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# Financial Market Risk & Return

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Table of Contents:

- Title
- Table of Contents
- Files
- Deliverables, Project Goals, Tools, and Libraries
- Project Summary, Key Findings, and Future of Project
- Documentation

8/13/2025

Files:

- CSV Files:
  - market\_data.csv
    - Historical daily open, close, high, low, and volume data for selected assets from Jan 1, 2015, to Jan 1, 2025.
  - market\_open\_data.csv
    - Asset open price data across the same date range.
  - market\_close\_data.csv
    - Asset close price data across the same date range.
  - asset\_metrics.csv
    - Asset-level performance metrics (Annualized Return, Volatility, Sharpe Ratio, Max Drawdown, Beta).
  - asset\_metrics\_clean.csv
    - Cleaned version for Tableau visualization compatibility.
  - market\_prices\_long\_clean.csv
    - Reformatted long-form market price dataset for Tableau integration.
  - portfolio\_efficient\_frontier.csv
    - Coordinates for points on the Efficient Frontier.
  - portfolio\_optimal\_weights.csv
    - Optimized weight allocations for different portfolio strategies (Max Sharpe, Min Variance).
  - portfolio\_summary.csv
    - Summary of optimized portfolios including returns, volatility, and Sharpe Ratio.
  - portfolio\_efficient\_frontier\_long\_clean.csv
    - Cleaned version for Tableau visualization compatibility.
  - portfolio\_optimal\_weights\_long\_clean.csv
    - Cleaned version for Tableau visualization compatibility.
  - portfolio\_summary\_clean.csv
    - Cleaned version for Tableau visualization compatibility.
- JupyterLab File:
  - FinancialMarketRiskReturnDataManipulation.ipynb
- Tableau Workbook File:
  - Financial Market Risk & Return.twb
- Images:
  - 30-Day Rolling Annualized Volatility — Equal-Weight.png
  - correlation\_heatmap.png
  - cumulative\_returns.png
  - efficient\_frontier.png

8/10/2025

Deliverables:

- Collect Data
- Understand Data
- Answer Analytical Questions
- Create Dashboard

Project Goals:

- Analyze historical market data to understand the effect of market risk and return.
- Calculate Key Performance Indicators (KPIs).
- Visualize KPIs.
- Create investment portfolios through modern portfolio theory, including an Efficient Frontier and optimal weights.
- Create interactive dashboards in Tableau to allow end-users to explore asset performance, portfolio allocation, and risk-return.

Tools:

Jupyter, Tableau

Libraries:

Pandas, NumPy, Matplotlib, Seaborn, yfinance

8/13/2025

### Project Summary:

This project analyzes the risk and return profile of select financial assets over a ten year period (2015 - 2025) through quantitative finance metrics and portfolio optimization methods. Data was collected using finance for popular stocks (AAPL, MSFT, and GOOG), index funds (DIA and SPY), and cryptocurrencies (BTC-USD and ETH-USD).

The analysis included calculating annualized returns, volatility, Sharpe ratios, beta, and maximum drawdowns, and constructing efficient frontiers through Monte Carlo simulations and optimization algorithms.

Results were visualized in interactive Tableau dashboards, which allows users to:

- Compare assets risk vs return.
- Explore efficient frontier portfolios.
- Observe allocation weights for different strategies.
- Track cumulative performance and drawdowns over time.

### Key Findings:

- Risk and Return Tradeoff:
  - Cryptocurrencies had a significantly higher volatility and returns compared to stocks and index funds.
- Portfolio Diversification:
  - Portfolios that had a combination of stocks, index funds, and cryptocurrencies had a higher Sharpe ratios than single asset investments.
- Efficient Frontier Insights:
  - The tangency portfolio (Max Sharpe) consistently favored a balanced mix of stocks and index funds with minimal cryptocurrency exposure for optimal risk-adjusted performance.
- Drawdown Behavior:
  - Index funds had lower drawdowns than stocks and cryptocurrencies during market downturns, which showcases the stability of index funds.
- Beta Trends:
  - Beta analysis showed that cryptocurrencies behaved independently of the stock and index fund markets, which shows the potential of diversification benefits.

### Future of project:

- Expand Assets:
  - Incorporation of additional assets such as commodities, bonds, and ETFs can broaden the scope of portfolio diversification analysis.
- Dynamic Risk-Free Rate:
  - Enabling automatic updates of the risk-free rate based on the current U.S. Treasury bill.
- Real-Time Data Integration:
  - Make the data collection pipeline more efficient by integrating real-time market data. This will in turn make dashboards as a real-time monitoring tool.

- Advanced Optimizations:
  - Explore more advanced optimization techniques such as Black-Litterman models.
- Machine Learning:
  - Use predictive modeling to forecast behaviors of assets, and integrate them in the portfolio optimization process.
- Enhanced User Experience:
  - Add more interactive filters, tooltips, and dashboards to make the dashboards more accessible to users of any financial literacy.

Documentation:

Use “python -m jupyterlab” to access jupyter lab through cmd

8/10/2025: JupyterLabs notebook

- Used JupyterLab to create market\_data.csv
- Chose AAPL, MSFT, GOOG, DIA, SPY, BTC-USD, ETH-USD for my data
  - These were chosen because they are popular companies, index funds, and crypto currencies
- Chose data range between January 1st, 2015 to January 1st 2025 to get ten years of historical data
- Created three files for data:
  - market\_data.csv
  - market\_open\_data.csv
  - market\_close\_data.csv
- Created functions to calculate:
  - Annualized returns
  - Annualized volatility
  - Sharpe ratio
  - Max Drawdown
  - Beta
- Computed asset-level metrics and put it into a csv file
- Created an Efficient Frontier + Max-Sharpe
  - Created functions for:
    - Computing return, volatility, and Sharpe using weights
    - Displaying large allocations
  - Created optimization helper functions:
    - Maximizing Sharpe
    - Minimizing portfolio variance
  - Created Efficient Frontier
- Ran optimizations
- Summarized
  - Made csv files
    - portfolio\_efficient\_frontier.csv
    - portfolio\_optimal\_weights.csv
    - portfolio\_summary.csv
- Created visuals
  - Made a Monte Carlo scatter plot

8/10/2025: Continued in JupyterLabs notebook

- Created beta calculations
  - Functions:
    - Computing beta for single stock
    - Computing beta for all stocks
    - Computing rolling beta for single stock

- Created asset return correlation heatmap
- Created cumulative return graph
- Created a rolling annualized volatility graph

8/10/2025: Used ChatGPT to make long and clean files

- Long and clean files made through ChatGPT:
  - market\_prices\_long\_clean.csv
  - asset\_metrics\_clean.csv
  - portfolio\_efficient\_frontier\_long\_clean.csv
  - portfolio\_optimal\_weights\_long\_clean.csv
  - portfolio\_summary\_clean.csv

8/11/2025: Used Tableau to create worksheets, parameters, and calculations

- Created Risk vs Returns scatter plot
  - Takes Annualized Return and Annualized Volatility and plots them for each asset
- Created Efficient Frontier scatter plot
  - Takes Target Return and Volatility to plot the Efficient Frontier
- Created Allocation of weight bar graph
  - Calculates the weight allocation of a selected portfolio.
- Created Parameters
  - Date Granularity
  - Portfolio Source
  - Risk-Free Rate (%)
  - Selected Portfolio ID
  - Trading Days/Year
- Created Calculations
  - Annualized Return (from daily)
  - Annualized Volatility (from daily)
  - Cumulative Index
  - Cumulative Return
  - Daily Return
  - Drawdown
  - Log Return
  - Max Drawdown (window)
  - Param Echo - for debugging
  - Portfolio Cumulative Index (Selected)
  - Portfolio Drawdown (Selected)
  - Portfolio Log Return (Selected)
  - Running Peak
  - Sel Return
  - Sel Sharpe
  - Sel Volatility
  - Sharpe (calc)
  - Weighted Log Return



- Weight (Selected)
- Is Selected Portfolio (on portfolio\_efficient\_frontier\_long)

8/12/2025: Continued using Tableau to create worksheets

- Created Cumulative Performance line graph
  - Takes Cumulative Index and Date to plot line graph
  - Filters by Ticker and Date
- Created Portfolio Performance line graph
  - Takes Portfolio Cumulative Index and Date to plot line graph
  - Is computed through WINDOW\_MAX and RUNNING\_MAX to show accumulation over time
- Created Portfolio Drawdown area graph
  - Takes Portfolio Drawdown and Date to plot area graph
- Created Sel Return
- Created Sel Volatility
- Created Sel Sharpe
- Created Drawdown area graph
  - Takes Drawdown and Date to plot area graph
- Created Weights bar graph
  - Calculates weight using Minimum Variance, Tangency (Max Sharpe), or both
- Created KPI Return
- Created KPI Volatility
- Created KPI Sharpe

8/12/2025: Used Tableau to create dashboard

- Overview dashboard
  - Shows Cumulative Performance and Risk vs Return graphs
  - Allows users to change tickers and years to show on Cumulative Performance graph.
- Portfolio Explorer dashboard
  - Shows Efficient Frontier, Allocation, Portfolio Performance, Portfolio Drawdown, Sel Volatility, Sel Return, and Sel Sharpe
  - Portfolio can be changed either by clicking a portfolio on the Efficient Frontier graph or by manually typing it in the Selected Portfolio ID box.
- Curated Portfolio dashboard
  - Shows Weights, KPI Volatility, KPI Return, and KPI Sharpe
  - Display of dashboard can be changed by selecting Minimum Variance, Tangency (Max Sharpe), or both