

Strategy Selection in Extreme Markets: Empirical Analysis and Optimization of Portfolio Performance in the French Stock Market

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Abstract. This paper uses a two-phase methodology to explore portfolio optimization strategies for stocks in the CAC 40 index during the COVID-19 pandemic. In the first phase, this paper compared the performance of equal-weighted, maximum Sharpe ratio, and equal-weighted risk contribution (EWRC) strategies, using historical data to analyze their performance in eight different market phases. In the second phase, based on the results of the first phase, the maximum Sharpe ratio strategy was found to be the most effective, and was subsequently refined by integrating the 20-day moving average (MA20) as a tactical component. The results showed that the MA20-enhanced maximum Sharpe ratio strategy outperformed other strategies in terms of risk-adjusted return over most of the evaluated time frames. It can therefore see the potential of technical indicators to aid investment decisions, especially in response to rapid market changes. These insights provide valuable guidance for investors strategizing during periods of market uncertainty, highlighting the benefits of dynamic strategy adjustments to volatile market conditions.

Keywords: CAC 40 index, MA20, investors.

1. Introduction

The COVID-19 pandemic quickly evolved into a global crisis with profound consequences for health, economics, and financial markets [1]. As the epidemic spreads, global stock markets have experienced violent fluctuations, and investors are facing extremely high uncertainty. Studies have shown that this kind of market volatility is not only reflected in the violent fluctuations of stock prices, but also in the rapid changes in the emotions of market participants and the instability of trading behaviors, and this uncertainty has led to various countries in different stages of the epidemic. The stock market has experienced deviations from market efficiency [2]. Against the background of such an extreme market environment, investors and market analysts have re-evaluated risk management strategies and portfolio construction methods to adapt to this new market reality.

As one of the major economies in the Eurozone, France's financial market has an important impact on regional and global financial stability. Especially during the epidemic, the French stock market has shown a central role in transmitting global financial shocks, and the French stock market and the stock markets of other countries have become more closely connected under this extreme market environment [3]. Therefore, in-depth study of the performance of the French market during this special period has important theoretical and practical significance for understanding and responding to the fluctuations of global financial markets.

As motioned above, choosing the constituent stocks in the French stock market CAC40 index as research objects to establish an investment portfolio can provide a unique perspective to observe the impact of the new crown epidemic. In fact, asset allocation is often considered one of the most important factors in determining portfolio performance [4]. Under this framework, tactical elements are introduced into the investment portfolio, and multi-period dynamic asset allocations are adjusted according to rapid changes in market behavior, so that the investment portfolio can flexibly respond to extreme events such as the COVID-19 epidemic [5].

Therefore, the first phase of this paper empirically studies how the performance of portfolios based on equally weighted, maximum Sharpe ratio and equally weighted risk contribution is affected by the COVID-19 pandemic. In the second phase, this paper selects investment strategies with good

performance based on the previous results and add MA20 as tactical elements for dynamic weight adjustment to try to find out whether better portfolio performance can be got.

The rest of the article is organized as follows: Part 2 describes the 3 portfolio strategies for the first phase (equally weighted and equally weighted risk contribution, The Maximum Sharpe ratio) and the second stage incorporate MA20 as tactical elements into the portfolio strategy to dynamically adjust the portfolio weight. Part 3 introduces the experimental framework in detail, including data sets, experimental methods, and performance measurement indicators. Part 4 reports and discusses the statistical results obtained from the two-stage experimental study, and Part 5 presents the conclusions drawn from the study.

2. Methodology

2.1. Phase 1: Apply Traditional Portfolio Strategies

The equal-weight strategy is one of the simplest asset allocation methods that the construction of does not require estimation of any unknown variables, nor does it require optimization techniques to obtain portfolio weight [6]. In the equal-weighted strategy, the weight of each asset is fixed and the same, expressed as

$$W_i = \frac{1}{N} \quad (1)$$

Where W_i is the weight of asset i and N is Number of assets in the portfolio. The goal of an equal-weighted risk contribution strategy is for all assets in the portfolio to contribute equally to total risk. This approach reduces reliance on a single asset or asset group and reduces concentration risk by balancing risk contributions across assets [7].

$$\min \sum_{i=1}^N (W_i \cdot (\sum_{j=1}^N W_j \cdot \sum_{ij}) - \frac{1}{N} \sum_{j=1}^N W_j \cdot (\sum_{k=1}^N W_k \cdot \sum_{jk}))^2 \quad (2)$$

Where W_i is the weight of asset I, $(\sum w)_i$ is the marginal risk contribution of asset i. Maximum Sharpe ratio optimization is an extension of mean-variance optimization proposed by Harry Markowitz in 1952, which enhances the model by introducing risk-free assets and considering the risk-adjusted return of the portfolio. Under this framework, the portfolio that maximizes the Sharpe ratio is the portfolio that provides the highest excess return at a given level of risk [8].

$$\max \left(\frac{W^T R - R_f}{\sqrt{W^T \Sigma W}} \right) \quad (3)$$

Where, w is the asset weight vector, R is the asset expected return vector, R_f is the risk-free rate, Σ is the covariance matrix of asset returns.

2.2. Phase 2: Add MA20 as Tactical Elements

Moving average 20 is a commonly used short-term trend indicator that smoothes daily price fluctuations by calculating the average price over the past 20 trading days, thereby providing insights on market dynamics.

In a tactical asset allocation (TAA) strategy, the 20-day moving average is used as a tactical element to adjust the asset weights of a portfolio. The core idea behind this approach is that when an asset's price rises above its 20-day moving average, it may signal the beginning of an uptrend in the short term, and investors may increase their weighting in that asset. Conversely, when an asset price falls across the 20-day moving average, it may signal the beginning of a short-term downward trend, and investors may reduce or liquidate the asset. The effectiveness of this strategy is supported by research in various literatures. Using historical moving averages as signals for market entry and exit can significantly improve the risk-adjusted return of a portfolio [9]. In addition, moving averages Adjusting the weight of an investment portfolio as tactical elements can produce excess returns under certain market conditions [10].

3. Empirical Framework

3.1. Data Sets

This study has collected historical data on the CAC 40 index constituents, covering the period from December 20, 2019 to August 9, 2021, and the dataset includes the ticker symbols of 38 companies listed on the Paris Stock Exchange

3.2. Scrolling Window and Out-of-sample Analysis

The empirical analysis in this paper uses a rolling window approach to evaluate the performance of different portfolio strategies at different stages of the COVID-19 pandemic. This COVID-19 is divided into eight stages based on WIKIPEDIA's description of the different stages of the outbreak in France. For each period, the dataset is divided into a stimulation set (D) and a validation set (Q), where approximately 75% of the data is allocated for estimating and 25% is reserved for validating (See Fig. 1).

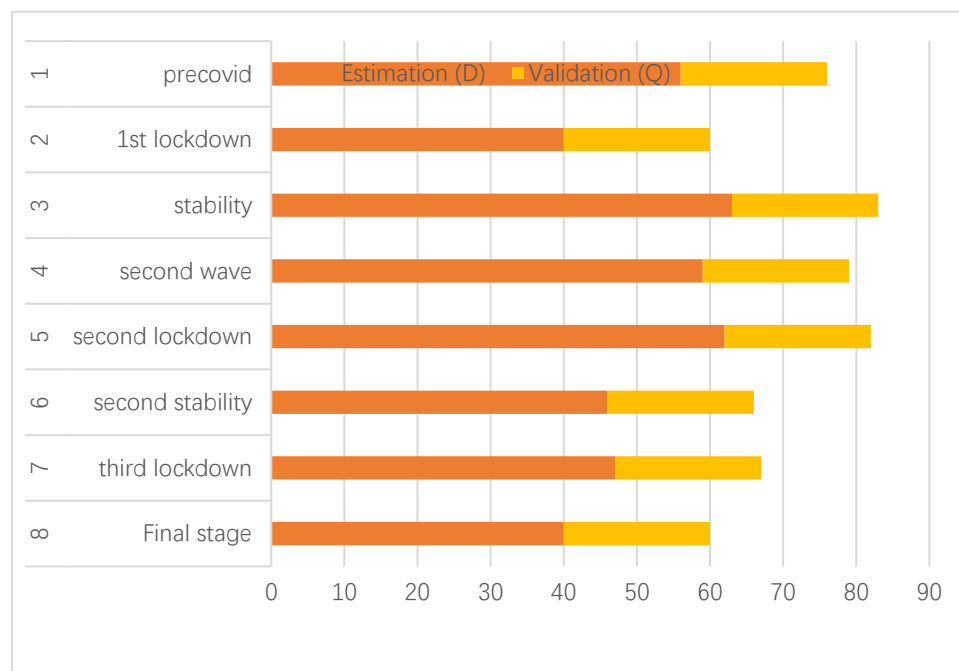


Figure 1. Covid-19 period analysis

Estimation window (within sample): For each time period, an estimation window of D days is used to calculate the parameters required for the portfolio optimization strategy. The estimate window moves forward a day after each iteration, ensuring that the parameters are constantly updated with the latest data.

Validation window (out of sample): After the estimate window, a test window of Q days is used to evaluate the performance of the optimized portfolio weights derived from the in-sample data.

This out-of-sample analysis ensures that the estimation set is large enough to capture underlying market dynamics, while the validation set provides an unbiased assessment of the portfolio's performance. The estimation set is used to optimize the portfolio parameters, and the validation set is used to evaluate how the optimized portfolio performs out-of-sample.

3.3. Performance Indicators

Evaluate the performance of each strategy using the following metrics in Table 1, which are calculated against the out-of-sample test window:

Table 1. Performance indicators

Performance indicator	Definition
Expected Return	The annualized average of the daily portfolio return, representing the average return that the portfolio is expected to generate
Volatility	The annualized standard deviation of the daily portfolio return, which represents the risk or uncertainty associated with the portfolio return.
Sharpe Ratio	A risk-adjusted return measure calculated as the difference between a portfolio's expected return and the risk-free interest rate, divided by the portfolio's volatility.
Maximum drawdown	The maximum loss observed in a portfolio between peak and trough until a new peak is reached. It is an indicator of downside risk over a specified time period.
Skewness	A measure of asymmetry in the distribution of returns.

These indicators provide a comprehensive view of performance, allowing comparisons not only from a return perspective, but also from the nature of the distribution of risk and return.

4. Results and Discussion

4.1. Performance of 3 Strategies

In Table 1, this paper compares the performance of three different investment strategies. In the first phase, the maximum Sharpe ratio strategy showed lower volatility, maximum retracement, and higher expected returns compared to the equal-weighted strategy and the equal-weighted risk-contribution strategy. This may be because the maximum Sharpe ratio strategy considers the ratio of expected returns to volatility when allocating assets, aiming to maximize risk-adjusted returns. In times of market instability, this strategy can reduce unnecessary risk exposure by optimizing the weight allocation of the asset portfolio.

Although the maximum Sharpe ratio strategy had a negative Sharpe ratio in the first phase, which may be due to the overall market underperformance during this phase, its relatively small negative value indicates that the strategy is relatively superior in terms of risk-adjusted returns. In addition, the skewness of the maximum Sharpe ratio strategy is close to zero, meaning that its return distribution is relatively more symmetrical and less risky.

Equal-weighted strategies and equal-weighted risk contribution strategies may not adequately consider the correlation between assets and their respective risk contributions, and therefore may underperform in times of high market volatility. These strategies may have limited effectiveness in diversifying risk, especially when systemic risks emerge in the market (See Table 2).

Table 2. 3 strategies performance matrix

Equally-weighted strtagey					
Period	Expected Return	Volatility	Sharpe ratio	Max Drawdown	Skewness
1	-6.399191539	0.621654308	-11.90242139	-0.314481165	-1.601486019
2	0.583291161	0.360341053	-1.156428987	-0.073422454	-0.516773762
3	-0.306630627	0.209485176	-6.237341723	-0.068220482	0.090302592
4	-1.404066828	0.237563804	-10.11966799	-0.092263825	-0.565232057
5	0.334647575	0.121165922	-5.491250478	-0.018395995	-0.110598288
6	0.146698896	0.085462503	-9.984508727	-0.019399189	0.124701687
7	0.500881799	0.063921489	-7.808300648	-0.004604462	0.008491782
8	1.410144672	0.114510942	3.581707264	-0.007946451	0.219623928
Equally-weighted Risk Contribution Strategy					
Period	Expected Return	Volatility	Sharpe ratio	Max Drawdown	Skewness
1	-6.18706416	0.599910902	-11.98021929	-0.30478355	-1.612974371
2	0.459502111	0.271735845	-1.989056282	-0.055309277	-0.585325732
3	-0.285757558	0.184240821	-6.978679035	-0.054525739	-0.071812445
4	-1.186938302	0.21199997	-10.31574818	-0.084454214	-0.700987931
5	0.256922061	0.113606249	-6.540819247	-0.018988636	0.156404013
6	0.179138104	0.06739578	-12.1797224	-0.014545457	-0.100462447
7	0.425449755	0.0544109	-10.55946965	-0.004665467	-0.267232792
8	1.247632464	0.090027927	2.750618296	-0.006704776	-0.042
Maximum Sharpe Ratio Strategy					
Period	Expected Return	Volatility	Sharpe ratio	Max Drawdown	Skewness
1	-6.6992649	0.67974557	-11.326686	-0.3205463	-1.4373671
2	0.72600716	0.45204546	-0.6061179	-0.0876875	-0.4677037
3	-0.1222098	0.4172144	-2.6897676	-0.1285327	-0.4698438
4	-1.528278	0.35304328	-7.1613826	-0.1124395	-0.6991587
5	1.12635293	0.2545797	0.49631973	-0.0187074	1.79929731
6	0.13210993	0.16092484	-5.3931392	-0.0385836	-0.2337523
7	0.74900766	0.09784526	-2.5651966	-0.0077191	0.13221682
8	1.93340059	0.21230813	4.39644311	-0.0170626	-0.006099

4.2. Add MA20 as Tactical Elements into the Maximum Sharpe Ratio Strategy

By comparing the performance matrix in Table2.which shows the performance of Maximum Sharpe Ratio Strategy and Maximum Sharpe Ratio Strategy with MA20.

In the first period, the Expected Return and Volatility of the two strategies were similar, but the strategy with MA20 improved slightly on the Sharpe Ratio and Max Drawdown. This suggests that in extreme market conditions, the addition of MA20 may help fine-tune the portfolio to achieve better risk-adjusted returns.

From Period 2 to Period 8, the strategies that added MA20 improved their sharpe ratio in most phases, especially in Period 8, where the Sharpe ratio improved significantly to 8.514, much higher than the 4.396 of the original strategy. This suggests that strategies incorporating MA20 have a significant increase in risk-adjusted returns.

In terms of maximum retracements, the strategy that joined MA20 also showed smaller retracements in most phases, meaning that the strategy was better able to protect the portfolio from losses when the market fell.

In terms of skewness, strategies that added MA20 showed positive skewness in Period 5 and 8, which may indicate that strategies were able to capture more large positive returns in these stages.

Overall, the MA20 strategy outperformed the original MA20 strategy on several key performance metrics, particularly in terms of the sharpe ratio and maximum retracement which indicates that the addition of MA20 provides an effective dynamic adjustment mechanism for the strategy, which helps to improve the overall performance of the portfolio (See Table 3).

Table 3. MSR and MSR with MA20 performance matrix

	Maximum Sharpe Ratio Strategy				
Period	Expected Return	Volatility	Sharpe ratio	Max Drawdown	Skewness
1	-6.6992649	0.67974557	-11.326686	-0.3205463	-1.4373671
2	0.72600716	0.45204546	-0.6061179	-0.0876875	-0.4677037
3	-0.1222098	0.4172144	-2.6897676	-0.1285327	-0.4698438
4	-1.528278	0.35304328	-7.1613826	-0.1124395	-0.6991587
5	1.12635293	0.2545797	0.49631973	-0.0187074	1.79929731
6	0.13210993	0.16092484	-5.3931392	-0.0385836	-0.2337523
7	0.74900766	0.09784526	-2.5651966	-0.0077191	0.13221682
8	1.93340059	0.21230813	4.39644311	-0.0170626	-0.006099
	Maximum Sharpe Ratio Strategy with MA20				
Period	Expected Return	Volatility	Sharpe ratio	Max Drawdown	Skewness
1	-6.71935845	0.66955604	-11.52907	-0.319391685	-1.650599317
2	0.409253015	0.351368943	-1.681272625	-0.063978461	-0.443539834
3	-0.104123061	0.22940793	-4.812924563	-0.062766039	-0.15250746
4	-1.488190007	0.238125206	-10.44908284	-0.098767917	-0.165059323
5	0.22088163	0.157292204	-4.953318398	-0.036409514	0.014824445
6	0.140095593	0.101430488	-8.477770546	-0.02050769	-0.126991962
7	0.48386202	0.06613801	-7.803953847	-0.006262343	0.047437234
8	1.707850056	0.083139494	8.514004842	0	0.837131602

5. Conclusion

This study comparatively analyzes the performance of the maximum Sharpe ratio strategy before and after adding MA20 tactical elements, aiming to evaluate the effectiveness of the dynamic adjustment mechanism under different market stages. The results show that the strategy after introducing MA20 is better than the traditional maximum Sharpe ratio strategy in multiple performance indicators, especially in terms of Sharpe ratio and maximum retracement. This suggests that in volatile market environments, the addition of MA20 may help portfolios achieve more robust risk-adjusted returns. However, it is important to note that although MA20 improves the overall performance of the strategy, there are limitations to the study which does not consider transaction costs, which can significantly affect net returns, especially when the strategy involves frequent trading. Future research should consider the impact of transaction costs to provide a more accurate assessment of strategy performance.

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