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CAPM Web Application for Financial Analysis

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***Abstract*— This paper introduces an innovative web application leveraging the Capital Asset Pricing Model (CAPM) to revolutionize financial analysis. As a cornerstone of modern financial theory, CAPM offers a systematic framework for managing portfolio risk and predicting expected returns. In addition to harnessing CAPM principles, the presented web application integrates advanced functionalities tailored to the intricate demands of academics, analysts, and financial researchers. This research endeavor unveils a cutting-edge web application that harnesses the power of CAPM for exhaustive financial analysis and portfolio optimization. Developed with Plotly and Streamlit, the application provides users with an intuitive and immersive platform to assess the performance of individual stocks about the S&P 500 index. Central to its functionality is the capability to explore historical stock data, unveiling temporal trends and correlations, facilitated by seamless data retrieval and visualization. Furthermore, the application facilitates equitable performance evaluations by standardizing stock prices, thereby offering a uniform scale for evaluating asset volatility and growth. This tool represents a significant leap forward in financial analysis, empowering users with more strategic investment insights and fostering a profound comprehension of market dynamics by seamlessly integrating traditional financial models with state-of-the-art web technologies. Through the utilization of the online application and CAPM, the study endeavors to prognosticate Return on Investment (ROI) and Risk of Investment (Beta) for various equities linked to the S&P 500, thereby facilitating informed decision-making and optimized portfolio management.**

***Index Terms*— CAPM, capital asset pricing model, expected return, risk-free rate, beta, S&P 500, investment, stocks**

I. INTRODUCTION

A financial model known as the Capital Asset Pricing Model (CAPM) provides a theoretical framework for estimating an investment's expected return while taking the risk of the investment into account relative to the market as a whole. Early in the 1960s, William Sharpe, John Lintner, and Jan Mossin developed the Capital Asset Pricing Model (CAPM), a mainstay of contemporary portfolio theory and used extensively in finance to value riskier securities and calculate the cost of capital. The Capital Asset Pricing Model (CAPM) is predicated on a specific type of utility function, wherein risk is quantified by variance and only the first and second moments are taken into account. An alternative approach would be to use asset returns, whose probability distributions are entirely explained by the first two moments (e.g., the normal distribution), and zero transaction costs, which are essential for diversification to eliminate all idiosyncratic risk. In these circumstances, the CAPM demonstrates that beta alone determines the cost of equity capital. The CAPM is still widely used because of its versatility and ease

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of use in a range of scenarios, even though it has failed multiple empirical tests and more contemporary methods of asset pricing and portfolio selection (like arbitrage pricing theory and Merton's portfolio problem) have been developed.

By building on Harry Markowitz's earlier work on diversification and modern portfolio theory, Jack Treynor (1961, 1962), William F. Sharpe (1964), John Lintner (1965), and Jan Mossin (1966) independently introduced the CAPM. For their combined contributions to the field of financial economics, Sharpe, Markowitz, and Merton Miller were awarded the 1990 Nobel Memorial Prize in Economics. Another version of CAPM, known as Black CAPM or zero-beta CAPM, was created by Fischer Black in 1972 and does not assume that there is a riskless asset. This version was more resilient to empirical testing and played a significant role in the CAPM's widespread adoption

A. Study Objective

The goal of this work is to predict and distinguish the Return on Investment (ROI) and Risk of Investment (Beta) of different stocks concerning the S&P 500.This was achieved through the web application and Capital Asset Pricing Model which was built by using Python and streamlit.

II. Literature Review

A. Capital Asset Pricing Model

The CAPM serves as a fundamental model that directs the process of determining share price by means of the careful balancing act between risk and return [1]. Its ability to adapt to shifting market conditions is still impressive. Despite the allure of real estate investments in the modern day, the study maintains the applicability of CAPM in real estate investment appraisal. The focus of recommendations is on improving return estimates through model improvement. For determining a company's cost of equity, financial advisors and practitioners still favor the Capital Asset Pricing Model (CAPM). Surveys by Brunner et al. (1998) and Graham and Harvey (2001) clearly show this preference. The tenets of the Capital Asset Pricing Model (CAPM) state that when an investor adds a particular asset to a diversified equities portfolio, the additional risk they incur should be sufficiently offset by the expected return they seek. The underlying idea of the concept is that investors look for a firm-specific premium for owning stock in a company, and that premium is closely correlated with the degree to which the security changes the entire equity portfolio's risk profile [4].

B. Beta as a measure of risk

A key idea in the Capital Asset Pricing Model (CAPM) is beta, which measures non-diversifiable risk by expressing how much a share's returns move in tandem with market fluctuations. With time, beta has gained popularity as a risk indicator in the investing world, helping investors and managers evaluate and control portfolio risk [1]. Beta is a significant factor in assessing an asset's or portfolio's past performance in comparison to a selected market benchmark, which is frequently the S&P 500 index for equities. An asset or portfolio may be more volatile than the benchmark if its beta value is higher than 1.00, which denotes above-average "riskiness" or volatility. On the other hand, betas less than 1.00 signify volatility that is below average in relation to the benchmark. A fully diversified stock portfolio, for example, with a beta of 1.25 is likely to have more volatility and historically higher returns than the S&P 500. A portfolio with a beta of 0.80, on the other hand, is predicted to provide a 20% lower return over time than the market and show less upward movement in advantageous market conditions[2].

C. CAPM as a method to estimate the cost of equity in practice in South Africa

PwC's 2008 valuation methodology survey of 25 top financial analysts and corporate financiers revealed that investment practitioners prefer to use the CAPM when figuring out the cost of equity. A frequency table with a range of 0 to 3 was used in the 2008 PwC survey. A score of 0 meant the method is seldom or never used, a score of 1 meant it is often used, a score of 2 meant it is regularly used, and a score of 3 meant it is always used. According to the poll, the CAPM, which received a score of 3.00, is the most widely utilized technique for determining the cost of equity that is currently in use in practice. According to the PwC poll, the APT model (scoring 0.10) and other techniques (scoring 0.2) were the second and third-best solutions, respectively; nevertheless, as their frequency scores show, these differences are minor. [3]

III. Methodology

The CAPM is one model that can be used to price a single securities or portfolio. For each security, we show how

the request should price it with respect to its security threat class using the security request line(SML) and its link to methodical threat(beta) and projected return. The SML allows us to calculate any security's price-to-threat rate in relation to the request as a whole. Accordingly, when the projected rate of return for each security is deflated by its beta measure, the price-to-threat rate for each security in the request equals the request price-to-threat rate, as stated in [3]. Anticipated return = threat-free rate Beta * Equity threat decoration or, Ra = Rf βa(Rm- Rf), where Ra is the anticipated return on the asset Rf is the threat-free rate of return βa is the beta of the asset Rm is the anticipated return of the request The threat-free rate is the anticipated rate of return that an investor can anticipate to admit on an investment that carries no threat. This is frequently the yield on a government bond having an exceptionally long maturity. The beta value of an asset shows how erratic it is compared to the request as a whole. A beta of 1 means that an asset will move in pattern with the request; a beta of further than 1 means that it'll move more volatilely than the request; a beta of lower than 1 means that it'll move less volatilely than the request. This information determines the anticipated movement of an asset. request threat decoration A larger return on investment is anticipated when investing in the request as a whole as opposed to a threat-free asset. This decoration serves to alleviate the threat associated with sharing in the request, which is the possibility that the request would cheapen and affect losses for investors[7].

A. Data Collection and Preprocessing

This research paper's dataset serves as a vital basis for the meticulous implementation of the Capital Asset Pricing Model (CAPM) in the field of financial analysis. Included in this dataset are the historical stock prices of five stocks that users have carefully selected. These stocks include well-known symbols like 'TSLA,' 'AAPL,' 'NFLX,' 'MSFT,' 'MGM,' 'AMZN,' 'NVDA,' and 'GOOGL.' The selected stocks are used as the main focus for a thorough investigation and evaluation of the complex interactions between risk, return, and more general market dynamics. The method of gathering data entails using the flexible features of the Python yfinance library to retrieve precise and thorough historical stock prices from Yahoo Finance. Simultaneously, the S&P 500 index data—a crucial benchmark for the market's overall performance—is obtained via the Federal Reserve Economic Data (FRED) API, made possible by the pandas_datareader library. With the ability to choose a time period from one to fifteen years, users are given a great deal of flexibility in defining the temporal scope of their analysis. This temporal granularity makes it possible to examine in detail how financial metrics and market dynamics change over time. To prepare it for analysis, the dataset is carefully preprocessed. This entails normalizing values to guarantee a consistent and thorough analytical framework and harmonizing stock prices with the data from the S&P 500 index through a process of merging.

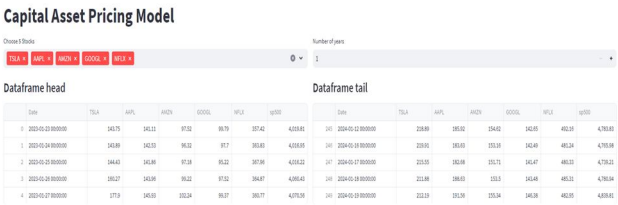
The dataset's primary variables have several facets, including

Date: This temporal dimension shows how the stock price data has changed over time and provides an important context for understanding how the market is changing.

Stock Prices: Essential elements that shed light on each equity's financial performance are the chosen stocks' daily closing prices.

S&P 500 Index: The index's daily closing values serve as an essential benchmark that makes it possible to evaluate each stock's performance in relation to more general market trends.

The present study employs data-driven insights to elucidate the complexities of risk and return relationships within the framework of the Capital Asset Pricing Model. Rich historical data, well-chosen stocks, and reliable preprocessing methods all work together to enable a thorough and nuanced investigation of the relationship between financial metrics and market dynamics, which advances our knowledge of the fundamental ideas behind the Capital Asset Pricing Model.



F. Web Application

A software program created with the Python Streamlit library is a web application that uses Streamlit. Streamlit offers developers a high-level interface that makes it easier to design and implement data-centric applications with little code, making the process of developing interactive web applications simpler. Streamlit is designed with ease

of use and speed of development in mind, so even those with no experience with data science or scripting can use it.

Python scripts can be used by developers to specify the user interface, data processing, and interaction components of a Streamlit web application. Users can access the application through a web browser once it has been automatically converted to a web application. A large portion of the complexity involved in web development is abstracted away by Streamlit, freeing developers to concentrate on building dashboards, visualizations, and other data-driven features.

Web Application Architecture: The Streamlit framework, a Python library made for writing minimally coded interactive and data-driven web applications, is used in the construction of the web application. The application is divided into discrete sections for data processing, visualization, and user input.

User Input: A user-friendly interface that enables dynamic input is present at the start of the application. Users can choose up to five stocks from a pre-arranged list, which includes popular symbols like 'TSLA,' 'AAPL,' 'NFLX,' 'MSFT,' 'MGM,' 'AMZN,' 'NVDA,' and 'GOOGL.' Users can also designate how many years they wish to examine historical stock price data.

Data Retrieval: The program dynamically retrieves historical stock prices for the chosen stocks from the Federal Reserve Economic Data (FRED) API (pandas_datareader) and the S&P 500 index data from the Yahoo Finance API (yfinance). After that, the dataset is combined and processed for additional study.

Data Visualisation: The application's core functionality is its dynamic financial data visualization. The program creates interactive line charts for stock prices, both in their original format and normalized to the starting price, by utilizing the Plotly Express library.

Financial Analysis: The program uses several financial analysis features, such as the computation of beta values, expected returns based on the CAPM, and daily returns. Tables displaying the results dynamically allow users to explore them.

Interactive Plot: To give users a visual depiction of the risk-return relationship for the chosen stocks, the web application also includes an interactive plot that compares expected returns against beta values.

G. Financial Analysis

This section examines the financial analysis carried out by the web application, describing the techniques used to glean valuable information from the historical stock prices of the chosen stocks. Key financial metrics, such as daily returns, beta values, and expected returns derived from the Capital Asset Pricing Model (CAPM), are the focus of the analysis

Calculating Daily Returns: The financial analysis begins with calculating the daily returns of each chosen stock. A more nuanced view of the daily performance of stocks can be obtained from daily returns. Every day, the daily_return function iterates through the dataset to determine the daily percentage change in stock prices.

Determined Beta and Expected Returns: Using the CAPM, the application dynamically determines the beta values and expected returns for the chosen stocks. Users can examine and contrast each stock's risk and return characteristics thanks to the tables that display these values.

This comprehensive financial analysis provides users with a holistic view of the risk and return characteristics of the selected stocks, facilitating informed decision-making within the framework of the Capital Asset Pricing Model. The interactive nature of the visualizations enhances user engagement and understanding of complex financial concepts.

Fig 2: Price of all stocks

Fig 3: Price of all stocks(After Normalizing)

From Fig 3, it can be seen that the normalized prices of six stocks—TSLA, AAPL, AMZN, GOOGL, NFLX, and the S&P 500—from April 2023 to January 2024 are displayed on the graph. To make comparing the relative performance of the stocks easier, normalizing entails scaling the prices to have a mean of 1.

IV. Results And Discussion

Over the period, TSLA was the best-performing stock, constantly maintaining a normalized price above 1.5. This indicates that TSLA performed better than the market's average stock.
Additionally performing well were AAPL and AMZN, whose normalized prices were over 1 for most of the time. Normalized prices for GOOGL and NFLX were more erratic, however, overall the trend was higher over that time. The normalized price of the S&P 500 index, which is a representation of the entire stock market, was erratic and centered at 1. In other words, the market did roughly what was predicted.
Overall, the graph in Fig 3, indicates that from April 2023 to January 2024, the tech sector's stocks—TSLA, AAPL, AMZN, and GOOGL—performed better than the overall market. Numerous reasons, such as rapid earnings growth or optimistic analyst sentiment, could be to blame for this.It is crucial to remember that past success does not always predict future outcomes. It's possible that stocks that have performed well in the past won't perform well in the future and vice versa. It's critical to take into account several variables when making investment decisions, including the company's financial standing, the competitive environment, and general market conditions.

Table I: Calculated Beta Value (Risk)

Calculated Beta Value

	Stock	Beta Value
0	TSLA	0.11
1	AAPL	0.05
2	AMZN	0.07
3	GOOGL	0.06
4	NFLX	0.22

Table II: Calculated Return Value

Calculated Return using CAPM

	Stock	Return Value
0	TSLA	120174.33
1	AAPL	59076.66
2	AMZN	80706.19
3	GOOGL	60143.4
4	NFLX	240350.94

The report in Table 2 shows that TSLA is expected to generate the highest return, followed by AAPL, AMZN, GOOGL, and NFLX. This is because TSLA and AAPL have the highest betas, which can be seen from Table 1 which means that they are more volatile than the market as a whole. Investors demand a higher return for taking on more risk, which is why TSLA and AAPL have the highest expected returns. It is important to note that the CAPM is a theoretical model, and its predictions may not be accurate in the real world. However, the CAPM is still widely used by investors to estimate the expected return of a stock.

V. Conclusion

To sum up, the web application and CAPM-based analysis offer insightful information about the dynamics of risk and return for certain equities, facilitating well-informed decision-making. It is stressed, therefore, that the CAPM is a theoretical model and that actual results may differ from its predictions. When making investment decisions, the study advises giving careful thought to a number of issues, such as the company's financial standing, the competitive landscape, and general market conditions. An important development in financial analysis is the combination of traditional financial models and state-of-the-art online technology, which improves strategic

investment plans and promotes a better comprehension of market dynamics. In order to forecast and distinguish Return on Investment (ROI) and Risk of Investment (Beta) for distinct companies relative to the S&P 500, the study makes use of the web application and CAPM. The literature review emphasizes how the CAPM may be used to evaluate real estate investments and how useful it is still for figuring out share prices. The methodology highlights the importance of the CAPM in securities pricing by emphasizing the relationship between systematic risk (beta) and expected return. The suggested method entails creating a web application with Streamlit and Python to calculate expected return and beta values, backed by thorough data gathering and preparation. The online application's architecture is intricate, with a focus on user interaction, financial analysis, data retrieval, and visualization. Daily returns, beta value computation, predicted returns based on CAPM, and dynamic financial data visualization are some of the key characteristics. The financial analysis part clarifies the computation of daily returns, beta values, and anticipated returns and offers a comprehensive grasp of risk and return characteristics. Normalized stock price visualizations comparing the performance of individual stocks to the S&P 500 from April 2023 to January 2024 are presented in the findings and discussion section. The best-performing stock is TSLA, which continuously keeps its normalized price above 1.5; AAPL and AMZN also do well. NFLX and GOOGL show more erratic trends. To sum up, the web application and CAPM-based analysis offer insightful information about the dynamics of risk and return for certain stocks, enabling educated decision-making. The analysis highlights that the CAPM is a theoretical model and that real-world outcomes may differ. It is advisable to give due consideration to several elements, including the company's financial standing, competitive environment, and overall market conditions, before making investment selections.

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