- A and b define the equality constraints.

The QPP Problems used in this project are

Variance Minimization Problem

Suppose:

Vector of weights:
$$w = \begin{bmatrix} w_1 \\ \vdots \\ w_{25} \end{bmatrix}^{25 \times 1}$$

Variance- covariance matrix:
$$C = \begin{bmatrix} \sigma_{11} & \sigma_{12} & \cdots & \sigma_{125} \\ \sigma_{21} & \sigma_{22} & \cdots & \sigma_{225} \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{251} & \sigma_{252} & \cdots & \sigma_{2525} \end{bmatrix}^{25 \times 25}$$

The Mathematical Programming Model:

Objective Function $\qquad Min\ \sigma^2 = w^T C w$

s.t

$$\mu_1 w_1 + \mu_2 w_2 + \cdots + \mu_n w_n \geq \mu_0$$
………………………….. (1)

$$w_1 + w_2 + \cdots + w_n = 1$$
………………………….. (2)

$$w_1 + w_2 + \cdots + w_{10} \geq 0.3$$
………………………….. (3)

$$w_1 + w_2 + \cdots + w_{10} \leq 0.55$$
………………………….. (4)

$$w_i \geq\ \ 0\ \ \forall i = 1,2, \ldots, n$$
………………………….. (5)

F. Stock market indices

The Indian stock market indices are a group of benchmark indices that track the performance of various sectors and market capitalization segments of the Indian stock market. These indices are widely followed by investors, traders, and analysts as a reliable indicator of the overall health and direction of the Indian stock market.

There are several stock market indices in India, but some of the most widely followed indices are the

- NIFTY 50,
- BSE Sensex,
- NIFTY Bank,

- NIFTY IT, and
- NIFTY Pharma, among others.

The NIFTY 50 index tracks the performance of the top 50 companies listed on the National Stock Exchange (NSE) based on market capitalization.

While the BSE Sensex tracks the performance of the top 30 companies listed on the Bombay Stock Exchange (BSE) based on market capitalization.

The sector-specific indices such as the NIFTY Bank, NIFTY IT, and NIFTY Pharma track the performance of companies in the banking, IT, and pharmaceutical sectors, respectively.

These indices are calculated based on the free float market capitalization weighted methodology. The free float market capitalization takes into account only those shares that are available for trading in the market and excludes those held by promoters, governments, and other strategic investors. This methodology ensures that the index represents the true value of the companies included in the index.

Investors and traders use these indices as a benchmark to evaluate the performance of their investments or to make investment decisions. They can compare the performance of their portfolio with that of the index to determine whether their investments are outperforming or underperforming the market. Analysts also use these indices to assess the overall trend and direction of the market and to identify potential investment opportunities.

5. Project Methodology

A. Defining the problem

The objective is to create a portfolio that satisfies the customer's needs. To define the problem more objectively, a good understanding of the customer's needs is required.

Bonanza profile on the customer:

- The investor is middle-aged with primary objective of wealth creation.
- Customer expects to generate returns 1.5 times the rate of fixed bank deposits.
- Lack of significant debt indicates financial stability, thereby increasing customer's risk-taking capacity.
- Customer seeks substantial long-term capital growth through a smart, trend-aware investment strategy with a strong emphasis on the energy sector. By strategically leveraging emerging opportunities within this space, the customer aims to achieve moderate and consistent returns.
- With an informed understanding of economic cycles, the customer is also prepared to adopt a patient, long-term view, allowing investments the necessary time to recover and grow in value.

Considering the risk profiler analysis, it shows that the customer has a "**Highly Aggressive**" risk profile.

Corpus customer is prepared to invest: **Rs 1,00,00,000**

Assumptions for the project:

- The customer wants to invest Rs 1,00,00,000 in equities.
- The customer expects 1.5x the FD rates Assuming the traditional 7% rates on which becomes 10.28% annually.
- 30% - 55% of equity investment is to be done in Large Cap, while the rest is to be invested in Mid Cap and Small Cap.

  Those figures translate to 0.8% monthly absolute returns or 10.28% annual returns.

The objective problem statement:

"To create a minimum risk portfolio of not more than 25 stocks, that have expected monthly return of at least Rs 80,000 with a corpus of Rs 1,00,00,000."

B. Data collection and cleaning methodologies

The first step is to choose the 25 stocks to build the portfolio with. The number "25" was reached by qualitative research. The objective was to find the right number of stocks that

    i.   Can be managed by a willing everyday investor.

    ii.   Exhibited the benefits of diversification.

Most online resources suggested a range of 10 – 25 stocks. It was decided to proceed for further analysis using the upper limit of 25.

The allocation is to be done to

    i.   **Large cap stocks**: Stocks of companies that has a market capitalization of Rs 20,000 crores or more.

    ii.   **Mid cap stocks**: Stocks of companies that has a market capitalization of Rs 5,000 crores to Rs 20,000 crores.

    iii.   **Small cap stocks**: Stocks of companies that has a market capitalization of Rs 5,000 crores or less.

Market capitalization of a company is its total value that is being traded on the stock market. It is calculated by multiplying its total number of shares and its current stock price.

The process of stock selection was started with the stocks of **Nifty 100 indices**.

Nifty100 Large cap, Nifty100 Mid cap, Nifty100 Small cap are a list of 100 large cap, mid cap, small cap stock that represents the top 100 companies within its cap.

The number of stocks to choose from each cap category was calculated according to the proportion of allocated funds in that category.

Sno.	Market Cap	Proportion	No. of Stocks as proportion of 25
1	Large cap	0.37	11
2	Mid cap	0.4	6
3	Small cap	0.23	9
			25

The return data on stocks are downloaded from Yahoo Finance with the help of the python package 'yfinance'.

Size of initial pool of stocks: **109**

Monthly return data was collected for **36** periods.

April 2022 – March 2025

A snippet of the data:

Date	ADANIENSC	ADANIPOWE	BFUTILITI	CGPOWE	COALINDI	DEEPIND	GMRP&U	GSPL	HINDOILEX	IEX.I	IWEL.	JPPOWE	JSWENERG	KPIGREE	KPIL.	MGL.	OIL.I	PETRONE	POWERINDI	RELIANC	RTNPOWE	SOLARING	TRITURBIN	WAAREERT	WEBELSOL
01-04-2022	2805.100098	280.3500061	383.299988	195.925659	144.5597076	128.051331	30.1000004	252.555	202.6499939	204.55	683.85	7.4000001	311.8916931	58.5372543	351.61	714.29	129.51	178.614609	3133.484619	1279.17078	5.409999847	2743.332275	190.7471771	66.0816803	116.1999969
01-05-2022	2049.850098	323.25	332.850006	180.134796	152.5051422	102.485016	20.2000008	244.898	177.8500061	185.58	538.6	6.9000001	271.6349487	50.4063072	351.91	702.96	135.18	198.762405	3511.029541	1206.91992	4.010000229	2601.646729	168.4430542	65.88188934	91.15000153
01-06-2022	2473.75	262.8500061	300.549988	189.738007	146.7338409	96.502449	19.5499992	209.596	186.8999939	151.35	449.8	6.44999981	205.6375002	72.8134155	347.03	705.65	142.57	190.352875	3135.480957	1189.95764	3.400000095	2735.279053	154.6451569	61.73617554	84.59999847
01-07-2022	3110.100098	313.9500122	325.549988	221.913757	167.0125122	97.4059448	24.3500004	223.707	174.5	152.16	495	6.4000001	236.0081042	76.1598282	361.86	700.17	107.71	192.674271	3217.067627	1150.43982	3.900000095	2737.871826	168.9870605	60.6772728	88.15000153
01-08-2022	3971.649902	413.9500122	402.5	222.606796	185.6309357	107.442001	35.0499992	233.339	163.6000061	153.49	535.8	7.55000019	337.2474976	101.719734	407.37	806.79	109.3	197.69302	3739.261963	1209.34973	3.970000029	3318.194336	202.71521	98.50815582	88.5
01-09-2022	3290.639951	373.5	406.149994	233.348557	170.1245422	123.582718	27.1499996	222.539	133.0500031	136.25	921.9	7.3499999	297.0013123	95.380928	416.46	788.19	98.895	178.742783	3475.960205	1093.61963	4.369999886	3910.084473	233.1758881	87.99902344	98.40000153
01-10-2022	3346.949951	334.8999939	391.25	257.406128	197.1360931	148.800995	25.2000008	219.548	138.3500061	134.19	1035.5	7.5	333.8854065	78.897789	471.83	815.7	112.32	183.7948	3162.365967	1172.66003	4.179999828	3895.724365	277.7463379	98.29837799	91.75
01-11-2022	2925.199951	332.75	400.399994	276.810608	182.1474762	130.308609	23.0499992	261.942	143.5	141.82	1008.35	7.69999981	304.714325	105.729317	503.92	854.11	119.1	190.143341	2949.107666	1256.25391	4.170000076	3858.030518	284.8438721	98.43823242	92.15000153
01-12-2022	2591.550049	293.5499878	386.350006	267.603363	192.03685	138.40979	23.25	256.357	137.3500061	134.29	953.5	7.55000019	284.3934631	97.0554276	555.02	794.29	123.9	139.217178	3332.872559	1171.55615	3.950000048	4395.87207	258.3398438	99.96665192	95.55000305
01-01-2023	1773.949951	223.8000031	367.649994	293.432648	191.866957	145.969269	19.7399992	261.165	130.100061	132.94	932.05	7.1500001	235.692581	105.252068	512.01	837.15	138.63	200.881561	3097.833111	1082.62695	3.809999943	3993.201172	269.2591248	98.76789093	95.59939847
01-02-2023	642.5499678	146.3000031	332.899994	302.204681	183.8024232	133.017197	18.5499992	274.659	138.3000031	138.65	1011.35	6.6500001	232.0338135	96.1614942	526.61	848.62	147.02	205.782242	3320.63623	1068.23083	3.380000114	3900.311768	315.2192688	120.8051071	78.19999695
01-03-2023	937.9000244	191.6000061	297.149994	297.056549	186.7722931	132.223248	16.0200005	256.94	120.1399969	122.73	1099.55	5.55000019	238.1647034	92.6390662	531.48	942.92	155.87	211.607574	3336.268799	1072.14038	2.950000048	3705.308594	330.7047729	154.71005225	77.25
01-04-2023	1027.349976	224.8500061	337.149994	307.342194	203.7754517	167.835098	18.9300003	276.365	164.5	150.16	1111	5.8499999	257.793396	112.333244	536.05	965.91	157.85	219.051041	3300.359619	1113.28186	3.109999895	3810.962158	362.6187744	177.2467499	87.55000305
01-05-2023	777.5499678	243.6499939	359.75	390.932129	210.9001617	171.282425	16.9099998	291.759	181.5500031	146.76	1620.75	6	251.2175293	109.3032	533.41	1014.2	159.34	208.833603	3842.095215	1136.00281	3.33999914	3739.163574	396.5677795	169.2450256	90.05000305
01-06-2023	767.5	249.8500061	365.200012	376.652161	201.939621	171.479416	17.7999992	276.365	206.100061	121.31	2091.35	6.1500001	269.7090149	180.980713	533.46	1004.6	151.72	205.920914	4150.395396	1172.95898	4.880000114	3727.845459	403.7645569	225.1672058	86.25
01-07-2023	814.8499756	273.2399878	376.5	400.087189	200.4098053	218.26445	20.6800003	278.356	228.4499969	117.64	2659.35	6.0999991	287.7518921	184.188324	619.03	1065.7	170.77	215.953461	3949.623535	1270.3136	4.849999905	3811.173096	397.0640869	279.4111328	102.0999985
01-08-2023	812.1500244	321.2399878	689.450012	427.253337	201.1091461	241.903198	24.9799995	268.352	164.8000031	123.06	2676.5	8	349.7974548	198.461685	656.97	980.33	163.16	139.078476	4397.915527	1199.4232	6.800000191	4836.3125	388.5768433	245.1065379	117.6999969
01-09-2023	809	377.4500122	651.5	440.041199	262.5845947	263.325806	35.630001	273.888	172.6999969	128.91	2431	10.25	435.9635315	182.720337	629.21	1001.6	188.69	224.886475	4105.702837	1168.53406	6.800000114	4809.882324	435.182251	255.1562042	143.1499939
01-10-2023	769.7000122	363.0499878	625.299988	388.195557	279.5298767	253.905411	30.9400005	264.742	164.25	122.72	2878.55	9.60000038	384.532395	181.965393	658.16	1005.2	188.69	187.069565	4135.742676	1140.08057	7.179999828	5499.92041	356.5636861	274.2964172	176.8000031
01-11-2023	872.5	431.5	652.25	447.206024	304.34723	268.041595	43.7599983	285.316	160.6499939	140.27	3655	13.1000004	407.0089417	256.58136	657.27	1013.8	192.7	190.06868	4670.253306	1184.7041	8.93999958	6247.615723	427.6876831	286.144165	195.8999939
01-12-2023	1046	525.1500244	531.5	452.18161	349.7971191	254.351822	56.2400017	302.428	182.1499939	163.82	5399.55	13.9499998	407.7066345	326.023987	704.25	1167.5	237.68	216.239029	5248.400391	1288.10315	9.010000229	6720.015625	421.0368347	395.8607483	245.3500061
01-01-2024	1067.5	562.700012	604.400024	466.262543	377.8459778	254.947021	51.1199989	363.705	187.1399963	143.92	5662.65	18.5499992	503.0923462	404.484314	789.37	1440.1	272.39	261.351563	5333.558594	1421.79944	10.98939977	6456.411133	373.7862244	767.1268921	369.75
01-02-2024	1065.5	549.9500122	882.450012	441.08606	406.2669983	248.53816	52.2999992	365.633	190.75	138.61	7009.75	18.2000008	506.6306763	579.756775	953.61	1446.2	349.06	265.576294	6005.683105	1455.85889	10.00000042	6739.451172	494.5433655	1110.332031	391.6000061
01-03-2024	1025.800049	533.7399878	772	539.825806	408.5003052	306.035645	42.7559983	352.33	177.6999969	131.91	5804	15.25	527.1630859	507.410065	1058.7	1338	383.36	255.621429	6962.496094	1480.8241	8.279999733	8779.538086	533.3237671	1403.938413	485.2999878
01-04-2024	1064.650024	612.4500122	862.25	552.849915	427.5030942	280.144135	64.0199966	292.784	216.3500061	153.46	7399.95	19.3500008	527.4824829	602.4953	1218.3	1415.8	402.22	301.608032	9584.12207	1462.03784	9.18999958	8962.25293	534.7693481	2477.938232	681.0499878
01-05-2024	1122.800049	755.7999878	909.950012	642.172119	462.2330627	275.084869	65.8700027	286.602	191.6499939	150.36	7100.9	19.25	610.9868774	607.17627	1189.7	1273.5	412.31	288.788116	10766.60547	1425.56165	19.18000031	9386.038086	584.1625366	2390.528564	556
01-06-2024	997.950122	718.5399758	837.799988	703.300476	288.03064	283.8899994	293.674	155.9700012	179	6736.6	19.6000004	734.5	601.312561	1167.4	1566.9	468.96	320.740784	12903.35059	1560.1051	17.2902832	1367.515991	573.7000122		
01-07-2024	1137.599376	734.4500122	807.099976	734.53833	491.4049072	312.682129	97.8899994	335.564	271.5599976	190.47	8673.05	19.8500004	728	618.85376	1370.9	1833.2	561.89	357.889404	11594.16406	1500.33289	17.70999908	10771.85559	591.524231	1637.706909	622.5499878
01-08-2024	1007.849976	632.0499878	788	634.717529	493.9927368	376.649994	138.270004	437.543	262.1499939	201.89	11763.1	17.9200001	711.1500244	604.061157	1348.1	1758.9	720.91	359.884064	12097.83594	1504.51868	16.13999939	10697.65039	716.4248047	1533.015137	948.2999878
01-09-2024	1009.650024	656.1500244	945.349976	757.542542	484.8690796	435.200012	160.5	420.085	231.1000061	202.53	12696.3	18.2399998	733.0499878	575.608948	1367.6	1924.5	566.84	334.653961	14540.2002	1476.57495	15.35000038	11512.09961	681.3571777	1902.133423	1090.849976
01-10-2024	975.7000122	532.700012	851.150024	703.001099	423.6482544	485	177.650002	388.95	205.8500061	176.24	11923.7	18.2000008	679.1500244	538.437866	1273.1	1428.6	460.53	326.276611	13812.34961	1332.05005	14.36999989	10223.7398	683.5046387	1511.986338	1421.75
01-11-2024	806.4000244	529.4500122	977.5	726.554199	378.5630798	547.25	120.949997	361.65	183.1600037	180.22	10130.9	17.7000008	642.6500244	543.158651	1297.1	1273.6	423.14	346.200012	14402.9502	1215.44995	13.68000031	9800.5	738.7833862	1341.463135	1656.849976
01-12-2024	753.0399756	513.2000122	804	633.589172	390.1421814	562.400024	106.449997	345.95	138.1699982	173.11	9356	16.3299999	508.6000061	367.114349	1058.1	1367.3	413.02	316.200012	12834.90039	1265.09998	11.13000011	10194.4502	668.0292358	1012.603149	1346.900024
01-02-2025	651.0499678	478.9500061	611.950012	571.46283	369.3500061	433.700012	98.75	271.9	180.3099976	155.93	8084.15	13.3599997	460.1000061	378.058807	878.75	1227.3	336.65	283.299998	11281.7002	1200.09998	8.920000076	8632.599609	484.3174744	823.7000122	337.0999756
01-03-2025	871.5	509.2399878	751.650024	637.231934	398.200012	501.149994	114.300003	292.05	171.0599976	175.77	9657.65	14.25	537.9000244	408.5	974.5	1386.5	386.75	293.600006	12648.7002	1275.09998	9.800000191	11242.2998	563.5999756	907.650244	1194.050049
01-04-2025	898.5	532.0499878	705.849976	626.799988	385.2999878	443.149994	113.5	325.05	183.1399969	190.35	9768.25	14.54	473.2000122	381.450012	970.15	1344.9	410.75	313.75	14495.05961	1405	9.93999958	13153.65039	520.1500244	960.049878	1309.199951
01-05-2025	837.75	520.2000122	685.700012	610.25	385.4500122	338.549988	108.550003	314.1	173.6499939	189.9	9255.15	13.2399998	463.3500061	359.25	946.45	1368	338.85	305.350006	14621.84961	1407	10.06999969	13104.34961	526.0399756	933	1205.139951

C. Formulation of the mathematical models

Two kinds of mathematical models will be used in this project.

1. Linear Programming Models to calculate relative efficiencies of different stocks in order to find the best performing stocks. (Mathematical models are given in section 4.D.). In this project, both CRS and VRS will be used. For DEA, Output Maximization models will be used.

2. Three Quadratic Programming Models to calculated optimum weights of the stocks selected for the portfolio, in order to have a portfolio with minimum variance, semi-variance and absolute deviation. (Mathematical models are given in section 4.E.)

The optimization was done on monthly data as the customer requirement is stated monthly.

Stock for IndiaMART InterMESH Limited was not considered for Semi-Variance and Absolute Deviation models as the company went public on June 24 2019 and 3 year data was not available.

C.1. Data Envelopment Analysis

Data Envelopment Analysis of the 109 stocks were performed separately within each cap. Each stock was considered a Decision-Making Unit and the following input and output variables were considered:

Input Variables	Output Variables
P/E ratio (TTM)	1-year returns
Beta	3-year returns
Sigma	5-year returns *(Not used for small cap)*
	EPS (TTM)

Rationale:

P/E ratio	PE ratio is the ratio of market value per share and earnings per share of the company. $$P/E\ Ratio\ = \frac{Share\ Price}{Earning\ per\ share}$$ It measures the number of times an investor is willing to pay for one share of the company with respect to the earnings of one share of that company. Generally, a lower P/E ratio is preferred by the investor.
Beta	Beta measures how volatile the stock of a company is with respect to the market. The market is represented by NIFTY100 index of the respective market cap. Relatively lower beta means that the stock is less volatile than its peers. $$Beta = \frac{cov(market, stock\ return)}{var(market)}$$ Market data: NIFTY Large Cap, Mid Cap, Small Cap
Std Dev	Sigma is the standard deviation of the return of the stock. It is the simplest measure of risk for any stock.
1yr, 3yr, 5yr returns	Returns are the desired outcome of owning a stock and the investor would want to maximize these values. 1 year, 3 year and 5-year returns are chosen to take into consideration both the short run and long run returns of stocks.
EPS	Earnings per share is the ratio of Earnings after Tax and Number of shares of the company. It represents how much of the profit after taxes one share of the company generates. A relatively higher EPS means that the company is more profitable. $$EPS = \frac{Net\ Income - Dividends}{\#\ Common\ share}$$

Calculations:

P/E ratio (TTM)	Downloaded from Yahoo finance on 09-03-2025
Beta	Calculated using Python, with maximum daily past data available up to 5years. $$\frac{cov(market, stock)}{var(market)}$$ For market data, NIFTY100 Large Cap, NIFTY100 Mid Cap, NIFTY100 Small Cap were used.
Sigma	Calculated using Python, with maximum daily past data available up to 5 years.
1yr, 3yr, 5yr returns	Calculated using Python, with maximum daily past data available up to 5 years. $$k \ year \ return \ = \ \prod_{i=s_k}^{t_k} (1 + r_i) - 1$$ $$k \ = \ 1, 3, 5$$ $$t_k \ = \ Number \ of \ trading \ days \ in \ past \ k \ years$$ $$s_k \ = Starting \ day \ for \ k \ years$$ $$r_i \ = \ return \ on \ i^{th} \ day$$
EPS (TTM)	Downloaded from Yahoo finance on 09-03-2025

*Any stock having a negative EPS were discarded initially from analysis.

A snippet of the obtained data

Sno.	Stock Ticker	1yr return	3yr return	5yr return	EPS	P/E	Beta	Sigma
1	ADANIENT.NS	125.803	1767.439	4226.87	18.24	96.086	1.414	0.032
2	COALINDIA.NS	71.438	54.102	36.6	47.58	4.657	0.739	0.02
3	TATASTEEL.NS	128.011	463.095	303.48	23.49	4.449	1.175	0.038
4	VBL.NS	123.886	323.766	599.63	22.99	60.763	0.516	0.024
5	BANKBARODA.NS	133.425	87.725	18.45	22.6	7.385	1.299	0.029
6	ADANIPOWER.NS	200.451	384.709	603.17	23.66	8.117	1.376	0.038
7	BAJAJHLDNG.NS	7.996	79.355	118.2	413.63	14.385	0.794	0.021
8	BOSCHLTD.NS	0.289	16.588	-8.24	468	40.312	0.999	0.021
9	ABBOTINDIA.NS	11.058	69.839	305.84	437.03	52.445	0.46	0.017
10	ITC.NS	59.215	61.575	52.08	14.72	26.325	0.727	0.017
11	BAJAJ-AUTO.NS	15.469	27.345	28.66	204.91	19.683	0.812	0.017
12	NTPC.NS	40.346	70.387	49	18.27	9.598	0.697	0.018
13	DRREDDY.NS	-12.467	51.771	86.23	218.99	21.467	0.493	0.018
14	NESTLEIND.NS	0.941	38.686	171.26	248.32	79.642	0.568	0.015

C.1.1. DEA results for large cap stocks:

(Efficient stocks by BCC model)

Ticker	P/E Ratio	Beta	Std Dev	1Y (%)	3Y(%)	5Y(%)	EPS	CRS/CCR	VRS / BCC
RELIANCE.NS	24.94	0.65	0.22	13.6	6.82	168.42	51.13	1.00	1.00
COALINDIA.NS	7.14	0.2	0.31	-2.52	163.36	365.25	55.71	1.00	1.00
ADANIPOWER.NS	15.24	0.64	0.51	-4.59	234.52	1800.37	32.34	1.00	1.00
SOLARINDS.BO	90.83	0.05	0.39	27.95	311.64	1154	123.67	1.00	1.00
CGPOWER.NS	104.2	1.22	0.41	18.28	261.71	12545.77	6.13	1.00	1.00
JSWENERGY.NS	50.07	0.08	0.47	2.04	81.1	1186.56	10.97	1.00	1.00
OIL.NS	8.53	0.63	0.46	-0.66	192.05	868.21	45.37	1.00	1.00
POWERINDIA.BO	179.76	0.32	0.61	81.67	254.98	1671.53	74.63	1.00	1.00
GVT&D.NS	101.15	1	0.37	83.98	1654.48	2101.25	15.41	1.00	1.00
NLCINDIA.NS	15.06	0.66	0.48	8.61	301.13	551.94	17	1.00	1.00
CESC.NS	14.61	0.81	0.42	30.28	123.44	413.39	10.52	1.00	1.00
ADANIENSOL.BO	60.87	1.13	0.58	15.07	-64.28	366.54	128.14	0.94	1.00
PETRONET.NS	12.25	0.52	0.34	14.86	74.79	92.18	24.28	0.91	1.00
POWERGRID.NS	17.37	0.39	0.30	8.5	111.02	323.61	16.67	0.58	1.00
NTPC.NS	15.78	0.47	0.32	8.84	193.12	474.31	21.46	0.74	0.98

C.1.2 DEA results for mid cap stocks:

(Efficient stocks by VRS model)

Ticker	P/E Ratio	Beta	Std Dev	1Y(%)	3Y(%)	5Y(%)	EPS	CRS	VRS
MGL.BO	13.09	0.8	0.40	3.62	96.19	94.53	105.93	1.00	1.00
IWEL.BO	102.05	-0.45	0.48	66.4	1264.8	5011.22	94.64	1.00	1.00
WAAREERTL.BO	50.6	0.43	0.67	-35.35	1464.6	42636.9	18.15	1.00	1.00
GMRP&UI.BO	4.99	0.88	0.53	167.31	201.19	145.81	22.92	1.00	1.00
WEBELSOLAR.NS	107.57	1.23	0.60	146.04	1165.5	9014.89	11.1	1.00	1.00
RTNPOWER.BO	0.49	1.23	0.50	18.36	64.43	696.75	20.04	0.32	1.00
GSPL.BO	12.3	0.7	0.37	-17.11	17.3	86.6	24.21	0.26	1.00
KPIGREEN.NS	30.28	1.11	0.51	-19.42	640.23	2801.74	16.38	0.67	1.00
KPIL.BO	30.22	0.86	0.41	-7.82	170.19	471.62	32.66	0.39	1.00
JPPOWER.NS	9.97	1.29	0.47	-6.56	114.29	2750	1.43	0.15	1.00
RPOWER.NS	7.44	1.72	0.56	52.14	248.02	3637.39	5.78	0.52	0.97

C.1.3. DEA results for small cap stocks:

(Efficient stocks by VRS model)

Ticker	P/E Ratio	Beta	Std Dev	1Y (%)	3Y (%)	EPS	CRS	VRS
DEEPINDS.NS	20.79	-0.27	0.53	63.76	397.29	24.11	1.00	1.00
BFUTILITIE.NS	18.78	0.7	0.59	-2.64	143.45	39.99	1.00	1.00
GENSOL.NS	8.1	-0.26	0.53	79.4	86	22.79	1.00	1.00
SOLEX-ST.NS	32.33	0.7	0.13	-71.42	448.69	19.52	1.00	1.00
NAVA.NS	14.99	0.79	0.52	116.42	657.05	34.6	1.00	1.00
SRIKPRIND.BO	6.51	0.95	0.62	-33.33	-23.6	3.32	0.18	1.00
HINDOILEXP.NS	13.57	1.11	0.45	-3.74	-20.4	12.61	0.42	1.00
IEX.NS	38.29	0.72	0.38	33.25	-19.98	4.59	0.39	0.93
GIPCL.NS	13.13	0.46	0.51	12.59	164.47	13.75	0.45	0.91

According to VRS/BCC model, the number of efficient stocks in each cap category are.

Cap	No. of stocks
Large	15
Mid	10
Small	7

C.2. Correlation Analysis

To further shortlist these stocks, correlation analysis was undertaken.

Pairwise correlation of monthly returns of all the stocks under each cap category were calculated and those pairs with the lowest absolute correlations were chosen for further analysis. To do this, first of all correlation matrix will be computed using. Corr () function in python and identified and extracted 25 least correlated stocks. The instance code used to extract are given below

```python
import numpy as np
import pandas as pd

# Convert covariance matrix to correlation matrix
std_dev = np.sqrt(np.diag(cov_matrix))  # Standard deviation of each asset
correlation_matrix = cov_matrix / np.outer(std_dev, std_dev)  # Element-wise normalization

# Convert to absolute correlation values
abs_corr_matrix = correlation_matrix

# Sum correlations for each stock (excluding self-correlation)
total_correlation = abs_corr_matrix.sum(axis=1) - 1  # Subtract 1 to ignore self-correlation

# Select 25 least correlated stocks
least_correlated_stocks = total_correlation.nsmallest(25).index

print("25 Least Correlated Stocks:")
print(least_correlated_stocks)
```

*the correlation data of obtained stocks are shared at end of report

Final list of 25 stocks

Sno.	Cap	Company	Stock Ticker
1	Large	Adani Power	ADANIPOWER.NS
2	Large	Adani Energy Solutions	ADANIENSOL.BO
3	Large	Coal India Limited	COALINDIA.NS
4	Large	Hitachi Energy India	POWERINDIA.BO
5	Large	Reliance Industries	RELIANCE.NS
6	Large	Solar Industries	SOLARINDS.BO
7	Large	CG Power	PATANJALI.NS
8	Large	JSW Ener	JSWENERGY.NS
9	Large	Oil India	IPCALAB.NS
10	Large	Petronet LNG	PETRONET.NS
11	Mid	Triveni Turbine	TRITURBINE.NS
12	Mid	Gujarat State Petronet	RECLTD.NS
13	Mid	Indian Energy Exchange	IEX.NS
14	Mid	Mahanagar Gas	MGL.BO
15	Mid	Inox Wind Energy	IWEL.BO
16	Small	Waaree Renewable	WAAREERTL.BO
17	Small	Websol Energy	WEBELSOLAR.NS
18	Mid	Rattan India Power	RTNPOWER.BO
19	Small	KPI Green Energy	KPIGREEN.NS
20	Small	Deep Industries	DEEPINDS.NS
21	Small	Hindustan Oil Exploration	HINDOILEXP.NS
22	Small	BF Utilities	BFUTILITIE.NS
23	Small	KPro. Infra	KPIL.BO
24	Small	GMR Power & Urban Infra	GMRP&UI.BO
25	Small	JP Power	JPPOWER.NS

The stocks obtained by the above methods are

1. Efficient

   These stocks produce the maximum output level defined by their short term, mid term, long term returns and EPS with the given set of inputs compared to the other stocks.

2. Uncorrelated

   These stocks have very low correlations among their returns. This is ideal for portfolio diversification, as strong positive correlation would mean that both upward and downward movements of stocks would be heavily magnified making the portfolio very risky. Whereas, strong negative correlation would mean that if one stock gains value, other stocks would lose value yielding lesser net return.

C.3. Quadratic Programming

Quadratic Programming models are applied to the prepared monthly data with

$$\mu_0 = 0.008$$

And the mean vector being,

Stock Symbol	Return
ADANIENSOL.BO	0.0469
ADANIPOWER.NS	0.0605
BFUTILITIE.NS	0.0345
CGPOWER.NS	0.0922
COALINDIA.NS	0.0304
DEEPINDS.NS	0.0550
GMRP&UI.BO	0.0379
GSPL.BO	0.0122
HINDOILEXP.NS	0.0270
IEX.NS	0.0264

Stock Symbol	Return
IWEL.BO	0.0606
JPPOWER.NS	0.0471
JSWENERGY.NS	0.0531
KPIGREEN.NS	0.0753
KPIL.BO	0.0312
MGL.BO	0.0112
OIL.NS	0.0448
PETRONET.NS	0.0101
POWERINDIA.BO	0.0566
RELIANCE.NS	0.0123
RTNPOWER.BO	0.0562
SOLARINDS.BO	0.0508
TRITURBINE.NS	0.0427
WAAREERTL.BO	0.1400
WEBELSOLAR.NS	0.0984

D. Obtained Portfolios

1. Portfolio Optimization

Optimum allocation

Cap	Ticker	Company Name	Allocation
Large-cap	OIL.NS	Oil India Ltd	11%
Large-cap	RELIANCE.NS	Reliance Industries Ltd	20%
Large-cap	ADANIENSOL.BO	Adani Energy Solutions Ltd	1%
Large-cap	POWERINDIA.BO	Hitachi Energy India Ltd	2%
Large-cap	JSWENERGY.NS	JSW Energy Ltd	3%
Mid-cap	IEX.NS	Indian Energy Exchange Ltd	14%
Mid-cap	MGL.BO	Mahanagar Gas Ltd	3%
Mid-cap	GSPL.BO	Gujarat State Petronet Ltd	1%
Mid-cap	KPIL.BO	Kalpataru Projects International Limited	3%
Mid-cap	KPIGREEN.NS	KPI Green Energy Ltd	1%
Mid-cap	GMRP&UI.BO	GMR Power and Urban Infra Ltd	18%
Small-cap	HINDOILEXP.NS	Hindustan Oil Exploration Co Ltd	15%
Small-cap	WEBELSOLAR.NS	Websol Energy System Ltd	2%
Small-cap	BFUTILITIE.NS	BF Utilities Ltd	6%

Large - cap	Mid - cap	Small - Cap
37%	40%	23%

Method	Annual Return	Annual Risk
Mean Variance	20.1%	0.713%

Sub Sector Allocation

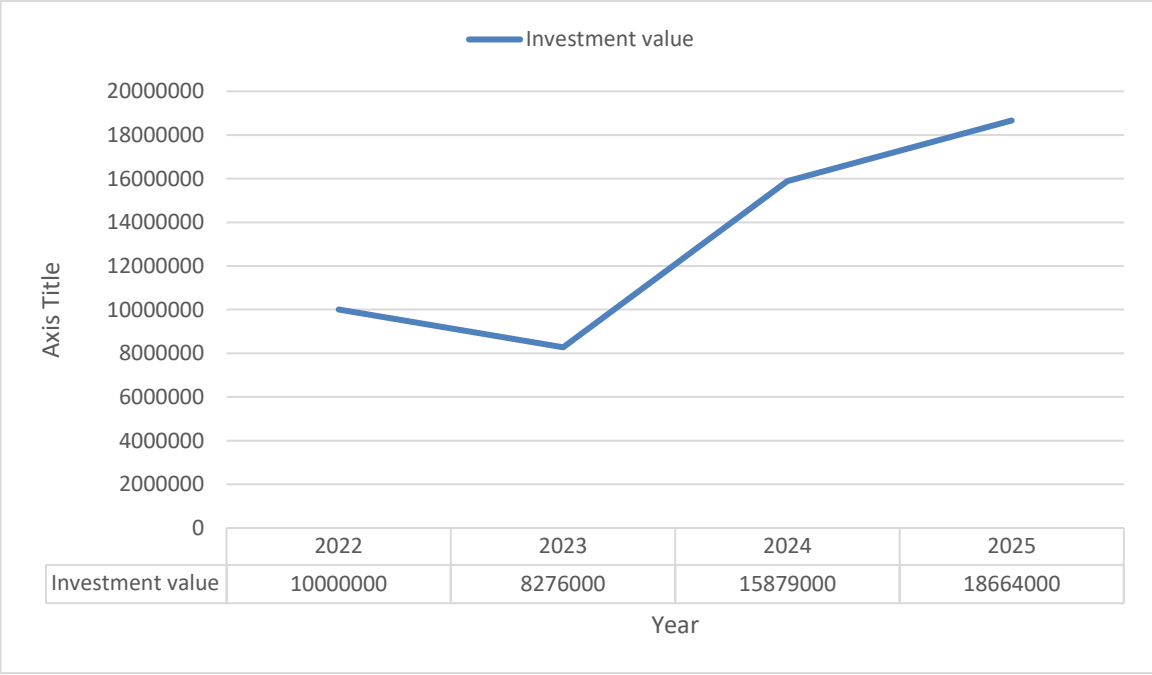

■ Solar ■ Thermal ■ Power Trading Exchange ■ Oil & Gas ■ Other
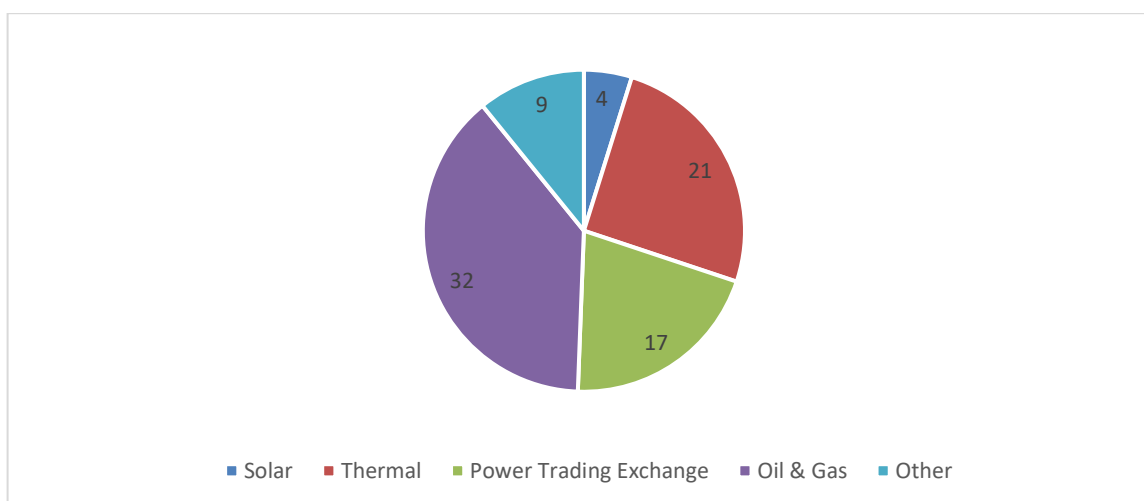
If Rs 1,00,00,000 was invested in the above portfolio on 1st January 2025, then monthly returns would be:

Method	January	February	March	Total
Return	-10,78,630.57	+21,36,634.45	-12,18,537.37	- 1,60,533.30

E. Fund Performance

|	2022	2023	2024	2025
Investment value	10000000	8276000	15879000	18664000

Year

Expected Monthly Returns (Theoretical):	1.79%	179000
Expected Monthly Returns (Historical):	1.24%	124000

The graph illustrates the changes in my investment value within the energy sector from 2022 to 2025. Starting at approximately 10 million in 2022, the portfolio saw a decline to around 8.2 million by 2023—likely a reflection of global energy market volatility, tighter regulations, or reduced demand during the energy transition phase. However, 2024 marked a significant recovery, with the value jumping to nearly 15.8 million. This rebound may have been driven by government push policies—such as subsidies for renewable infrastructure, favorable tax credits, or increased public investment in energy projects—which boosted sector performance and investor sentiment.

Efficient Frontier Analysis
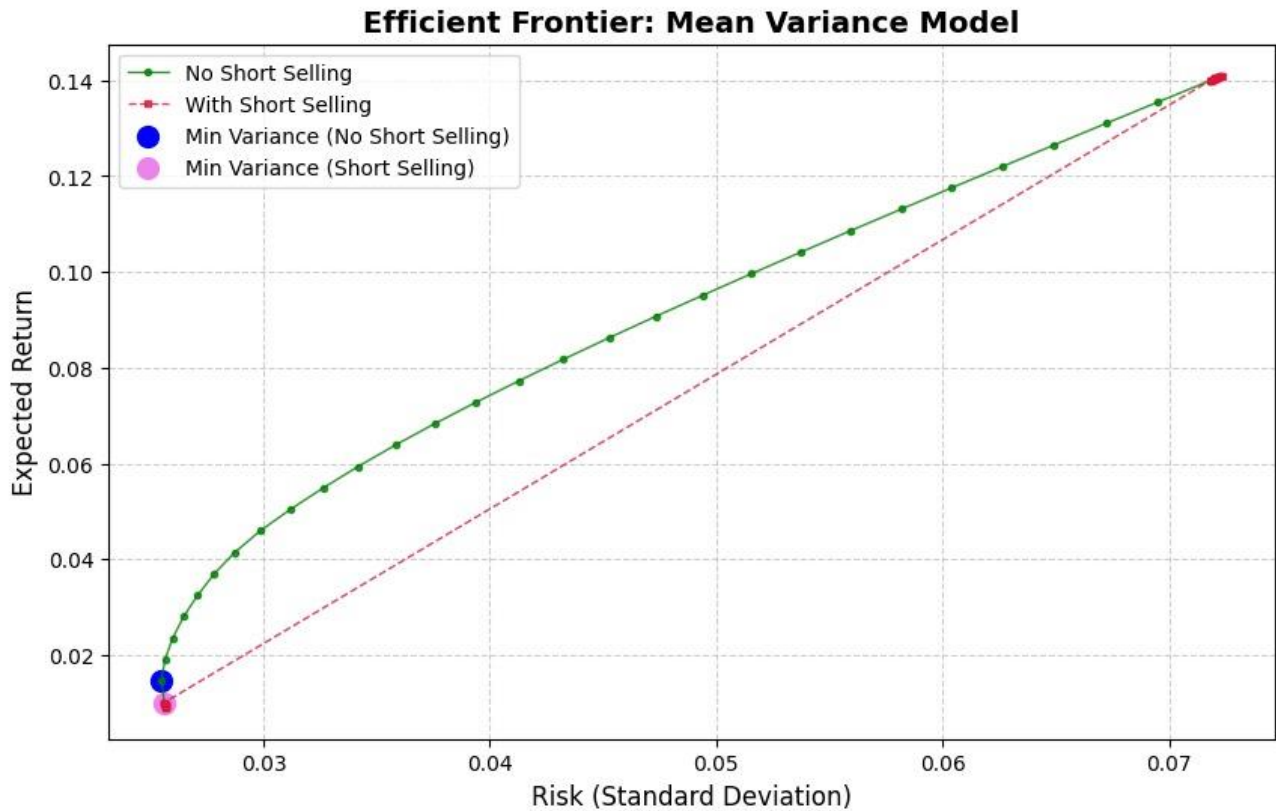
The obtained **MV portfolio** is overperforming with respect to customer expectations, and has

Monthly rate of return: 1.7 %

Monthly standard deviation: 0.21%

Which is exactly satisfying the customer requirements, and has

Monthly rate of return: 0.8%

Hence, MV portfolio is optimal for the customer.

To further study the effectiveness of the variance optimized portfolio, a comparison to 2 professionally managed stock bucket is done.

Green Energy Theme	

Category:	Equity
Fund type:	Stock Basket
Fund house:	Niveshaay
Launched:	March 2021
Asset under management:	RS 1200 Crore
Risk profile:	Very high
Number of stocks in portfolio:	25
CAGR:	42%
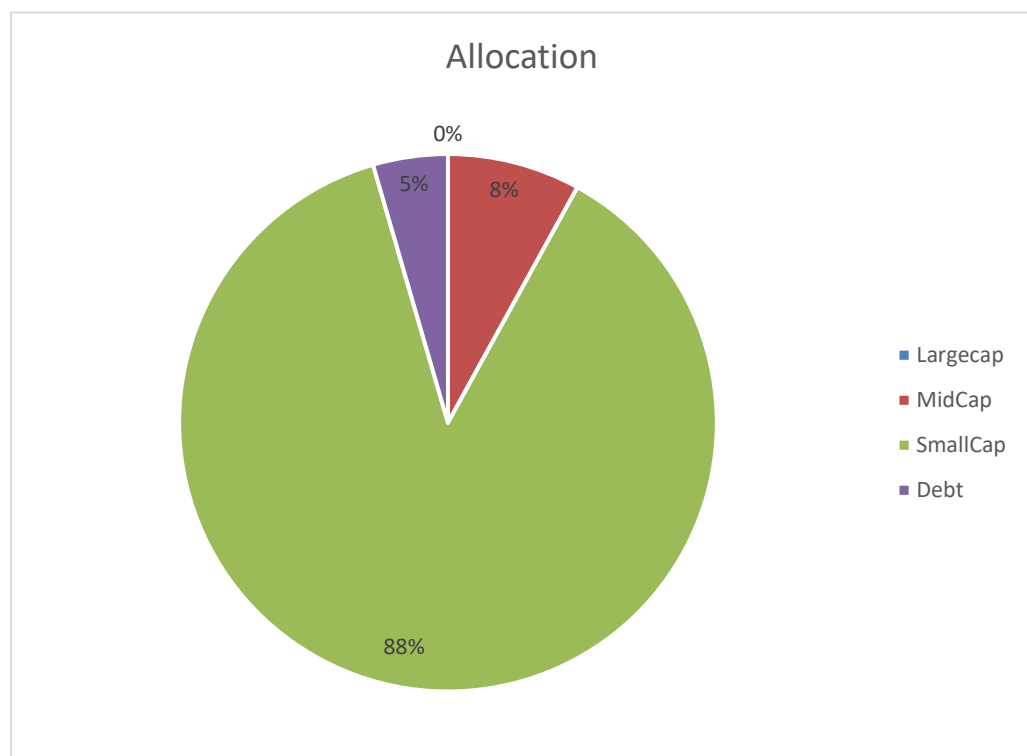
Heavy emphasis on SmallCap stocks: The portfolio is highly aggressive and growth-oriented, favoring higher risk and potential higher return.
Minimal diversification: There's limited exposure to other equity classes (MidCap and LargeCap), and only a small allocation to Debt, which could impact stability and risk management.
No LargeCap allocation: This might reduce stability since LargeCap stocks are typically more stable and less volatile.

SR ENERGY Theme	

Category:	Equity
Fund type:	Stock Bucket
Fund house:	SR WEALTH ELITE
Inception:	Sept 2020
Asset under management:	RS 1,610.31 Crore
Risk profile:	Very high
Number of stocks in portfolio:	10
CAGR:	16%

Allocation

Legend: Largecap, Midcap, Smallcap, Debt

Values shown: 0, 10, 10, 80
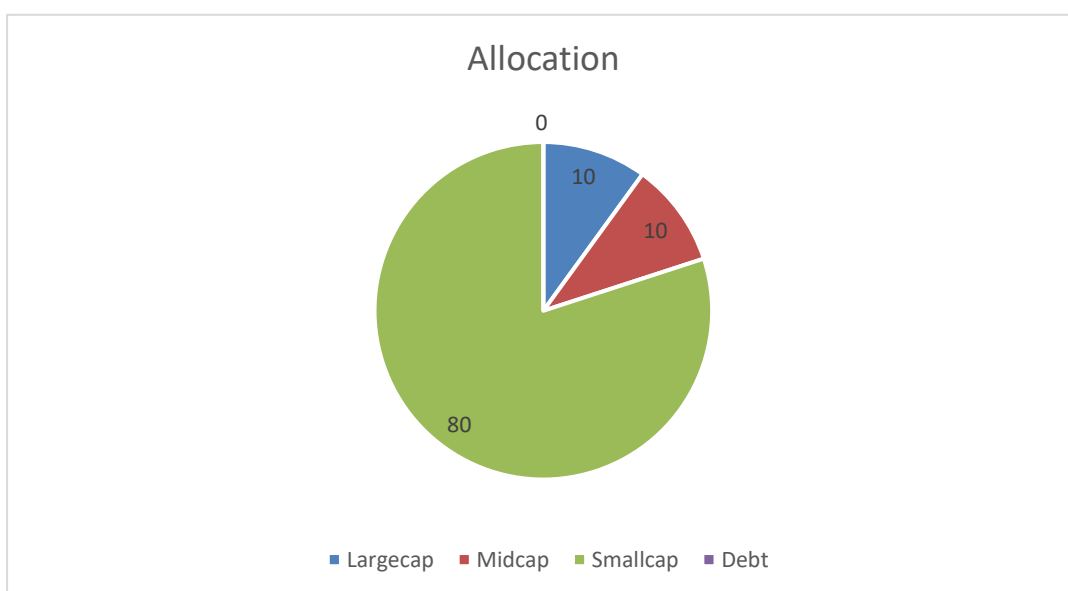
Dominant SmallCap Exposure: The portfolio is strongly skewed toward SmallCap investments, indicating a bold, growth-driven strategy. While this could lead to higher returns, it also significantly increases exposure to volatility.

Limited Diversification: With only modest allocations to MidCap and virtually none to Debt or LargeCap segments, the portfolio lacks balance. This narrow focus may amplify risk, especially during market downturns.

Absence of LargeCap Holdings: The complete lack of LargeCap stocks removes a key stabilizing element. These typically offer more consistent performance and can cushion against the fluctuations of smaller-cap equities.

Cap wise allocations of different funds
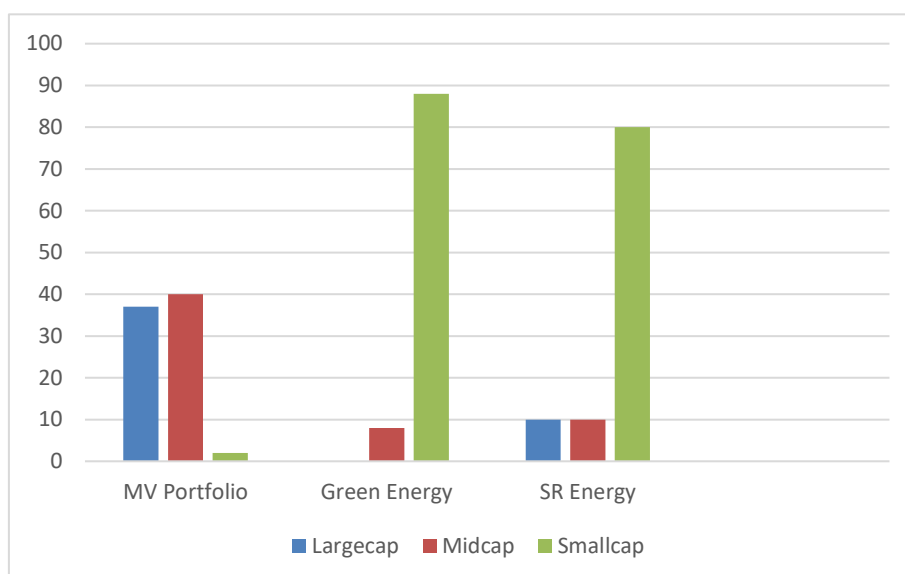
All the funds allocation to SmallCap stocks as compared to the MV portfolio inherently increases the risk level of those funds. SmallCap stocks are generally more volatile and sensitive to economic shifts, making them riskier than their large cap or Midcap counterparts. In contrast, the MV portfolio likely includes a diversified mix of asset classes, which helps spread risk and smooth out returns over time. By concentrating solely on SmallCap equities, these funds forgo the stabilizing effect of diversification, resulting in a higher susceptibility to market fluctuations.

Allocation Drift
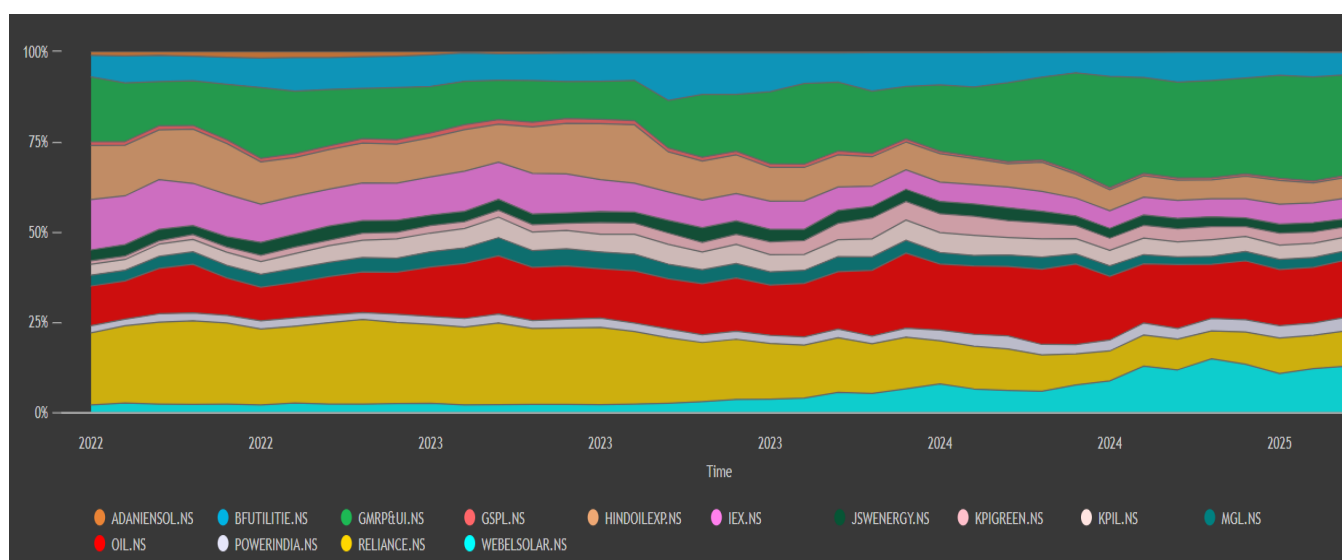
Allocation drift visualize the gradual change in the portfolio's asset allocation due to differences in asset performance over time. If a particular stock or sector outperforms others, its weight in the portfolio increases even if no additional investment is made. This can shift the portfolio away from its original intended allocation and risk profile.

6. Conclusion

1. The MV (Mean-Variance optimized) portfolio achieves a monthly return of **1.7%** with a low standard deviation of **0.21%**, outperforming both benchmark expectations and professionally managed SmallCap-heavy portfolios in terms of stability and risk control.

2. After a downturn in 2023, the portfolio sharply rebounded in 2024 and 2025, growing from **₹8.27 million to ₹18.66 million**. This growth was likely supported by favourable macroeconomic policies, reflecting strong sectoral momentum in energy.

3. Between 2022 and 2025, the investment grew from ₹10,000,000 to approximately ₹18,664,000, resulting in a total wealth generation of ₹8,664,000.

4. The width of individual areas indicates increased diversification by 2025, with more evenly distributed weights among a broader set of stocks than in early 2022. This may increase risk exposure to a few stocks or sub-sectors, reducing the effectiveness of diversification.

5. As government is actively investing in energy infrastructure, grid modernization, and clean energy incentives, creating a supportive policy environment for both private and institutional investors.

   - The portfolio demonstrates a balanced exposure across traditional (Oil & Gas, Thermal) and emerging sectors (Solar, Power Trading Exchange), aligning with India's energy transition goals.
   - Strong representation in Oil & Gas (32%) and Thermal (21%) reflects stable cash flow anchors, while Solar (4%) and Power Trading Exchange (17%) position the portfolio for long-term growth.

7. Limitations of the project

1. **Lack of Qualitative Research**

   Portfolio management is considered both art and science. The objectiveness comes from the different mathematical models and analyses methods used to obtain the weights of the different stocks in the portfolio.

   However, there is an important place for subjectiveness in portfolio management. Domain knowledge gives portfolio managers an edge over others. A professional portfolio manager may be able to analyze how geo-political scenarios can affect India's stock sectors and adjust their portfolios accordingly.

   For example, Adani stocks has been soaring in the Indian stock market for the past few years. Most objective analytical techniques would show Adani stocks as one of the most promising for the future. But, organizations like Hindenburg Research realized through their extensive qualitative and quantitative research the potential downfall of Adani stocks and adjusted their position in the market accordingly.

   Due to time constraints, qualitative research on the initial 109 stocks was out of the scope. However, the process of choosing stocks through NIFTY indices and then DEA has strong objective foundations to be regarded as a credible method.

2. **No consideration given towards industry wise allocation**

   This is a result of the above illustrated point. If extensive qualitative research was available for this project, then in the stock selection process, sectoral NIFTY indices such as NIFTY Auto Index, NIFTY Bank Index, NIFTY Pharma Index etc. could have been used rather than NIFTY100 indices.

3. **Ignorance of certain constraints**

   Certain constraints generally regarded in portfolio creation were ignored in this project such as the customer's Tax status, Investment horizon, Liquidity needs and Special situations for the purpose of simplicity.

8. Bibliography

OPERATIONS RESEARCH, AN INTRODUCTION, 10th Edition, Hamdy A. Taha

PORTFOLIO MANAGEMENT IN PRACTICE, Christine Brentani

Powers, Jennifer & R. McMullen, Patrick, *"Using data envelopment analysis to select large market cap securities",* Vol 7, No. 2 Journal of Business and Management, 2000

"The big picture of operations research", Mohamed Leila, published in Towards Data Science

9. Data

Data

Date	ADANIENSOL.BO	ADANIPOWER.NS	BFUTILITIE.NS	CGPOWER.NS	COALINDIA.NS
01-04-2022	2805.100098	280.3500061	383.2999878	195.9256592	144.5597076
01-05-2022	2049.850098	323.25	332.8500061	180.1347961	152.5051422
01-06-2022	2473.75	262.8500061	300.5499878	189.7380066	146.7338409
01-07-2022	3110.100098	313.9500122	325.5499878	221.9137573	167.0125122
01-08-2022	3971.649902	413.9500122	402.5	222.6067963	185.6309357
01-09-2022	3290.699951	373.5	406.1499939	233.3485565	170.1245422
01-10-2022	3346.949951	334.8999939	391.25	257.4061279	197.1360931
01-11-2022	2925.199951	332.75	400.3999939	276.8106079	182.1474762
01-12-2022	2591.550049	299.5499878	386.3500061	267.603363	192.03685
01-01-2023	1773.949951	223.8000031	367.6499939	299.4326477	191.8661957
01-02-2023	642.5499878	146.3000031	332.8999939	302.2046814	183.8024292
01-03-2023	997.9000244	191.6000061	297.1499939	297.0565491	186.7722931
01-04-2023	1027.349976	224.8500061	337.1499939	307.3421936	203.7754517
01-05-2023	777.5499878	249.6499939	359.75	390.9321289	210.9001617
01-06-2023	767.5	249.8500061	365.2000122	376.6521606	201.939621
01-07-2023	814.8499756	273.2999878	376.5	400.0871887	200.4098053
01-08-2023	812.1500244	321.2999878	689.4500122	427.2539368	201.1091461
01-09-2023	809	377.4500122	651.5	440.0411987	262.5845947
01-10-2023	769.7000122	363.0499878	625.2999878	388.1955566	279.5298767
01-11-2023	872.5	431.5	652.25	447.2060242	304.34729
01-12-2023	1046	525.1500244	591.5	452.1816101	349.7971191
01-01-2024	1067.5	562.7000122	604.4000244	466.2625427	377.8459778
01-02-2024	1065.5	549.9500122	882.4500122	441.0860596	406.2669983
01-03-2024	1025.800049	533.7999878	772	539.8258057	408.5003052
01-04-2024	1064.650024	612.4500122	862.25	552.8499146	427.5090942
01-05-2024	1122.800049	755.7999878	909.9500122	642.1721191	462.2330627
01-06-2024	997.9500122	718.5999756	897.7999878	703.3004761	445.2474976
01-07-2024	1137.599976	734.4500122	807.0999756	734.5383301	491.4049072
01-08-2024	1007.849976	632.0499878	788	694.7175293	493.9927368
01-09-2024	1009.650024	656.1500244	945.3499756	757.5425415	484.8690796
01-10-2024	975.7000122	592.7000122	851.1500244	703.0010986	429.6482544
01-11-2024	840.5499878	554.7999878	986.1500244	730.7957764	395.7649231
01-12-2024	806.4000244	529.4500122	977.5	726.5541992	378.5630798
01-01-2025	753.0999756	513.2000122	804	633.5891724	390.1421814
01-02-2025	651.0499878	478.9500122	611.9500122	571.4628296	369.3500061
01-03-2025	871.5	509.2999878	751.6500244	637.2319336	398.2000122
01-04-2025	898.5	532.0499878	705.8499756	626.7999878	385.2999878
01-05-2025	837.75	520.2000122	685.7000122	610.25	385.4500122

	ADANIENSOL.B	ADANIPOWER.N	CGPOWER.NS	COALINDIA.N	DEEPINDS.N	GMRP&UI.BO	GSPL.BO	HINDOILEXP.N	IEX.NS	JWEL.BO	JPPOWER.N	JSWENERGY.N	KPIGREEN.N	KPIL.BO	MGL.BO	OIL.NS	PETRONET.N	POWERINDIA.B	RELIANCE.N	RTNPOWER.BO	SOLARINDS.BO	TRITURBINE.N	WAAREERTL.B	WEBELSOLAR.NS
ADANIENSOL.B	0.04066262	0.0198268	0.00158262	0.0053265	0.0041776	0.01554072	-0.00029276	0.0008722	0.0011633	0.0038316	0.00500333	0.0100316	0.0173065	0.00497334	0.05558959	0.000323061	0.00218463	0.001232553	0.0031284	0.007706234	0.005984477	0.00128074	0.012675167	0.00838
ADANIPOWER.N	0.0198268	0.02247628	0.00225705	0.0063262	0.0017004	0.0135029	0.000802061	0.00032929	0.00375463	0.0036304	0.009829	0.0120116	0.0054749	0.0025472	0.0046686	-0.00095573	0.0030563	0.0064288	0.0024675	0.01316561	0.00351688	0.00085674	0.01279079	0.00351
CGPOWER.NS	0.00158262	0.0022571	0.00825493	0.0825493	0.0825493	0.0825493	0.0825493	0.0825493	0.0825493	0.0825493	0.00230387	0.0825493	0.00082346	0.000315687	0.000268731	0.0008939	0.00953025	0.00272953	0.00437688	-0.0001939	0.00094
COALINDIA.NS	0.0053265	0.0063262	0.00193526	0.0083384	0.0009726	0.00789149	0.00207198	0.00304507	0.0026282	0.0012722	0.0046235	0.0054117	-0.00013	0.0209853	0.00287801	0.00523669	0.00280702	0.00030574	0.01119805	0.00294576	0.00190472	0.00229478	0.005809906	0.00248
DEEPINDS.NS	0.00417759	0.0017004	0.00566497	0.0009726	0.01455513	0.0051543	0.002297688	0.00105513	0.00216462	0.0044818	0.00149441	0.0049266	-0.0047343	0.0019674	-0.0002588	0.00232746	-0.00002067	-0.001455	0.00098663	0.000675363	0.005205367	0.0051012	-0.00102334	0.00873
GMRP&UI.BO	0.01554072	0.0135029	0.00258338	0.0079149	0.0051543	0.04536958	0.005716427	0.0082862	0.0142083	0.0103276	0.0163241	0.0160372	0.0180319	0.00445978	0.0064039	0.00544711	0.00640235	0.03948595	0.00343585	0.01567379	0.005563952	0.0077499	0.01460216	0.01632
GSPL.BO	-0.00029276	0.000802061	0.01558504	0.0020179	0.0023767	0.005716427	0.009942466	0.0032539	0.00368919	0.005661	0.0027941	0.0023195	0.0019346	0.0024757	0.0037617	0.00560502	0.002806529	0.000566402	0.0024533	0.00093412	0.000521955	0.0041014	0.00272137	0.0083
HINDOILEXP.NS	0.00087201	0.00032929	-3.9978E-05	0.00304507	0.00105513	0.0082862	0.0032539	0.0176953	0.00519427	0.00607609	0.0024885	0.000516	0.0067594	0.0027593	0.0051802	0.00734131	0.0047806751	-0.00092163	0.00293735	-0.00269733	-0.00247206	1.54E-05	0.007376309	0.00285
IEX.NS	0.0011633	0.00375463	0.00215280	0.0026282	0.00216462	0.0142083	0.00368192	0.00519427	0.0097727	0.0035542	0.006351	0.0052945	0.0072607	0.0056471	0.0032629	0.0053487	0.0035086	0.00413891	0.0079423	0.0042754	0.0025206	0.0035499	0.0017474	0.0055
JWEL.BO	0.0038316	0.0036304	0.002335855	0.0012722	0.0044818	0.0103276	0.005661	0.00607609	0.0035542	0.0430871	0.0049693	0.0030412	0.00986894	0.0067456	0.0059132	0.0042955	0.00386574	0.00393627	0.0017944	0.00747347	0.00355072	0.0097097	0.01824541	0.01395
JPPOWER.NS	0.00500333	0.009829	0.00230387	0.0046235	0.00149441	0.0163241	0.0027941	0.0024885	0.006351	0.0049693	0.0845136	0.0120029	0.0073379	0.0031073	0.0037956	0.00167011	0.004903939	0.05882497	0.0180797	0.01498868	0.00347652	0.00258558	0.01528497	0.01133
JSWENERGY.N	0.0100316	0.0120116	0.0032262273	0.0054117	0.0049266	0.0160372	0.0023195	0.000516	0.0052945	0.0030412	0.0120029	0.01940766	0.0056343	0.0051941	0.0053498	0.0208883	0.00491154	0.00750085	0.0315335	0.00914383	0.00434235	0.0052664	0.01937876	0.00958
KPIGREEN.NS	0.0173065	0.0054749	0.000634982	-0.00013	-0.0047343	0.0180319	0.0019346	0.0067594	0.0072606	0.00986894	0.0073379	0.0056343	0.04063271	0.0500458	0.0068959	0.00382938	0.00269933	0.00058227	0.0035312	0.01339085	0.0011205233	0.0039401	0.02304318	0.00411
KPIL.BO	0.00497334	0.0025472	0.001581163	0.0208853	0.0019674	0.00445978	0.0024757	0.0027593	0.0056471	0.0067456	0.0031073	0.0051941	0.0500458	0.0026399	0.00375893	0.00440477	0.00303903	0.0044536	0.0033117	0.00160545	0.003320082	0.00375563	0.01293539	0.00725
MGL.BO	0.05558959	0.0046686	0.001324376	0.00287801	-0.0002588	0.0064039	0.0037637	0.0051802	0.0032629	0.0059132	0.0037956	0.0053498	0.0068959	0.00375893	0.0152083	0.004567198	0.00467391	0.00347976	0.0036371	-0.00221296	0.00075286	0.0039677	0.01643906	0.00373
OIL.NS	0.000323061	-0.00094557	0.00082346	0.00523669	0.00232746	0.00544771	0.00560502	0.0073413	0.0053487	0.0042955	0.00167011	0.0208883	0.01322	0.00444048	0.0048572	0.015470824	0.00493438	-0.00012324	0.00382235	-0.00281706	0.00213376	0.0561571	0.009066972	0.00598
PETRONET.NS	0.00218463	0.0030563	0.000315687	0.00280702	-0.00002067	0.00640235	0.002806529	0.00471807	0.0035086	0.00386574	0.004903939	0.00491154	0.0049572	0.00493115	0.00467391	0.00493438	0.0063361	0.0031222715	0.0156428	-0.00115199	-0.00166836	0.0098074	0.010366877	0.00571
POWERINDIA.B	0.001232553	0.0064288	0.000268731	0.00030574	-0.001455	0.03948595	0.000566402	-0.00092163	0.00413891	0.00393627	0.05882497	0.00750085	0.00058227	0.0044536	0.00347976	-0.00012324	0.0031222715	0.00872742	0.0102449	0.0072652	0.0033445	0.0009212	0.01473196	0.00852
RELIANCE.NS	0.0031284	0.0024675	0.000339011	0.0111805	0.00098663	0.00343585	0.0024533	0.00293735	0.0079423	0.0017944	0.0180797	0.0315335	0.0035312	0.0033117	0.0036371	0.00382235	0.0156428	0.0102449	0.035116	0.00336371	0.00282351	0.001564281	0.00244478	0.0055
RTNPOWER.BO	0.007706234	0.0131658	0.00635025	0.00294576	0.000675363	0.01567379	0.00093412	-0.00269733	0.0042754	0.00747347	0.01498868	0.00914383	0.01339085	0.00160545	-0.00221296	-0.00281706	-0.00115199	0.0072652	0.00336371	0.05356721	0.00416835	0.0039854	0.05719514	0.00151
SOLARINDS.BO	0.005984477	0.00351688	0.00272953	0.00190472	0.005205367	0.005563952	0.000521955	-0.00247206	0.0025206	0.00355072	0.00347652	0.00434235	0.00110205233	0.003320082	0.00075286	0.00213376	-0.00166836	0.0033445	0.00282351	0.00416835	0.0119010	0.00294394	0.002650132	0.00371
TRITURBINE.NE	0.00128074	0.00085674	0.00437688	0.00229478	0.0051012	0.0077499	0.0041014	1.54E-05	0.0035499	0.0097097	0.00258558	0.0052664	0.0039401	0.00375563	0.0039677	0.0561571	0.0098074	0.0009212	0.00142036	0.0039854	0.00294394	0.01527316	0.004229138	0.0027
WAAREERTL.B	0.012675167	0.01279018	-0.0001939	0.005809906	-0.00102334	0.01460216	0.00272137	0.007376309	0.0017474	0.01824541	0.01528497	0.01937876	0.02304318	0.01293539	0.01643906	0.009066972	0.010366877	0.01473196	0.0065567	0.00571614	0.002650132	0.004229138	0.07057962	0.01933
WEBELSOLAR.I	0.00838	0.00351458	0.00094	0.00248	0.00873	0.01632	0.0083	0.00285	0.0055	0.01395	0.01133	0.00958	0.00411	0.00725	0.00373	0.00598	0.00571	0.00852	0.0055	0.00151	0.00371	0.0027	0.01933	0.03684