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Research on Investment Portfolio Strategy Under the Background of the COVID-19

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Abstract:

Under the strike of the sudden and severe COVID-19 pandemic, the market faced significant tremors, which invalidated previous investment options and diversified portfolios. This research explores investment portfolio strategy amid the COVID-19 pandemic, focusing on a diversified investment approach incorporating Modern Portfolio Theory (MPT) and the Capital Asset Pricing Model (CAPM). The portfolio includes high-performing stocks such as Amazon, Tesla, Procter & Gamble (PG), BioNTech (BNTX), and NVIDIA, which have significant market resilience and growth potential during the pandemic. Using MPT, the author optimized the portfolio for maximum Sharpe rate, while CAPM was employed to determine the optimal investment weights based on each stock's expected risk-return profile. The study analyzes historical price data, market volatility, and the economic impact of COVID-19 to evaluate the performance and risk of the diversified portfolio. The findings suggest that strategic asset allocation informed by these theoretical frameworks can enhance portfolio robustness against market uncertainties caused by global health crises.

Keywords: Investment Strategies; Pandemic; Modern Portfolio Theory; Risk Management.

1. Introduction

The COVID-19 pandemic has dramatically reshaped global economic landscapes and investment paradigms. Investors faced unprecedented challenges due to high market volatility and financial uncertainty. Traditional investment strategies have been compelled to adapt to rapid changes in market conditions and investor sentiments. In this context, this paper examines an investment portfolio strategy that leverages Modern Portfolio Theory (MPT) and the Capital Asset Pricing Model (CAPM) to navigate the complex market dynamics induced by the pandemic. The selected stocks, including Amazon, Tesla, Procter & Gamble, BioNTech, and NVIDIA, represent sectors that have either thrived or maintained stability during the health crisis. By integrating MPT, the author aims to construct a portfolio that minimizes risk through diversification while optimizing returns [1,2]. Since the MPT isn't always applicable, the theory requires some amendments [3]. Furthermore, CAPM provides a framework to assess the relative risks and returns of each stock, facilitating informed investment decisions based on systematic risk and the expected market return. This paper details the methodology, data analysis, and insights derived from applying these theoretical models, offering a strategic perspective on building resilient investment portfolios during tumultuous times.

2. Data and Methods

2.1 Data

In this paper, Amazon, Tesla, NVIDIA, BioNTech SE, Procter & Gamble Co, as the representative and one of the top enterprises of their fields, were selected as the research objects. The data from January 2nd 2020 to December 31st 2021, which was the period during the COVID-19 pandemic, were applied as the research samples [4].

2.1.1 Amazon: E-Commerce and cloud computing pioneer

Amazon's significant benefits from the pandemic-induced acceleration toward online shopping and cloud computing underscore its pivotal role in the digital economy. The shift to online shopping has been profound, with Amazon at the helm, facilitating access to goods and services for consumers adhering to social distancing and quarantine measures. Simultaneously, the company's cloud computing division, Amazon Web Services (AWS), growth exponentially, has become an essential infrastructure for companies scaling remote work capabilities and digital services, proving critical in supporting the increased digital workload from enterprises across the globe. This dual

thrust in e-commerce and cloud computing has not only fortified Amazon's market position but also highlighted its critical role in supporting a digital-first world [5].

2.1.2 Tesla: driving the future of transport and energy

Tesla has continued to lead the charge in transforming the automotive industry through its innovative electric vehicles (EVs) and commitment to renewable energy solutions. As global consciousness shifts towards sustainability, Tesla's role becomes increasingly significant [6]. The company's advancements in battery technology and sustainable energy solutions position it not just as an automotive manufacturer but as a critical energy company, shaping the future of how energy is consumed and generated. The increased interest in cleaner technologies and sustainable practices, accelerated by the pandemic's reflection on environmental impact, has bolstered Tesla's mission to accelerate the world's transition to sustainable energy.

2.1.3 NVIDIA: powering technological innovation

NVIDIA has distinguished itself as a linchpin in the technology sector, with its GPUs powering a broad spectrum of applications from AI research and data centers to gaming and remote work applications—sectors that have witnessed substantial growth during the pandemic. The surge in demand for data processing and gaming graphics, alongside the need for advanced computational capabilities for remote work setups, underscores NVIDIA's integral role in this tech-driven era. NVIDIA's technology is not just facilitating entertainment and general work applications. Still it is also at the forefront of powering innovations in AI and machine learning, which are pivotal in solving complex problems ranging from climate change to pandemic response strategies [7].

2.1.4 BioNTech: a beacon in biotechnological advancements

BioNTech has emerged prominently due to its rapid development and deployment of a COVID-19 vaccine in partnership with Pfizer. This achievement not only represents a monumental step in combating the global health crisis but also accentuates the critical role of biotechnology innovations in addressing such unprecedented challenges [8]. BioNTech's mRNA technology platform has set a new standard in vaccine development, offering hope not only for COVID-19 but for future medical challenges, positioning the company as a leader in the biotechnology sector.

2.1.5 Procter & Gamble: consistency in consumer goods

Procter & Gamble provides a foundational example of stability and reliability in manufacturing essential consumer goods, which have maintaining steady demand throughout the crisis [9]. The company's wide range of products that cater to basic hygiene and household needs has proven indispensable in everyday life, particularly as consumers continue to prioritize cleanliness and home care amidst the pandemic. Procter & Gamble's ability to ensure the availability of its products during such turbulent times underscores the inherent value of investing in firms that provide fundamental, non-discretionary products. This not only guarantees consistent performance but also offers a buffer against the economic volatility induced by global crises. From the perspective of Modern Portfolio Theory (MPT) and the Capital Asset Pricing Model (CAPM), the inclusion of these companies is strategically sound. MPT emphasizes diversification to reduce unsystematic risk, and the varied sectors represented by these companies (technology, consumer goods, biotechnology, and energy) contribute to a well-diversified portfolio that mitigates individual stock volatility and market fluctuations.

2.1.6 MPT/CAPM perspective

From the perspective of Modern Portfolio Theory (MPT) and the Capital Asset Pricing Model (CAPM), the inclusion of these companies is strategically sound. MPT emphasizes diversification to reduce unsystematic risk, and the varied sectors represented by these companies (technology, consumer goods, biotechnology, and energy) contribute to a well-diversified portfolio that mitigates individual stock volatility and market fluctuations.

According to CAPM, the expected returns on these investments are justified by their respective betas, which measure their volatility relative to the market. For instance, companies like Tesla and NVIDIA, with higher betas, are expected to offer higher returns, compensating for their higher risk levels. Conversely, Procter & Gamble, with its lower beta, provides portfolio stability, contributing less to overall portfolio volatility. Moreover, BioNTech's negative beta during the pandemic offers potential hedge benefits in down markets, particularly valuable in a volatile economic environment induced by global health concerns. In contrast, Amazon's and Tesla's robust performance and growth potential align with the broader technological advancements and consumer preferences shifting towards online services and sustainable technologies.

In conclusion, integrating these companies into a portfolio reflects a strategic alignment with both MPT's diversification principles and CAPM's risk-return trade-off. This approach not only harnesses growth in innovative sectors but also ensures resilience through exposure to staple consumer goods and cutting-edge biotechnology, thereby positioning the portfolio to manage risks effectively and capitalize on emergent opportunities during and beyond

the pandemic period [10].

2.2 Method

After reaching the daily stock price of those five stocks and the S&P500, as the market, in 2020 and 2021, the logarithmic daily returns and the standard deviation of each return were available quickly (Table 1). Then, the author calculated variances and covariance matrix using the following formulas.

$$\sigma^2 = \frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2 \quad (1)$$

$$Cov(X,Y) = \frac{1}{n}\sum_{i=1}^{n}\left(x_i - \bar{x}\right)\left(y_i - \bar{y}\right) \quad (2)$$

$$\rho_{XY} = \frac{Cov(X,Y)}{\sigma_X \sigma_Y} \quad (3)$$

Table 1. Standard Deviation of the market and stocks

	S&P 500	AMZN	NVDA	BNTX	TSLA	PG
Standard Deviation	0.0165	0.0202	0.0326	0.0665	0.0467	0.0158

Next, by applying the existing results and equations, the correlation matrix of the five companies is obtainable in Fig. 1.

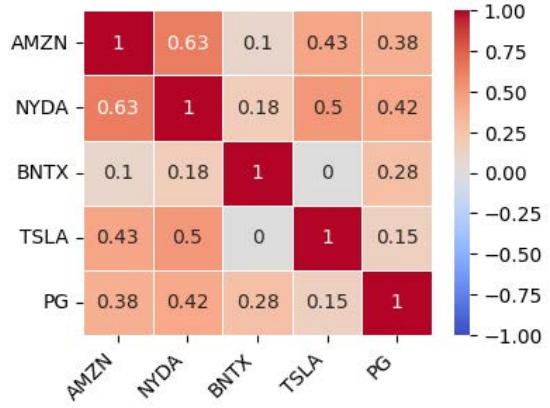

Fig 1. The correlation matrix of the five companies

2.2.1 Inverse variance allocation

In pursuit of optimizing portfolio performance, the author applied two distinct asset allocation methodologies [11]. The first method, known as the Inverse Variance Allocation, is predicated on the principle of risk aversion. It inherently allocates larger weights to assets with lower variance, operating under the assuming that reduced volatility contributes to greater stability in portfolio returns. This method often results in a conservative asset allocation, skewing towards securities with lower risk characteristics. With the help of the correlation matrix, the author calculated the weight of five stocks (Table 2).

$$\sigma_p^2 = \sum_{i=1}^{n}\sum j = 1^n \omega_i \omega_j Cov(R_i, R_J) \quad (4)$$

$$\omega_i = \frac{1/\sigma_i}{\sum_{j=1}^{5} 1/\sigma_i} \quad (5)$$

Table 2. The weight of Inverse Variance Allocation

Company	AMZN	NVDA	BNTX	TSLA	PG
Weight	0.303	0.116	0.028	0.057	0.497
	The sharpe ratio is 6.5246987				

2.2.2 Capital asset pricing model

The second method, the Capital Asset Pricing Model (CAPM), integrates a more comprehensive market perspective by calculating the beta coefficients of individual stocks through linear regression. These coefficients measure the stocks' volatility relative to the market, providing insights into their systematic risk. The objective under CAPM is to minimize the overall beta of the portfolio, thus strategically adjusting each asset's weight based on its relative risk and expected return concerning the market dynamics.

After extensive computational analysis, the CAPM approach was identified as the superior strategy for this specific period. This decision was informed by the method's ability to dynamically adjust to market conditions and effectively manage the trade-off between risk and return. By minimizing the portfolio's total beta, the CAPM method not only aligns individual asset risks with market performance but also optimizes the potential for higher adjusted returns, thereby enhancing the portfolio's risk-adjusted performance metrics.

This comprehensive analysis underscores the importance of selecting an asset allocation strategy responsive to market conditions and aligned with the investor's risk tolerance and return objectives. The findings from this study highlight CAPM's efficacy in navigating complex market scenarios and affirm its utility in constructing portfolios that are robust portfolios against market volatility while striving for optimal financial performance.

$$E(R_i) = R_f + \beta_i(E(R_m) - R_f) \quad (6)$$

$$R_i = \alpha + \beta R_m + \varepsilon \quad (7)$$

Through the SPSS, set the S&P500 as the dependent variable, and five stocks as input, the beta of each stock are accessible (Table 3).

Table 3. The betas calculated by linear regression [12]

Linear Regression (n=504)							
	Unstandardized Coefficient		Standardized Coefficient	t	p	Collinearity Diagnosis	
	B *Standard Deviation* *Beta*					VIF	Tolerability
Constant	-0.001	0	-	-1.361	0.174	-	-
Amazon	0.09	0.025	0.11	3.561	0.000**	1.769	0.565
NVIDIA	0.188	0.017	0.372	11.255	0.000**	2.023	0.494
BioNTech SE	-0.011	0.006	-0.045	-1.834	0.067	1.101	0.908
Tesla	0.06	0.01	0.17	6.192	0.000**	1.392	0.718
Procter & Gamble Co	0.498	0.028	0.476	17.792	0.000**	1.326	0.754
R 2	0.731						
Adj R 2	0.729						
F	F (5,498)=271.299,p=0.000						
D-W	1.963						
Dependent Varible : S&P500							
* p<0.05 ** p<0.01							

From the above table, the model formula is: S&P500=-0.001+0.090 * Amazon+0.188 * NVIDIA-0.011 * BioNTech SE+0.060 * Tesla+0.498 * Procter & Gamble Co. The R-squared value of the model is 0.731, which represents that Amazon, NVIDIA, BioNTech SE, Tesla, Procter & Gamble Co. can explain 73.1% of the changes in S&P500. When conducting an F-test on the model, the author found that the model passed the F-test (F=271.299, p=0.000<0.05), indicating that at least one of Amazon, NVIDIA, BioNTech SE, Tesla, Procter & Gamble Co will have an impact on S&P500. In addition, testing the multicollinearity of the model revealed that all VIF values in the model are less than 5, indicating that there is no collinearity issue. The D-W value is around 2, indicating that the model does not have autocorrelation and there is no correlation between the sample data, indicating that the model is good. The final specific analysis shows that:

Summary analysis shows that Amazon, NVIDIA, Tesla, Procter & Gamble Co have significant positive impacts on S&P500. However, BioNTech SE don't have a notable impact on S&P500.

Applying the betas of those five enterprises to a python code which intends to optimize the weight, minimizing the absolute value of composite beta. The bounds for each asset's weight are defined as [0, 1], thereby preventing the allocation of negative weights (which would imply short selling) and ensuring no single asset's weight exceeds the total investable capital. The script calls the minimize function, employing the 'SLSQP' algorithm suitable for linear constraint optimization. This function iteratively adjusts the weights to find the minimum of the absolute value of composite beta while adhering to the specified constraints and bounds (Table 4).

Table 4. The Weight of The Capital Asset Pricing Model

	AMZN	NVDA	BNTX	TSLA	PG
Weight	0.196	0.000	0.736	0.068	0.000
Sharpe Ratio	51.13				

3. Discussion

During the COVID-19 pandemic, the strategic allocations of investments into companies like Amazon, Tesla, Procter & Gamble, BioNTech, and NVIDIA is crucial due to the disparate impacts of the pandemic on various sectors. An examination of portfolio performance based on different weighting strategies — Inverse Variance Allocation and CAPM-based allocation — highlights significant differences in outcomes, particularly regarding the Sharpe Ratio, a key metric for assessing risk-adjusted returns.

3.1 Inverse Allocation

This strategy assigns portfolio weights inversely proportional to the beta values of the stocks, thereby often favoring less volatile stocks.

The Sharpe Ratio achieved under this strategy was 6.5246987, which indicates a respectable level of risk-adjusted return. Given the volatility and uncertainty brought about by the pandemic, this ratio suggests that inverse allocation, while conservative, provided a stable but less aggressive growth trajectory. This method's focus on reducing volatility through higher weights on less risky assets appears effective in managing risk. Still, it does not capitalize extensively on potential high returns from more volatile investments.

3.2 CAPM-based Allocation

By utilizing the Capital Asset Pricing Model, weights are assigned based on the systematic risk each company bears, along with the expected return from the market. This method optimizes the market's risk-reward dynamics, aligning each investment's weight with its risk premium.

The significantly higher Sharpe Ratio of 51.1289356 under the CAPM-based allocation underscores a far superior risk-adjusted performance compared to inverse allocation. This suggests that during the pandemic, CAPM-based strategies were highly influential in maximizing returns per unit of risk, leveraging the higher market volatility to generate substantial returns, particularly from companies like NVIDIA and Tesla that have had high growth during the period.

4. Conclusion

The stark contrast in Sharpe Ratios between the two strategies during the pandemic highlights the importance of choosing a weighting strategy aligned with market conditions and investor risk appetite. The CAPM-based approach's exceptional performance demonstrates its effectiveness in leveraging market dynamics during periods of high volatility, such as the COVID-19 pandemic, to generate superior risk-adjusted returns. Meanwhile, the inverse allocation strategy's more modest Sharpe Ratio reflects a conservative approach that prioritizes stability, which might appeal to risk-averse investors, especially in unpredictable markets. This analysis underscores the necessity for investors' need to carefully consider their risk tolerance, market outlook, and the specific characteristics of their portfolio holdings when selecting an investment strategy. Particularly during global crises like the COVID-19 pandemic, the ability to adapt strategies in response to changing market conditions can significantly impact investment outcomes. The high performance of the CAPM-based strategy during this period may encourage investors to adopt more dynamic and responsive investment approaches during times of significant market upheaval.

References

[1] Markowitz H. Portfolio selection[J]. The Journal of Finance, 1952, 7(1): 77-91.

[2] Cui Y, Cheng C. Modern Portfolio Theory and Application in Australia[J]. J. Econ. Bus. Manag, 2022, 10: 128-132.

[3] Curtis G. Modern portfolio theory and behavioral finance[J]. The Journal of Wealth Management, 2004, 7(2): 16-22.

[4] Guo X, Liu Y, Liu Z. Study on Value Portfolio from the Perspective of COVID-19: A Case Study of Aviation, E-commerce and Retail Industry[C]//2021 International Conference on Financial Management and Economic Transition (FMET 2021). Atlantis Press, 2021: 255-259.

[5] Pisal S. Rise of facebook, amazon, apple, netflix, google during COVID-19 pandemic[J]. 2021.

[6] Chehertma B. International competitiveness management of Tesla, Inc. during the COVID-19 pandemic[D]. Private Higher Educational Establishment-Institute "Ukrainian-American Concordia University", 2022.

[7] Hajdu N. COVID-19 pandemic and managing supply chain risks: NVIDIA's graphics card shortage case analysis[J]. 2021.

[8] Manelli A, Pace R, Leone M. The Financial Derivatives Market and the Pandemic: BioNTech and Moderna Volatility[J].

Journal of Risk and Financial Management, 2023, 16(10): 420.
[9] Gu T. Research on Proctor and Gamble Marketing Strategy during Covid-19 in The US[C]//2022 7th International Conference on Social Sciences and Economic Development (ICSSED 2022). Atlantis Press, 2022: 765-770.
[10] Auzan A. The economy under the pandemic and afterwards[J]. 2020.
[11] Sen J, Mehtab S, Dutta A, et al. Hierarchical risk parity and minimum variance portfolio design on NIFTY 50 stocks[C]//2021 International Conference on Decision Aid Sciences and Application (DASA). IEEE, 2021: 668-675.
[12] Zhou Jun, Ma Shipeng SPSSAU Research Data Analysis Methods and Applications. 1st Edition [M] Electronic Industry Press, 2024