

# Financial & Risk Analytics – Market Risk Analysis Stocks

## Part B- Coded Project

Business Report

DSBA – Course

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# Foreword

## Context

Investors face market risk, arising from asset price fluctuations due to economic events, geopolitical developments, and investor sentiment changes. Understanding and analyzing this risk is crucial for informed decision-making and optimizing investment strategies.

## Objective

The objective of this analysis is to conduct Market Risk Analysis on a portfolio of Indian stocks using Python. It uses historical stock price data to understand market volatility and riskiness. Using statistical measures like mean and standard deviation, investors gain a deeper understanding of individual stocks' performance and portfolio variability.

Through this analysis, investors can aim to achieve the following objectives:

- Risk Assessment: Analyze the historical volatility of individual stocks and the overall portfolio.
- Portfolio Optimization: Use Market Risk Analysis insights to enhance risk-adjusted returns.
- Performance Evaluation: Assess portfolio management strategies' effectiveness in mitigating market risk.
- Portfolio Performance Monitoring: Monitor portfolio performance over time and adjust as market conditions and risk preferences change.

# Contents

Sr. No	Topics	Pages
1	Objective	4
2	Data Overview	5
3	Statistical summary of data	6
4	Exploratory Data Analysis	8
5	Volatile and Risk Analysis	17
6	Mean and Std Deviation	19
7	Sharpe Ratio	22
8	Portfolio Simulation / Optimization (Monte Carlo)	23
9	RSI values	24
10	Portfolio Performance Monitoring	26
11	Insights and Recommendations	29

# List of Tables

Sr. No	Name of Tables	Pages
1	Top 5 rows	5
2	Basic info of dataset	5
3	Statistical summary	6
4	Missing Values in dataset	7
5	Risk Summary Metrics	17
6	Sharp Ratios	22
7	RSI Indicators	24

## List of Figures

Sr. No	Name of Figures	Pages
1	Stock Price Graph (Stock Price vs Time)	8
2	Distribution of Weekly Stock Prices	10
3	Correlation Map	12
4	Cumulative returns plot	13
5	Cluster Map plot	14
6	Scatter Plot	15
7	Annualized Volatility vs Annualized Return	18
8	Mean Vs Std Deviation Plot	20
9	Risk/Return Zones Plot	21
10	Portfolio Simulation	23
11	RSI indicators for each stock	25
12	Cumulative Portfolio Returns Over time	26
13	Rolling Sharpe Ratio	27

## Objective

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## Data Analysis of problem statement –

The dataset contains data corresponding to polished and unpolished stones.

Sheet name –

1. *Market\_Risk\_Data\_coded.csv*

## Part B –

### **Data Dictionary**

The dataset contains weekly stock price data for 5 Indian stocks over an 8-year period. The dataset enables us to analyze the historical performance of individual stocks and the overall market dynamics.

## Data Overview –

To start the data analysis, we need to import the necessary libraries, specify the working directory, and load the dataset. Then, we will view the first five rows using head () function to get a preliminary understanding of the data. The Dataset has 417 number of rows with 6 columns.

	Date	ITC Limited	Bharti Airtel	Tata Motors	DLF Limited	Yes Bank
0	28-03-2016	217	316	386	114	173
1	04-04-2016	218	302	386	121	171
2	11-04-2016	215	308	374	120	171
3	18-04-2016	223	320	408	122	172
4	25-04-2016	214	319	418	122	175

TABLE 1 - TOP 5 ROWS OF DATASET

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 418 entries, 0 to 417
Data columns (total 6 columns):
 #   Column      Non-Null Count Dtype  
--- 
 0   Date        418 non-null   object 
 1   ITC Limited 418 non-null   int64  
 2   Bharti Airtel 418 non-null   int64  
 3   Tata Motors  418 non-null   int64  
 4   DLF Limited  418 non-null   int64  
 5   Yes Bank    418 non-null   int64  
dtypes: int64(5), object(1)
memory usage: 19.7+ KB
```

TABLE 2 - BASIC INFO. OF DATASET

Regarding the datatype of the columns in the dataset, we can confirm that-

- We can observe we have 5 numerical and 1 object datatypes.

## Statistical Summary –

Using Describe () function, we can analyses the summary statistics of the dataset –

	count	mean	std	min	25%	50%	75%	max
ITC Limited	418.0	278.964115	75.114405	156.0	224.25	265.5	304.00	493.0
Bharti Airtel	418.0	528.260766	226.507879	261.0	334.00	478.0	706.75	1236.0
Tata Motors	418.0	368.617225	182.024419	65.0	186.00	399.5	466.00	1035.0
DLF Limited	418.0	276.827751	156.280781	110.0	166.25	213.0	360.50	928.0
Yes Bank	418.0	124.442584	130.090884	11.0	16.00	30.0	249.75	397.0

TABLE 3 - STATISTICAL SUMMARY OF DATASET

## Observations-

- All five stocks (ITC Limited, Bharti Airtel, Tata Motors, DLF Limited, and Yes Bank) have the same number of data points, with a count of 418 each.
- Bharti Airtel exhibits the **highest average price (mean of 528.26)** among the listed stocks.
- Yes Bank shows the **lowest average price (mean of 124.44)** and the smallest minimum value (11.0).
- Bharti Airtel also demonstrates **the largest price volatility**, indicated by the highest standard deviation (226.51).
- The price range is widest for Bharti Airtel (from 261.0 to 1236.0) and narrowest for Yes Bank (from 11.0 to 397.0).
- The **median (50%) price for Tata Motors (399.5)** is notably higher than its mean (368.62), suggesting a potential positive skew in its price distribution.
- Across all stocks, the **75th percentile values are significantly higher than the 25th percentile** values, indicating substantial price variation within each stock's dataset.

## Missing Values –

There are no duplicates and missing values in the dataset.

```
Date          0
ITC Limited   0
Bharti Airtel 0
Tata Motors    0
DLF Limited   0
Yes Bank       0
dtype: int64
```

TABLE 4 – MISSING VALUES IN DATASET

# Exploratory Data Analysis

Let's analyze Stock Price Graph (Stock Price vs Time) –

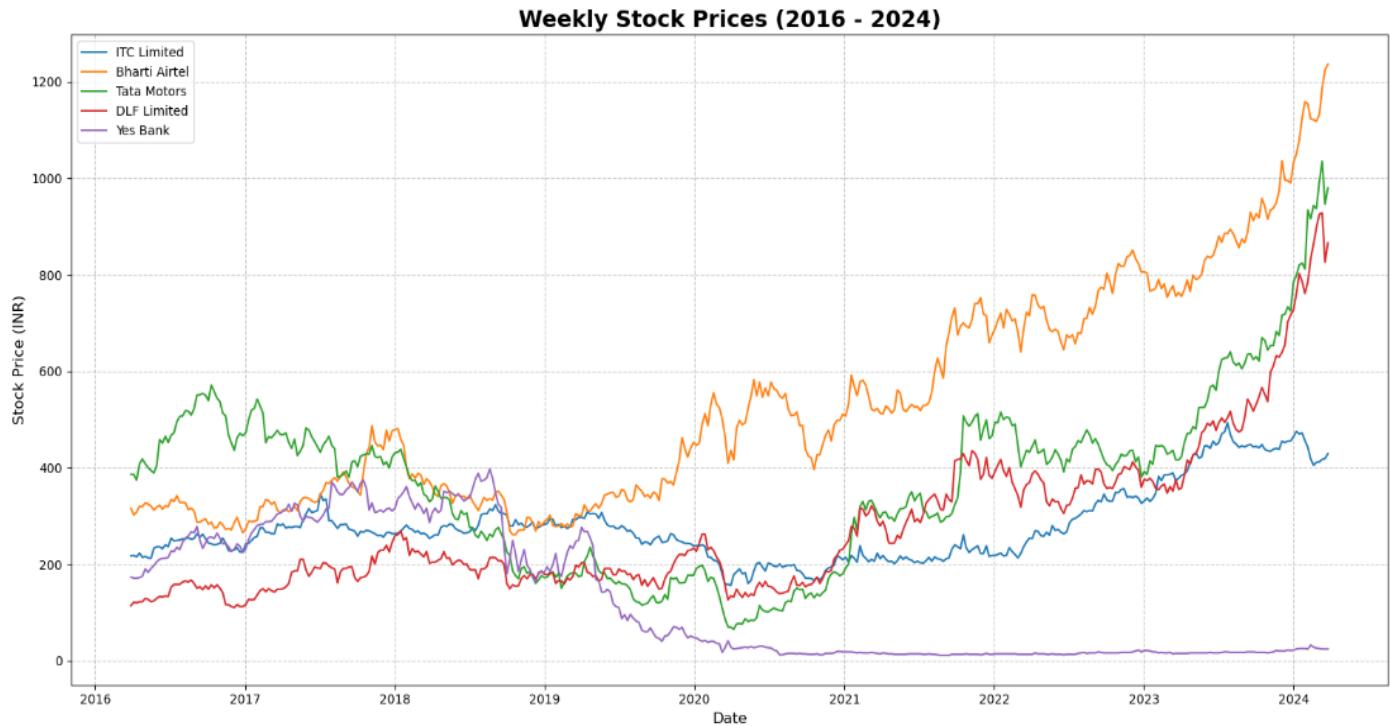


FIGURE 1 - STOCK PRICE GRAPH (STOCK PRICE VS TIME)

## Observations –

- **Bharti Airtel's Strong Growth:** Bharti Airtel exhibits a significant upward trend, particularly starting around mid-2020. Its price has risen dramatically, reaching the highest levels among the five stocks by the end of the observed period. This suggests strong positive market sentiment or company-specific growth drivers.
- **Tata Motors' Volatility and Recovery:** Tata Motors shows considerable volatility throughout the period. It experienced a notable dip around 2020 (likely influenced by broader market conditions) but has since shown a strong recovery and upward trajectory, although not as consistently steep as Bharti Airtel.
- **ITC Limited's Steady but Slower Growth:** ITC Limited displays a more gradual and relatively stable upward trend compared to Bharti Airtel and Tata Motors. While it has shown growth, its price movements are less dramatic.

- **DLF Limited's Fluctuations and Recent Upswing:** DLF Limited's stock price has fluctuated significantly. It experienced a sharp decline around 2020, followed by a recovery and a noticeable upward trend in the later part of the period, suggesting a potential turnaround or renewed investor interest.
- **Yes Bank's Dramatic Decline and Stagnation:** Yes Bank stands out with a stark decline starting around mid-2019, followed by a prolonged period of very low and relatively stagnant prices. This indicates significant negative market events or company-specific challenges that heavily impacted its stock value.
- **Impact of 2020 Market Event:** The chart clearly shows a dip or significant change in trajectory for most stocks around the 2020 period, likely reflecting the impact of the COVID-19 pandemic and the subsequent market reactions. The recovery rates and patterns varied across the different stocks.
- **Divergent Performances:** The performances of these five stocks have been quite diverse over the 8-year period. Bharti Airtel and, to a lesser extent, Tata Motors and DLF Limited have shown strong growth, while Yes Bank experienced a major downturn. ITC Limited has followed a more conservative growth path.
- **Volatility Differences:** The visual inspection confirms the earlier statistical observation about volatility. Bharti Airtel and Tata Motors appear to have experienced more significant price swings compared to ITC Limited, especially in recent years. Yes Bank's volatility was high during its decline but low during its stagnation phase.

Overall this chart highlights the varying fortunes and market dynamics affecting these five Indian stocks over a significant period. Bharti Airtel has been a clear outperformer, while Yes Bank faced substantial challenges. The other stocks show different patterns of growth and volatility, reflecting their unique business environments and market sentiment.

## Lets analyse histograms for each stock –

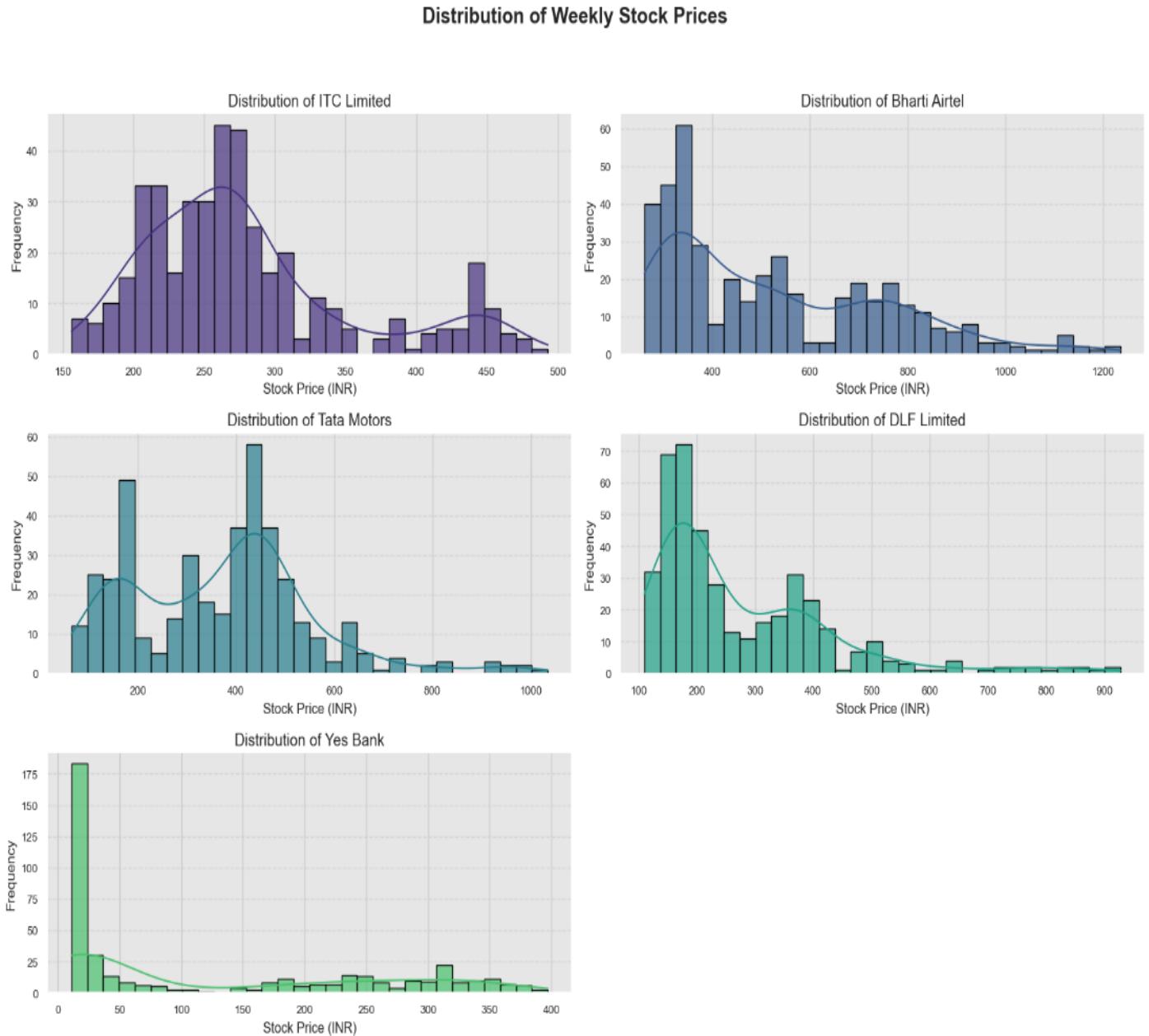


FIGURE 2 - DISTRIBUTION OF WEEKLY STOCK PRICES

- **ITC Limited:** Shows a bimodal distribution with peaks around the 250-300 INR and a smaller peak near 450 INR, suggesting price stability around these levels with occasional upward movements.

- **Bharti Airtel:** Exhibits a right-skewed distribution, indicating that while most prices are in the lower to mid-range, there's a tail extending towards higher prices, reflecting its upward growth trend.
- **Tata Motors:** Presents a distribution with a primary peak around 400 INR and a secondary, smaller peak near 200 INR, suggesting price consolidation at these levels with some price volatility.
- **DLF Limited:** Displays a strongly right-skewed distribution with the majority of prices concentrated in the lower range (below 300 INR) and a long tail towards higher values, indicating a period of lower prices followed by significant increases
- **Yes Bank:** Shows a highly right-skewed distribution with a dominant peak at very low prices (below 50 INR), consistent with its observed price decline and subsequent stagnation.
- **Volatility Indication:** The spread of each histogram provides a visual cue to the stock's volatility. Yes Bank and DLF Limited show wider spreads overall, although concentrated in different price ranges, suggesting higher historical volatility compared to ITC Limited.
- **Central Tendency:** The peaks of the histograms roughly indicate the mode (most frequent price) for each stock during the analyzed period, offering a sense of their typical trading price.

## Let's analyse Correlation map –

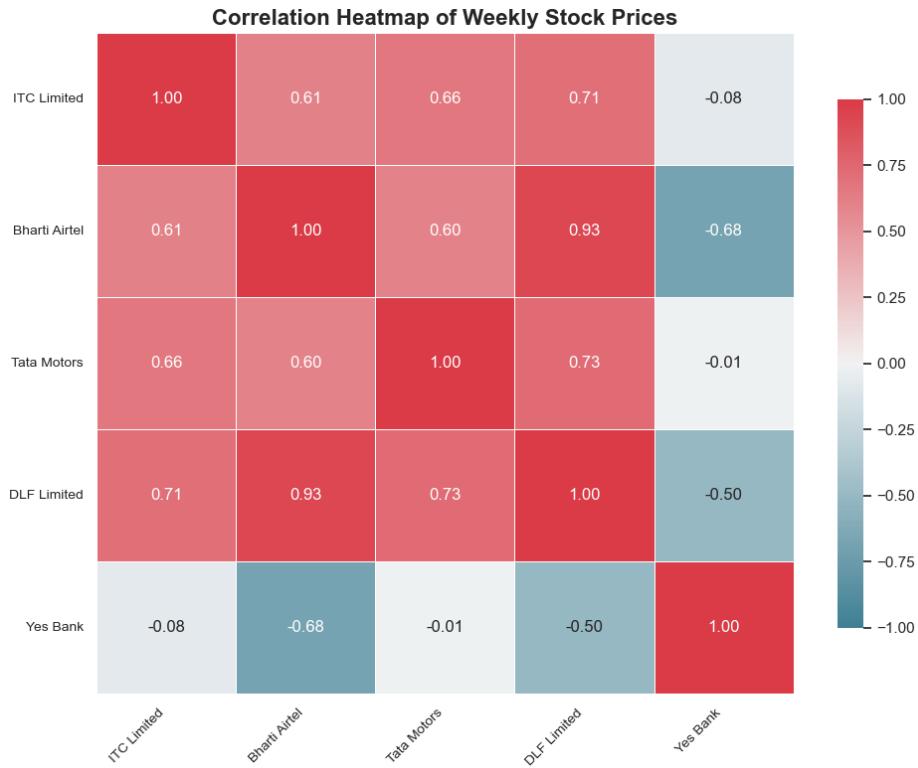


FIGURE 3 - CORRELATION MAP

- **Positive Correlation Among Major Stocks:** ITC Limited, Bharti Airtel, Tata Motors, and DLF Limited show moderate to strong positive correlations with each other (coefficients ranging from 0.60 to 0.93). This suggests their weekly price movements tend to be in the same direction, likely influenced by shared market factors.
- **Strongest Positive Correlation:** DLF Limited and Bharti Airtel exhibit the highest positive correlation (0.93), indicating a very strong tendency for their weekly prices to move together.
- **Weak Correlation with Yes Bank:** Yes Bank shows a very weak or even negative correlation with the other four stocks (coefficients ranging from -0.68 to -0.01). This implies its price movements are largely independent or even inversely related to the others.
- **Negative Correlation with Bharti Airtel and DLF:** Yes Bank has a notable negative correlation with Bharti Airtel (-0.68) and DLF Limited (-0.50), suggesting that when the prices of Bharti Airtel and DLF Limited increase, Yes Bank's price tends to decrease, and vice versa.
- **Relatively Lower Correlation for Tata Motors:** While still positive, Tata Motors' correlation with Bharti Airtel (0.60) and DLF Limited (0.73) is slightly lower compared to the correlation between Bharti Airtel and DLF Limited, suggesting a slightly less synchronized movement.

- **Potential Diversification Benefit:** The weak to negative correlations involving Yes Bank suggest it could offer some diversification benefits to a portfolio primarily composed of ITC Limited, Bharti Airtel, Tata Motors, and DLF Limited, as its price movements are less likely to mirror those of the other stocks.

### Let's analyse Cumulative returns plot –

It helps visualize long-term performance and compare which stock outperformed or underperformed over time.

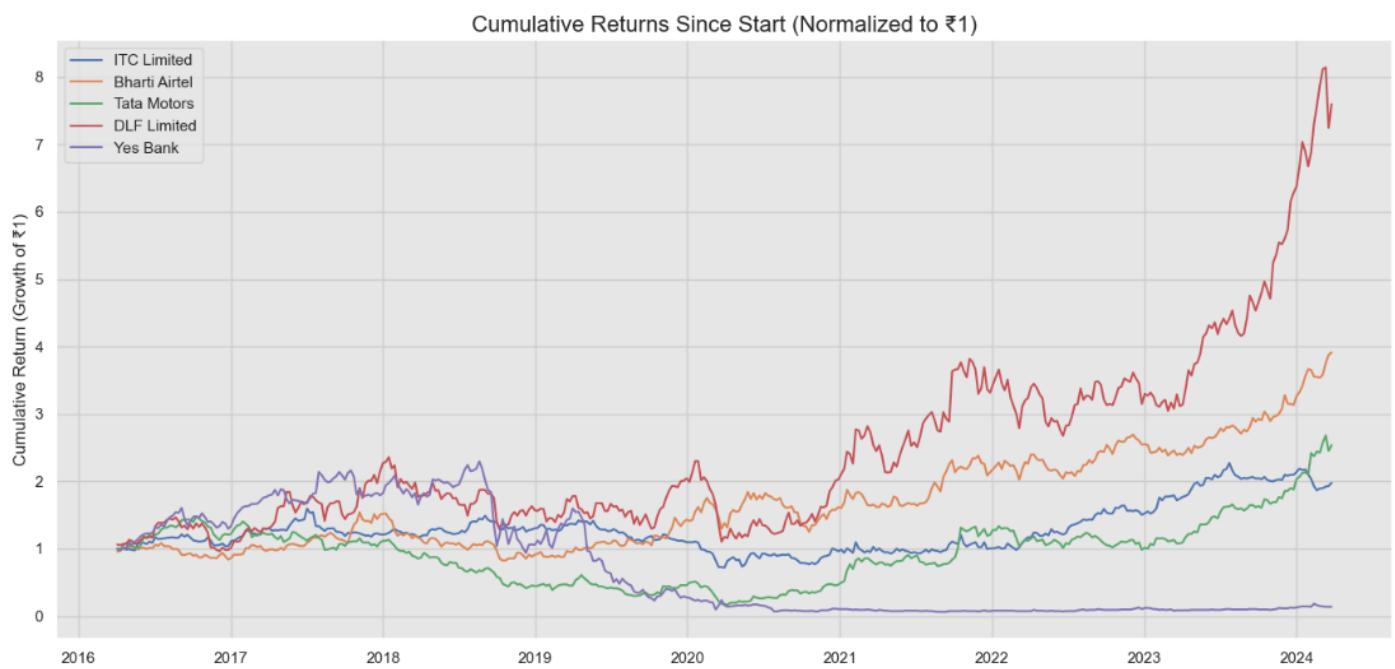


FIGURE 4 - CUMULATIVE RETURNS PLOT

Here are six observations from the cumulative returns chart, normalized to an initial investment of ₹1:

- **Bharti Airtel and DLF Limited Show Strongest Growth:** Bharti Airtel and DLF Limited exhibit the highest cumulative returns by the end of the period, significantly outperforming the other stocks, indicating substantial growth on the initial investment.
- **Tata Motors Recovers Strongly:** Tata Motors experienced a period of decline but showed a strong recovery and eventual positive cumulative return, although lagging behind Bharti Airtel and DLF Limited.

- **ITC Limited Demonstrates Steady Growth:** ITC Limited shows a consistent, albeit less dramatic, positive cumulative return over the entire period, indicating a more stable growth trajectory.
- **Yes Bank Suffers Significant Loss:** Yes Bank's cumulative return plummets sharply and remains significantly below the initial investment, highlighting a substantial loss in value over the observed period.
- **Divergent Performance Post-2020:** The period after 2020 shows a clear divergence in performance, with Bharti Airtel and DLF Limited accelerating their growth while Yes Bank continues to stagnate at a low level.
- **Risk-Return Profile Indication:** The varying slopes of the lines provide a visual indication of the risk-adjusted returns. Steeper inclines suggest higher returns, while the volatility of the lines hints at the level of risk associated with each stock.

### Cluster map -

A cluster map groups stocks with similar price movements using **hierarchical clustering**. It helps spot **stock clusters** that move together — great for **diversification** and **sectoral behavior** insights.

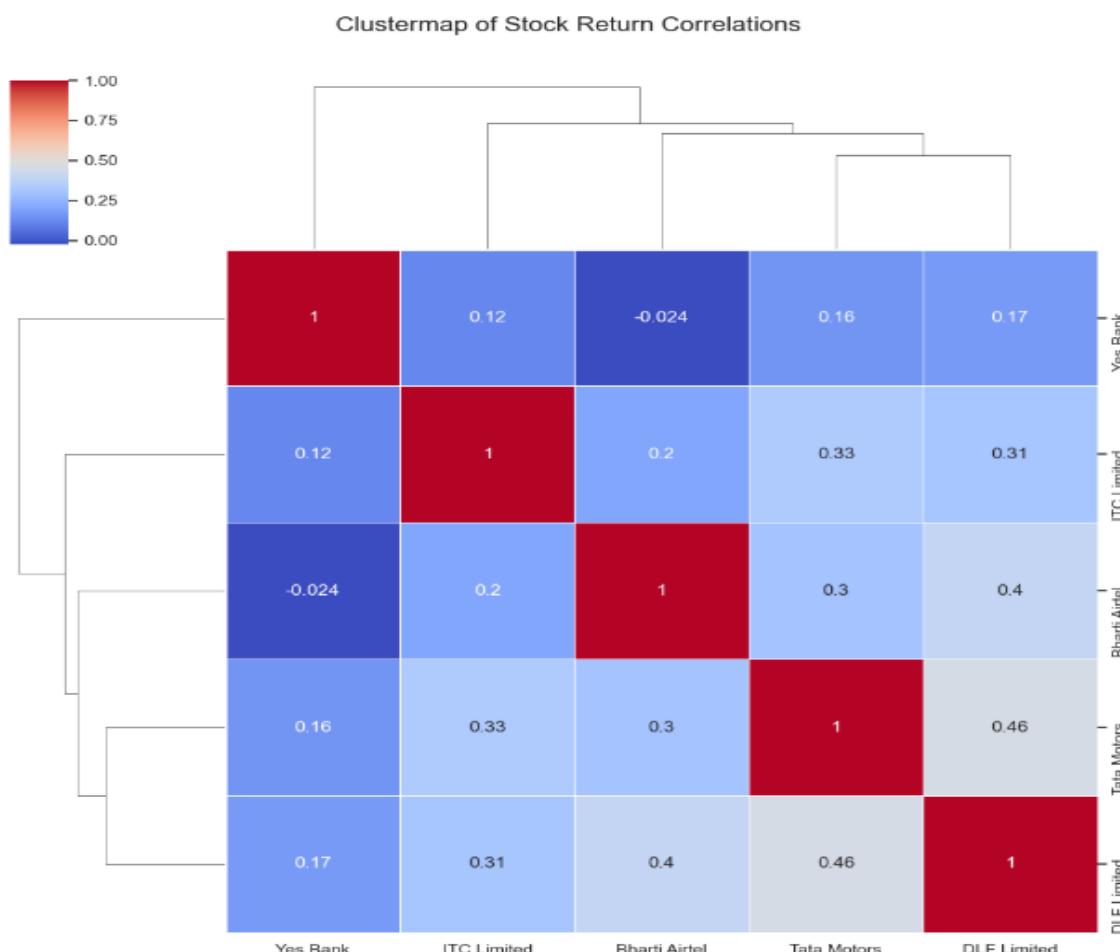


FIGURE 5 - CLUSTER MAP

- **Yes Bank Forms a Distinct Cluster:** Yes Bank is positioned far from the other stocks in the dendrogram, indicating that its return correlations are quite different from the rest. This aligns with previous observations of its unique price behavior.
- **Relatively Low Return Correlations Overall:** The majority of the pairwise return correlations are relatively low, with most values hovering around 0.1 to 0.4. This suggests that the weekly returns of these stocks don't have a very strong linear relationship with each other.
- **Highest Positive Return Correlation:** Tata Motors and DLF Limited show the highest positive return correlation (0.46) among the pairs, suggesting their weekly percentage price changes tend to move in the same direction more so than other pairs.
- **Near-Zero Return Correlation:** Yes Bank and Bharti Airtel exhibit a return correlation close to zero (-0.024), implying that their weekly returns have almost no linear relationship.
- **Weak Positive Return Correlations:** The correlations between Yes Bank and the other individual stocks (ITC Limited, Tata Motors, DLF Limited) are also weak, ranging from 0.12 to 0.17.
- **Clustering of ITC Limited and Bharti Airtel:** ITC Limited and Bharti Airtel appear relatively close in the dendrogram, suggesting some similarity in their return correlation patterns with the other stocks, although their direct return correlation is also relatively low (0.20).

## Scatter Plot-



FIGURE 6 - SCATTER PLOT

- **Limited Strong Linear Relationships:** The scatter plots generally show a dispersed cloud of points rather than tight linear patterns. This visually confirms the earlier finding of relatively low pairwise return correlations between most of the stocks.
- **Tata Motors and DLF Limited Show Some Positive Association:** The scatter plot between Tata Motors and DLF Limited shows a slightly more discernible upward trend compared to other pairs, supporting their relatively higher positive return correlation.
- **Yes Bank's Distinct Return Profile:** The scatter plots involving Yes Bank show little to no clear linear relationship with the returns of the other stocks. Its returns appear to be distributed somewhat independently, especially when compared to Bharti Airtel and DLF Limited.
- **Distribution of Individual Stock Returns:** The histograms along the diagonal provide a view of the distribution of weekly returns for each individual stock. Yes Bank's histogram appears more concentrated around zero with a longer tail to the right, while others show a more spread-out distribution.
- **No Obvious Strong Non-Linear Patterns:** Visually inspecting the scatter plots, there don't appear to be strong non-linear relationships between the weekly returns of the different stock pairs.
- **Volatility Indication (Scatter Spread):** The spread of the points in each scatter plot can offer a qualitative sense of the relative volatility of the returns. Wider spreads along either axis indicate greater variability in the weekly returns of that particular stock when paired with another.

## Stock Returns Calculation and Analysis

### **Volatility & Risk Analysis**

We'll compute, please refer code -

1. Weekly Returns
2. Mean Returns and Standard Deviation
3. Annualized Return and Volatility
4. Plot Volatility vs Return

We get output as –

Risk Metrics Summary:				
	Mean Weekly Return	Weekly Volatility	Annualized Return	\
Yes Bank	-0.000475	0.091095	-0.024715	
Tata Motors	0.004088	0.061976	0.212571	
DLF Limited	0.006540	0.057796	0.340099	
Bharti Airtel	0.004029	0.039073	0.209511	
ITC Limited	0.002281	0.036127	0.118629	

	Annualized Volatility
Yes Bank	0.656895
Tata Motors	0.446915
DLF Limited	0.416772
Bharti Airtel	0.281760
ITC Limited	0.260514

TABLE 5 – RISK METRICS SUMMARY

- **Highest Annualized Return for DLF Limited:** DLF Limited exhibits the highest annualized return (0.3401 or 34.01%), indicating it has been the most profitable stock on an annualized basis over the period.
- **Highest Volatility for Yes Bank:** Yes Bank displays the highest weekly volatility (0.0911) and consequently the highest annualized volatility (0.6569 or 65.69%), signifying the greatest price fluctuations and thus the highest risk among the analyzed stocks.
- **Negative Mean Weekly and Annualized Return for Yes Bank:** Yes Bank has a negative mean weekly return (-0.000475) and a negative annualized return (-0.0247 or -2.47%), confirming its poor performance and loss of value over the period.

- **Lower Volatility for ITC Limited and Bharti Airtel:** ITC Limited and Bharti Airtel show the lowest weekly and annualized volatilities, suggesting they have been relatively less risky compared to the other stocks.
- **Higher Risk-Adjusted Returns Potential for DLF and Bharti Airtel:** While DLF Limited has the highest return, Bharti Airtel also shows a strong annualized return (0.2095) with considerably lower volatility (0.2818), suggesting a potentially better risk-adjusted return compared to DLF.
- **Tata Motors Offers Moderate Return with Moderate Risk:** Tata Motors presents a moderate annualized return (0.2126) with a moderate level of annualized volatility (0.4469), positioning it between the higher-risk/higher-return profile of DLF and the lower-risk/lower-return profile of ITC Limited and Bharti Airtel.

### Plot Annualized Volatility vs Annualized Return

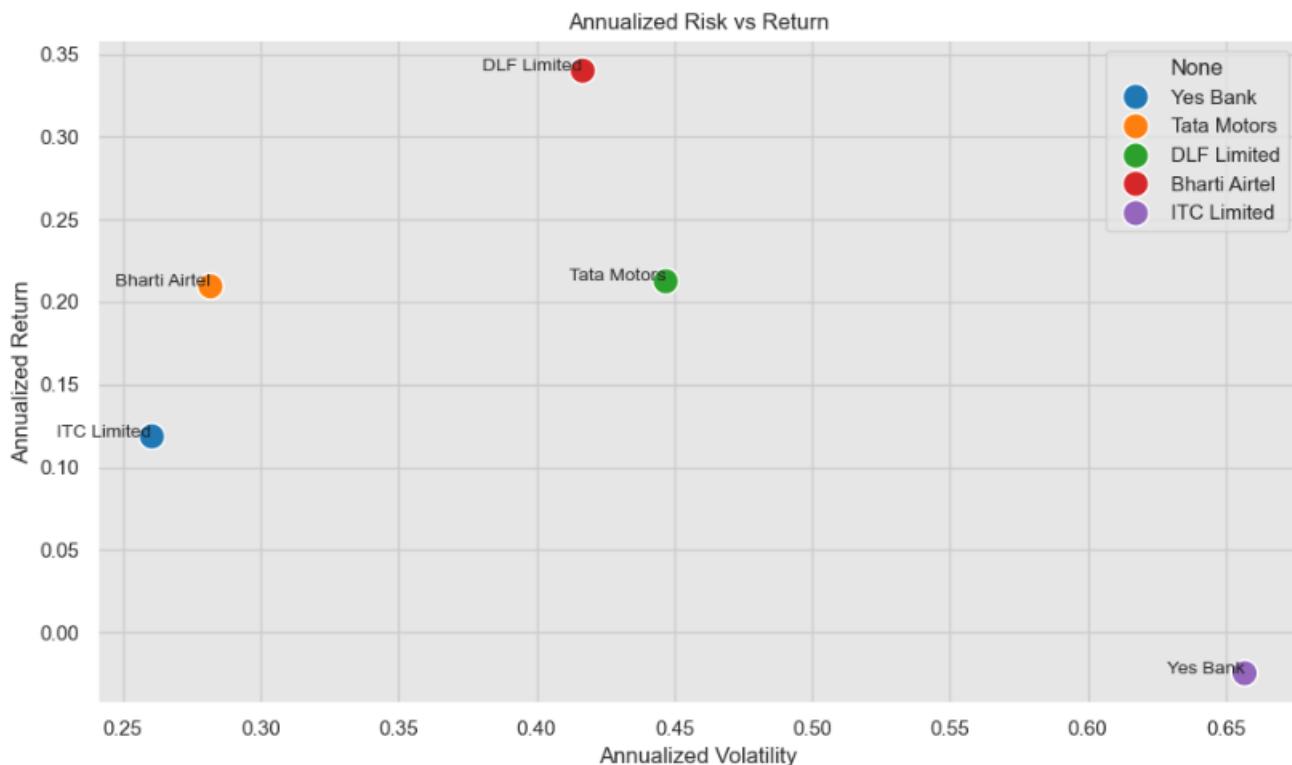


FIGURE 7 - ANNUALIZED VOLATILITY VS ANNUALIZED RETURN

- **DLF Limited Exhibits Highest Return and Moderate Risk:** DLF Limited is positioned at the highest point on the y-axis (Annualized Return) and has a moderate level of Annualized Volatility, indicating strong performance with a manageable level of risk.
- **Yes Bank Shows Lowest Return and Highest Risk:** Yes Bank is located at the lowest point on the y-axis (negative Annualized Return) and the furthest to the right on the x-axis (highest Annualized Volatility), highlighting its poor performance and high risk.
- **Bharti Airtel Offers Competitive Return with Lower Risk:** Bharti Airtel provides a relatively high Annualized Return with a lower Annualized Volatility compared to Tata Motors and DLF Limited, suggesting a potentially better risk-adjusted return.
- **ITC Limited Demonstrates Lowest Risk with Moderate Return:** ITC Limited is situated at the lowest point on the x-axis (lowest Annualized Volatility) but also has a lower Annualized Return compared to Bharti Airtel and DLF Limited, indicating a lower-risk, lower-reward profile.
- **Tata Motors Offers Moderate Risk and Return:** Tata Motors lies in the mid-range for both Annualized Volatility and Annualized Return, indicating a moderate risk-reward trade-off.
- **Clear Separation of Risk-Return Profiles:** The scatter plot clearly separates the stocks based on their annualized risk and return characteristics, allowing for a visual comparison of their investment profiles. DLF Limited stands out for high return, Yes Bank for high risk and low return, and ITC Limited for low risk.

Now, we'll compute Mean and Std Variation, please refer code -

1. Calculates **weekly returns**
2. Computes **mean** and **standard deviation** of returns for each stock
3. Prints them in a nicely formatted table
4. Plots **Mean vs Standard Deviation** for easy visual analysis

Plot Mean return vs Standard deviation Plot.

Mean and Standard Deviation of Weekly Returns:

	Mean Weekly Return	Standard Deviation
Yes Bank	-0.000475	0.091095
Tata Motors	0.004088	0.061976
DLF Limited	0.006540	0.057796
Bharti Airtel	0.004029	0.039073
ITC Limited	0.002281	0.036127

Mean Weekly Return vs Standard Deviation (Risk)

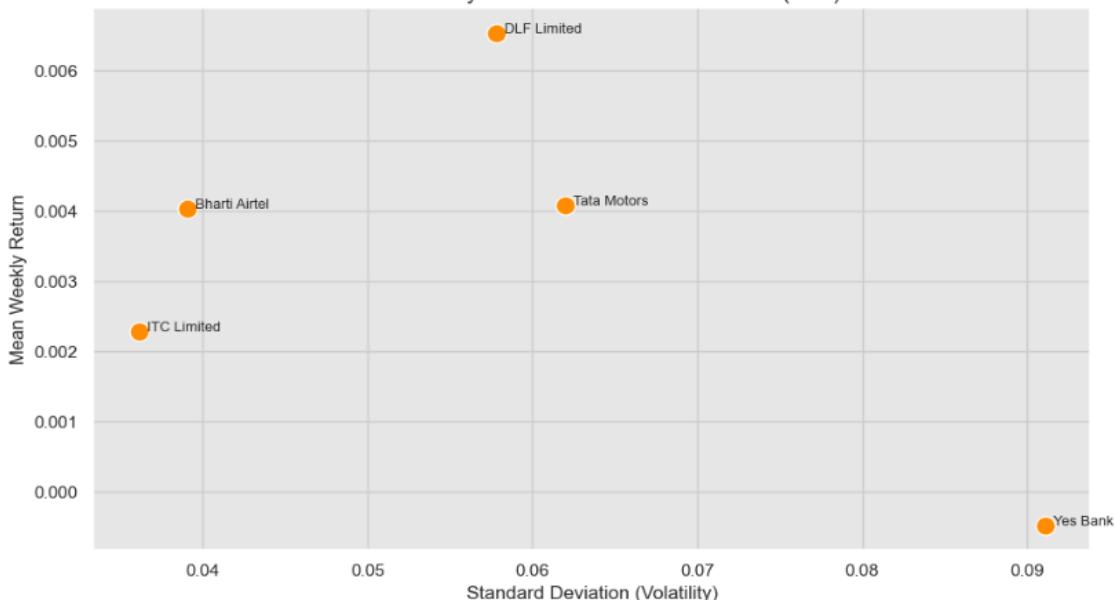


FIGURE 8 - MEAN VS STD DEVIATION PLOT

- **DLF Limited Offers Highest Mean Weekly Return:** DLF Limited has the highest value on the y-axis (Mean Weekly Return), indicating the highest average weekly profit among the analyzed stocks.
- **Yes Bank Exhibits Highest Weekly Risk:** Yes Bank is positioned furthest to the right on the x-axis (Standard Deviation), signifying the highest volatility and thus the highest weekly risk.
- **Inverse Relationship Indicated for Yes Bank:** Yes Bank combines the highest risk with a negative mean weekly return, making it an outlier with an unfavorable risk-return profile.
- **Bharti Airtel Offers Competitive Return with Lower Risk:** Bharti Airtel provides a relatively high mean weekly return compared to ITC Limited and Tata Motors, while having a lower standard deviation (risk) than Tata Motors and Yes Bank.
- **ITC Limited Shows Lowest Risk but Also Lower Return:** ITC Limited has the lowest standard deviation (lowest weekly risk) but also the lowest positive mean weekly return among the profitable stocks.
- **Risk-Return Trade-off Visualization:** The plot effectively visualizes the risk-return trade-off for each stock. Generally, higher potential returns come with higher associated risk (volatility), although Yes Bank deviates significantly from this trend.

## Risk/Return Zones Plot –

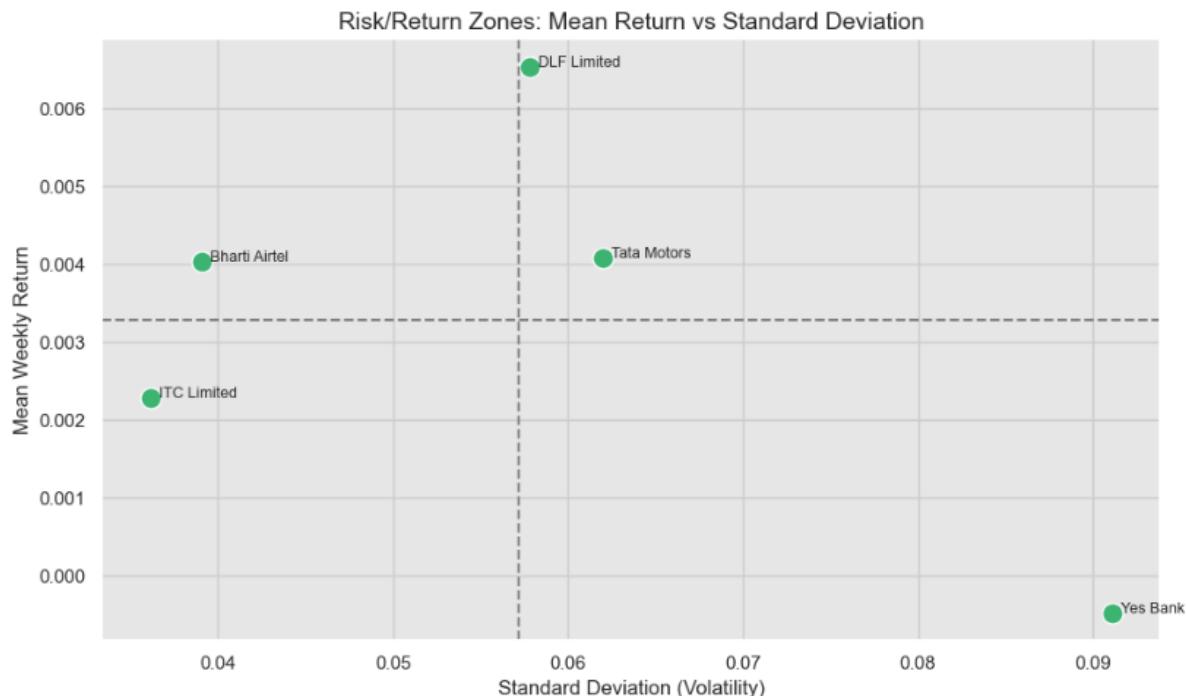


FIGURE 9 - RISK/RETURN ZONES PLOT

- The **top-left** is your sweet spot: **high return, low risk**
- The **bottom-right** is where you should be cautious
- **Risk/Return Landscape Defined by Quadrants:** The chart's dashed lines likely demarcate average weekly return and volatility, creating four areas that categorize each stock's risk-reward profile.
- **DLF: Appealing High-Return, Mid-Range Risk:** DLF Limited appears in the upper-middle to upper-right, suggesting it offers better-than-average weekly gains but with a somewhat elevated level of price swings.
- **Yes Bank: High Risk, Disappointing Returns:** Situated in the lower-right, Yes Bank exhibits the most volatility while delivering below-average (potentially negative) weekly returns.
- **Bharti Airtel & Tata Motors: Balanced Risk-Reward:** Located in the upper-left to center, Bharti Airtel and Tata Motors present a middle ground of moderate weekly gains coupled with moderate to lower-than-average price fluctuations.
- **ITC: Low-Key Gains, Low Volatility:** ITC Limited occupies the lower-left, indicating it provides more modest weekly returns but with the least amount of price volatility among the profitable stocks.
- **Portfolio Strategy Implications:** This visual breakdown is key for tailoring investment portfolios to individual risk tolerances and return goals. For example, someone prioritizing

stability might favor ITC Limited, whereas someone comfortable with more risk might consider DLF Limited for its higher potential gains.

### Sharpe Ratio Calculation –

$$\text{Sharpe Ratio} = \frac{\text{Mean Return} - \text{Risk-Free Rate}}{\text{Standard Deviation}}$$

#### Sharpe Ratios:

	Mean Return	Standard Deviation	Sharpe Ratio
DLF Limited	0.006548	0.057796	0.026652
Tata Motors	0.004088	0.061976	-0.014717
Bharti Airtel	0.004029	0.039073	-0.024849
Yes Bank	-0.000475	0.091095	-0.060105
ITC Limited	0.002281	0.036127	-0.075254

Table 6 – Sharpe Ratios

- **DLF: Positive Risk-Adjusted Return:** DLF Limited's positive Sharpe Ratio (0.0267) suggests favorable returns relative to its risk.
- **Others: Negative Risk-Adjusted Returns:** Tata Motors, Bharti Airtel, Yes Bank, and ITC Limited show negative Sharpe Ratios, indicating returns didn't justify the risk.
- **Yes Bank: Worst Risk-Adjusted Performance:** Yes Bank's most negative Sharpe Ratio (-0.0601) reflects poor returns for its high volatility.
- **ITC: Least Bad Among Negatives:** ITC Limited's less negative Sharpe Ratio (-0.0753) indicates the least severe underperformance relative to its risk among the negative group.
- **Negative Sharpe Implies Undercompensation for Risk:** Generally, negative Sharpe Ratios point to returns that don't adequately reward the level of risk taken.
- **DLF Outperforms on Risk-Adjusted Basis:** DLF Limited is the only stock where returns compensated for the risk, unlike the others.

## Portfolio Simulation / Optimization (Monte Carlo)

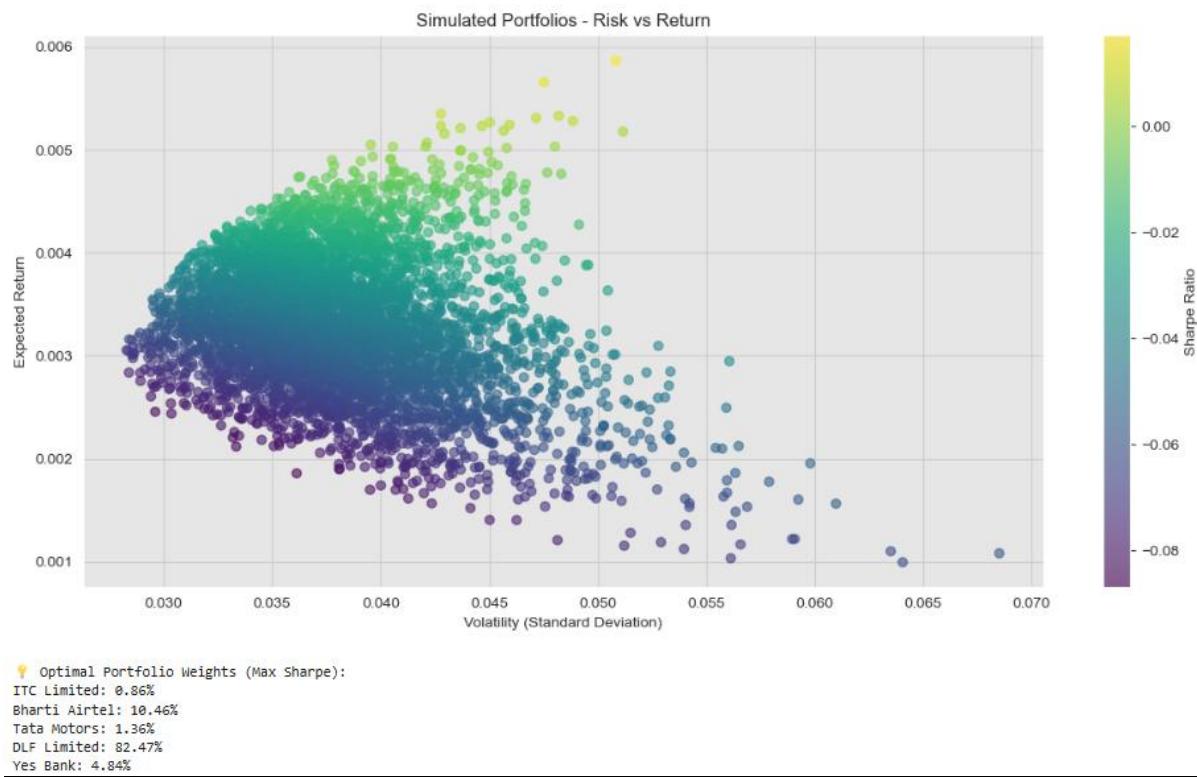


FIGURE 10 - PORTFOLIO SIMULATION

- **Efficient Frontier Visualization:** The scatter of points represents numerous simulated portfolio allocations with varying combinations of the five stocks, illustrating the spectrum of potential risk and expected return outcomes. The portfolios generally curve upwards and to the left, hinting at an "efficient frontier" where, for a given level of risk, the highest possible return is achieved.
- **Color Gradient Represents Sharpe Ratio:** The color of each point corresponds to its Sharpe Ratio, as indicated by the color bar. Yellowish or lighter points represent portfolios with higher (less negative, in this case) Sharpe Ratios, suggesting better risk-adjusted performance relative to the darker purple points with more negative Sharpe Ratios.
- **Sub-Optimal Sharpe Ratios Predominate:** The prevalence of darker purple hues across the majority of the simulated portfolios suggests that most random allocations result in negative Sharpe Ratios, echoing the earlier single-stock analysis where only DLF Limited had a positive ratio (though the color scale here doesn't explicitly show positive values).
- **Lower Volatility Portfolios Tend Towards Better Sharpe Ratios:** There's a general trend of lighter (better Sharpe Ratio) points being concentrated towards the left side of the plot,

indicating that portfolios with lower volatility (standard deviation) tend to have less negative, and thus relatively better, risk-adjusted returns within this simulation.

- **Identified Optimal Portfolio:** The star icon points to a specific portfolio allocation identified as having the maximum Sharpe Ratio within this simulation. Its listed weights for each stock (ITC: 0.86%, Bharti Airtel: 10.46%, Tata Motors: 1.36%, DLF: 82.47%, Yes Bank: 4.84%) represent the combination of holdings that theoretically offers the best risk-adjusted return based on the historical data used for the simulation.
- **Dominant Weighting Towards DLF Limited:** The optimal portfolio heavily favors DLF Limited (82.47%), which aligns with its positive Sharpe Ratio observed earlier, suggesting its strong performance and moderate risk make it a key component for maximizing risk-adjusted returns in this simulated portfolio.

### **Value at Risk (VaR) Estimation –**

VaR estimates the maximum loss (with a certain confidence) over a period.

Let's calculate 1-week VaR at 95% confidence using Historical Method using sample initial investment – 1 Lakh rupees.

**Value at Risk (1-week, 95% confidence): ₹8,108.35 (Please refer code)**

### **RSI (Relative Strength Index) for each stock –**

We'll:

1. Define a function to calculate RSI
2. Apply it to all stock columns
3. Store and print the latest RSI values for each stock
4. Optionally, plot RSI for each stock

 Latest RSI Values (last available date):

Date	RSI
ITC Limited	38.983051
Bharti Airtel	86.404834
Tata Motors	74.074074
DLF Limited	68.222222
Yes Bank	54.545455

Table 7 – RSI Indicators

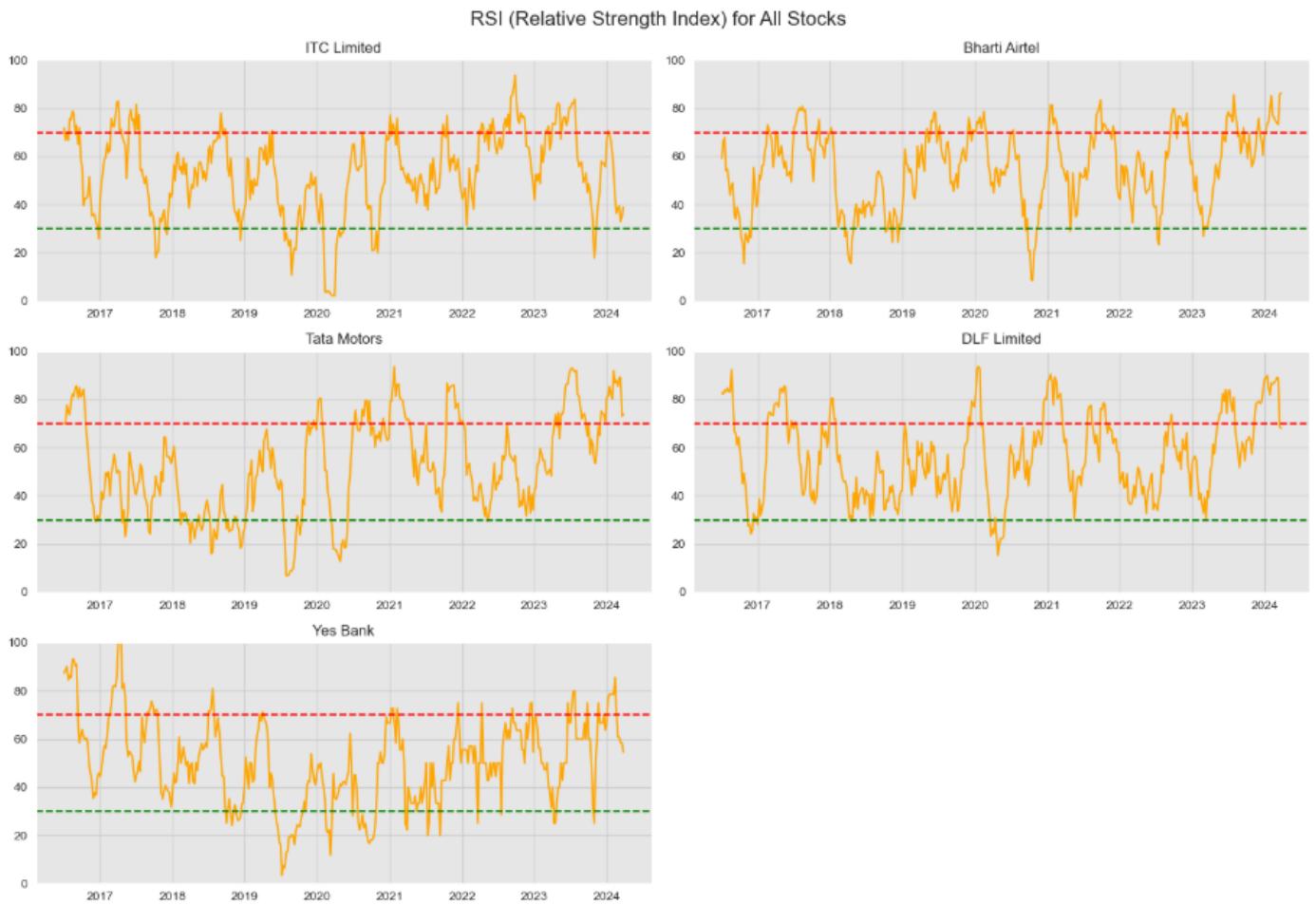


FIGURE 11 - RSI INDICATORS FOR EACH STOCK

- Oscillation Between Overbought and Oversold Levels: All five stocks show RSI values oscillating between the commonly used overbought (above 70, marked by the red dashed line) and oversold (below 30, marked by the green dashed line) levels over the analyzed period.
- Prolonged Periods in Neutral Territory: For most stocks, a significant portion of the RSI values remains within the neutral zone (between 30 and 70), indicating periods of neither strong buying nor selling pressure.
- Bharti Airtel Shows Frequent Overbought Conditions: Bharti Airtel's RSI appears to frequently reach or exceed the overbought threshold, particularly in the later part of the period, suggesting periods of strong upward momentum that may precede price corrections.
- Yes Bank's RSI Reflects Price Weakness: Yes Bank's RSI spends a considerable amount of time at or below the oversold level, especially after its significant price decline around 2019, indicating sustained selling pressure and weak momentum.

- Divergences Not Immediately Apparent: A quick visual scan doesn't reveal any obvious strong or prolonged RSI divergences (where the RSI moves in the opposite direction of the price), which could signal potential trend reversals, but a more detailed analysis would be needed to confirm this.
- Varying Volatility of RSI: The "choppiness" or frequency of swings in the RSI varies across the stocks, potentially reflecting the underlying price volatility of each individual stock. For instance, Yes Bank's RSI appears more volatile in its decline phase compared to the more gradual movements in ITC Limited's RSI.

### **Portfolio Performance Monitoring –**

- Track cumulative portfolio returns over time
- Monitor rolling Sharpe Ratio to assess risk-adjusted performance
- Allow room for adjustment strategies when risk/return profile shifts

We'll use:

- Weekly stock prices from your dataset
- Optimal weights (from earlier portfolio simulation)
- Visualizations for monitoring performance

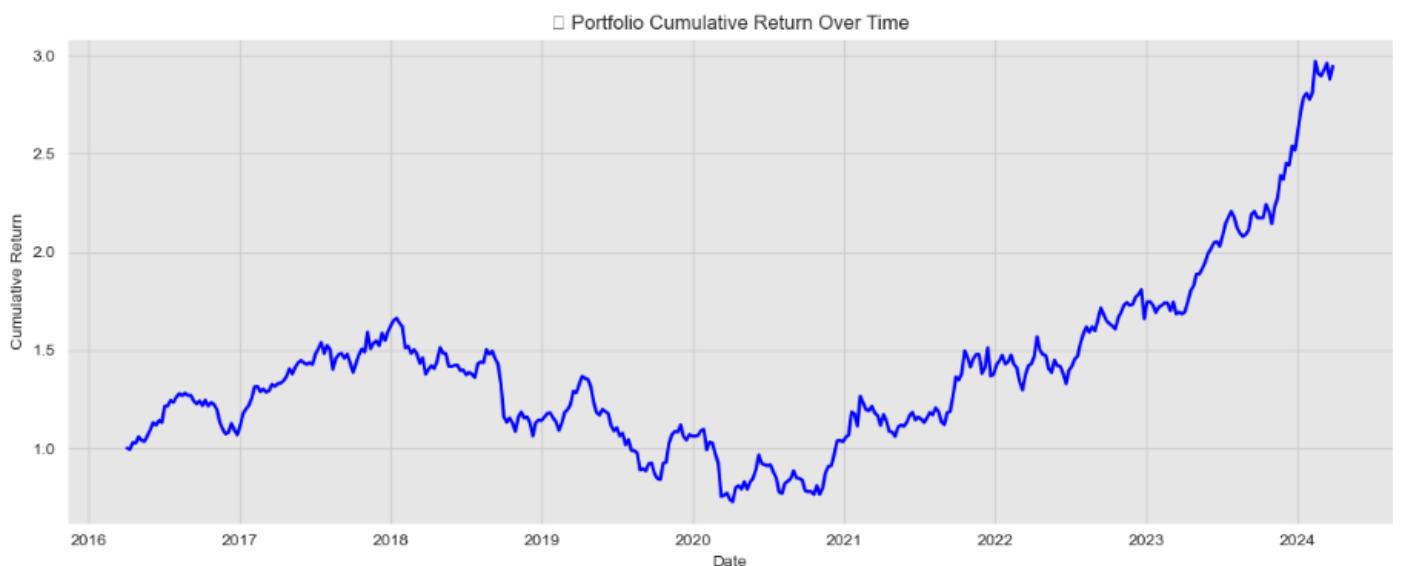


FIGURE 12 - CUMULATIVE PORTFOLIO RETURNS OVER TIME

## Portfolio Cumulative Return Analysis (2016–2024)

### ➤ Performance Highlights:

- 2016–2018:
  - Steady growth
  - Indicates stable market conditions and solid stock selection
- 2018–2020:
  - Increased volatility
  - Sharp drawdown in early 2020 likely due to COVID-19 impact
  - Portfolio dipped below previous highs
- 2020–2021:
  - Recovery phase followed by sideways movement
  - Possible reasons:
    - Rebalancing
    - Underperformance of some assets
- 2022–2024:
  - Strong and consistent uptrend
  - Portfolio tripled in value
  - Indicates strong bull market or high-performing stocks in allocation

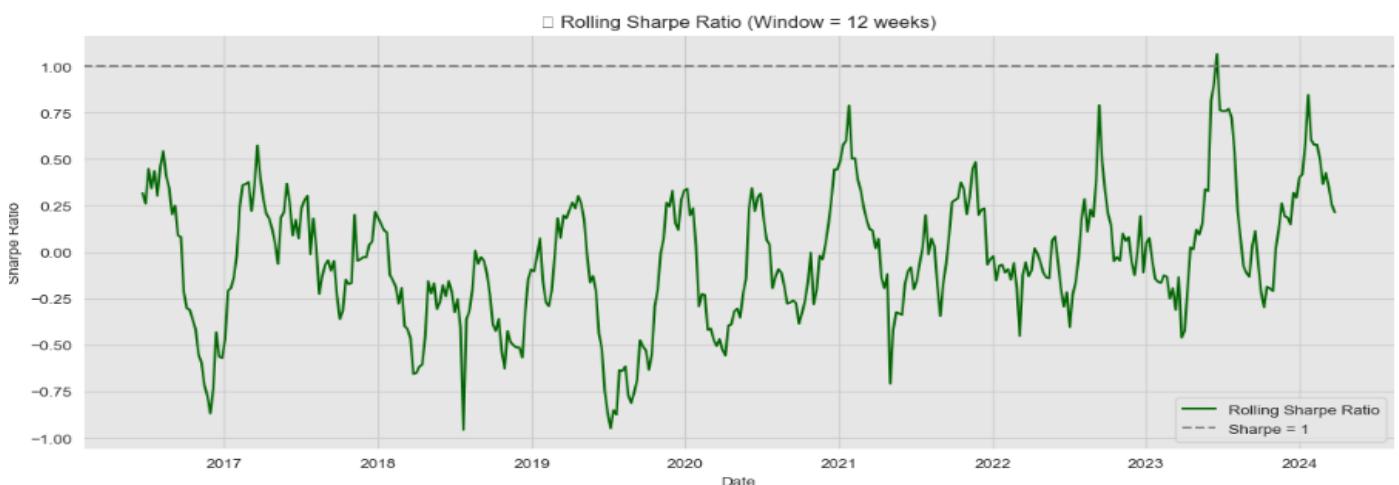


FIGURE 13 - ROLLING SHARPE RATIO

## Rolling Sharpe Ratio Analysis (2016–2024)

### General Observations:

- The Sharpe Ratio frequently fluctuates between **-1.0 and +0.75**, indicating **high volatility in risk-adjusted returns**.
- The portfolio **rarely exceeds** the benchmark Sharpe Ratio of **1.0**, which represents strong risk-adjusted performance.

### Period-wise Breakdown:

- **2016–2018:**
  - Frequent **short-lived spikes above 0.3–0.5**
  - Indicates **moderate risk-adjusted gains**, but quickly followed by declines
- **2019–2020:**
  - Increased **negative Sharpe Ratio periods**
  - Signals **poor performance relative to volatility**, likely due to **market uncertainty** before and during early COVID-19
- **2021–2022:**
  - More **consistent moderate positive Sharpe values (0.25–0.5)**
  - Reflects **stable improvement** in performance vs risk
- **2023–2024:**
  - Several **sharp spikes above 0.75**, with one nearly hitting **1.0**
  - Represents **strongest period of risk-adjusted returns** in the entire timeframe

# Insights and Recommendations -

## Key Insights:

- Performance Variation:
  - Stocks exhibit diverse growth patterns (Bharti Airtel/DLF: high returns; Yes Bank: significant loss; ITC: steady).
  - DLF Limited shows the highest returns but with increased volatility; Yes Bank has high risk and negative returns.
- Risk-Return Spectrum:
  - DLF offers the highest returns but is volatile; Yes Bank is the riskiest with negative returns; ITC is stable with moderate returns.
  - Bharti Airtel and Tata Motors offer a balanced mix of growth and risk.
- Correlation:
  - Pairwise correlations of weekly returns are low to moderate, suggesting diversification benefits.
  - Strong correlation between DLF and Bharti Airtel, indicating limited diversification if combined.
- Sharpe Ratio:
  - DLF is the only stock with a positive Sharpe Ratio, signaling favorable risk-adjusted returns. The others underperform.
- Portfolio Optimization:
  - Simulated portfolios favor DLF due to its high Sharpe Ratio and risk-adjusted performance.
- RSI (Relative Strength Index):
  - RSI shows cyclical overbought and oversold conditions, indicating short-term trading opportunities but no clear long-term signals.

## **Recommendations:**

- DLF Limited:
  - Prioritize for Growth: DLF shows strong returns and favorable risk-adjusted performance but requires careful volatility management.
  - Optimize Portfolio: Incorporate DLF in portfolios optimized for the Sharpe Ratio to enhance risk-adjusted returns.
- Yes Bank:
  - Avoid/Minimize: Due to its negative returns and high risk, Yes Bank should be approached with caution or potentially excluded unless a strong turnaround is expected.
- Bharti Airtel:
  - Balanced Growth: A solid option for investors seeking a good balance of growth and lower risk than DLF.
- ITC Limited:
  - Low-Risk Exposure: Ideal for conservative investors seeking stability, with moderate returns but low volatility.
- Diversification:
  - Strategically Diversify: Use low correlation between Yes Bank and others for portfolio diversification, but be mindful of the strong correlation between DLF and Bharti Airtel.
- RSI for Timing:
  - Use for Tactical Adjustments: Employ RSI to monitor short-term momentum for entry/exit points but don't rely on it alone.
- Continuous Monitoring & Rebalancing:
  - Adjust Regularly: Regularly review and rebalance the portfolio to adapt to market shifts and optimize risk-return performance.

By implementing these insights and recommendations, we can make informed decisions for managing and optimizing your stock portfolio, balancing risk with potential returns.