

Research on the trading strategy based on an All-Weather asset allocation model combined with HURST Exponent

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Abstract. Investors are constantly seeking strategies that can provide stable returns across different economic conditions. The All-Weather investment strategy, pioneered by Bridgewater Associates, has gained significant attention for its ability to navigate various market environments effectively. This paper examines the All-Weather investment strategy and the application of the Hurst Exponent to equity investing. The All-Weather strategy aims to achieve stable returns on a portfolio across a variety of economic conditions by allocating assets to four different economic environments. This study details the components of the All-Weather strategy and how it hedges against different economic environment risks by allocating the same risk weights. In addition, the article explores the application of the Hurst Exponent to the equity component, analyzing how it can help investors identify stock trends and combine it with momentum indicators to make buy and sell decisions. By analyzing the All-Weather strategy and the Hurst Exponent, this article provides investors with a composite investment strategy that combines macroeconomic conditions and stock trend analysis.

Keywords: Trading strategy, All-Weather asset allocation model, HURST Exponent.

1. Introduction

In the context of global financial markets, the search for stable and profitable investment strategies has become increasingly complex and challenging. With economies experiencing cycles of boom and bust, inflationary pressures, and geopolitical uncertainties, investors are constantly seeking methods to safeguard their portfolios against volatility and downturns. Risk parity, a strategy that focuses on balancing risk across various asset classes, emerges as a beacon of stability in this tumultuous financial landscape. It aims to ensure that each asset contributes equally to the portfolio's overall risk, thereby potentially reducing volatility and enhancing returns over the long term. The All-Weather strategy, developed by Bridgewater Associates, exemplifies the application of risk parity principles, designed to perform robustly across different economic climates.

This article introduces the basic concepts of All-Weather strategies, including their categorization and understanding of economic climates and corresponding asset allocation strategies.

To complement this strategy and add a layer of analytical depth, the Hurst Exponent becomes pivotal, especially in the realm of stock market investments. The Hurst Exponent, a statistical measure that assesses the autocorrelation of a time series, helps in determining the nature of market trends—be it trending, mean-reverting, or random.

Thus, the article delves into the application of Hurst Exponent in stock investment and analyzes its effectiveness in identifying stock trends and predicting market movements.

Through rigorous analysis and empirical research, this paper aims to deepen the understanding of how risk parity, specifically the All-Weather strategy, can be integrated with the Hurst Exponent to enhance portfolio performance in diverse economic environments. By combining these methodologies, the study seeks to offer novel insights into achieving stable and profitable investment outcomes.

The remaining of this paper is structured as follows. Section II reviews the previous studies. Section III gives basic data and the use of the All-Weather and Hurst Exponent. Section IV shows the formulae and the corresponding results.

2. Literature review

There have been many studies on risk parity strategy and All-Weather, and the following are some of the existing ones. Zhang conducts an empirical study on the application of risk parity strategies in asset allocation. By comparing different portfolio strategies, it is found that the risk parity strategy exhibits superior performance in risk control and investment return compared to traditional maximum Sharpe ratio strategies and global minimum variance strategies [1]. Wang focuses on the All-Weather strategy in hedge funds, which, by categorizing economic environments into four types, attempts to balance risk allocation across various economic conditions, showcasing a unique method to hedge against economic cycle fluctuations [2].

Momentum is a way to find the rate or trend of a stock's price changing over a period of time. Zhang highlights the challenges inherent in traditional financial models to adequately capture the dynamics of the momentum effect, advocating for a multidimensional approach that includes investor psychology and market microstructure [3].

There are a lot of way to analyze the Hurst Exponent and R/S analysis method is one of the most precise ways. Yang and Zhang's study on the application of the R/S analysis method and time series similarity in stock index prediction provides valuable insights into the predictability of stock market trends. Their research underscores the significance of fractal characteristics in financial markets, demonstrating that the Shanghai Composite Index exhibits self-similarity and long-range dependence, with an average cycle period that can be identified [4].

There have been many studies on Hurst Exponent. Li explores quantitative investment strategies based on the Hurst Exponent, highlighting the fractal characteristics of the A-share market. Through the Partition Function (PF) method and utilizing Shanghai and Shenzhen 300 stock index data, it outperforms passive investment strategies in the Shanghai and Shenzhen 300 Index, emphasizing the practicality of Hurst Exponent-based quantitative trading strategies [5].

Huo's research on long-term memory analysis of the CSI 300 Index using fractal and multifractal analysis methods increases the understanding of the memorability of the Hurst Exponent by examining the multifractal nature of the market [6].

Nirhale provides an in-depth analysis of estimating the Hurst exponent in the context of fractional Brownian motion (fBM) driven volatility, emphasizing high-frequency data and option prices. The paper focuses on three methodologies for estimating the Hurst parameter: the 2-Variation Magnitude Estimator, the Realized Variance Estimator, and the Implied Volatility Estimator. The paper demonstrates the practicality and effectiveness in capturing the underlying dynamics of market volatility [7].

Huang examined the bond market's behavior through the Hurst Exponent. The findings indicated that the Chinese bond market exhibited a Hurst Exponent greater than 0.5, signifying a biased random walk with trends and persistence. This result supported the feasibility of active trading in the bond market, challenging the notion of market efficiency and suggesting that past information could guide future investment decisions to generate excess returns [8].

Yu and Wu explored the multifractal nature of financial markets, particularly comparing the CSI 300 stock index futures and Hang Seng index futures. They introduced a multifractal measurement model to assess market inefficiency and risk, discovering that multifractality summarizes market inefficiency and risk, with both being reasons for the emergence of multifractality. The research established that multifractality could serve as a more effective indicator than the Hurst Exponent in analyzing market inefficiency [9].

Sun and Ren applied the Hurst Exponent to analyze the fractal characteristics of the Shanghai Stock Market in Hebei Province. The research revealed that the Hurst Exponent of each stock was greater than 0.5, indicating the presence of self-similarity, state persistence, and long-term memory in the market, traits not consistent with the Efficient Market Hypothesis (EMH). The study pointed out the inadequacy of linear financial market models in explaining the actual nonlinear market behaviors, suggesting that fractal characteristics are significant in understanding market dynamics [10].

The collective insights gained from these research efforts reveal the complex interplay between market dynamics, investment strategies, and the underlying mathematical and statistical models that inform them. It also makes a strong case for the All-Weather and Hurst Exponent, setting the stage for subsequent research.

3. Data and Method

3.1. Data and Sample

There are four basic standards to judge a company. They are momentum, quality, and value and market capitalization.

Momentum: In the same industry, stocks that have risen more in the past year are more likely to perform well in the next month.

Quality: In the same industry, stocks with better statements (more cash flow, less debt) over the past year are more likely to perform well in the next month.

Value: In the same industry, stocks with lower P/E ratio over the past year are more likely to perform well in the next month.

Market capitalization: In the same industry, stocks with lower Market capitalization over the past year are more likely to perform well in the next month.

The stock selection strategy is to pick stocks from top 50 in S&P500 from each sector and rank them in descending order of momentum and quality and in ascending order of value and market capitalization, ultimately selecting the top stocks in each sector as the portfolio. At the same time, TIPS and United States treasury bonds should be put in, because the portfolio need to meet the standard of the All-Weather strategy.

As shown in the table 1, the stocks cover the following sectors: finance, technology, healthcare, commodities and energy.

Table 1. Stock selected.

No.	Symbol	No.	Symbol	No.	Symbol	No.	Symbol
1	T	6	JPM	11	MSFT	16	PG
2	JNJ	7	VZ	12	GOOGL	17	CVX
3	PFE	8	BAC	13	AAPL	18	FB
4	MA	9	CSCO	14	NVDA	19	TYH24
5	BRK.B	10	INTC	15	NFLX	20	IBIJ

3.2. Method

3.2.1. Risk parity

Risk parity is to maximize risk diversification, rather than risk minimization. The portfolio risk is allocated to each asset in equal amounts in order to achieve portfolio optimization. In other word, equal distribution of risk among different assets in the portfolio is the core idea of risk parity. In this thesis, the risk parity model taken is All-Weather.

All-Weather is one of the strategies used by the Bridgewater which is the largest Hedge Fund. The idea of this strategy is to categorize economic environments into four categories: rising or falling economic growth, rising or falling inflation. Each economic environment is assigned the same risk weights - 25% of all assets in the portfolio allocated to each economic environment. As shown in the figure 1.

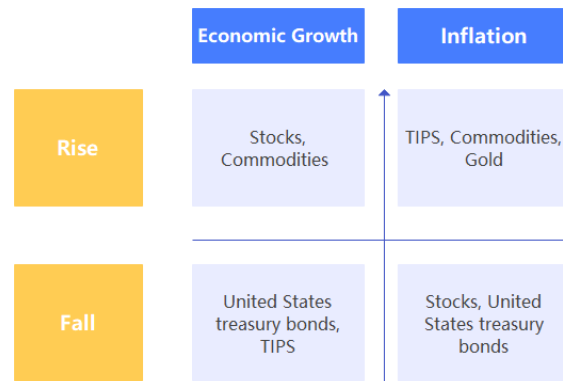


Fig 1. Categories.

Since the portfolio is profitable at every stage of the economy, the portfolio is no longer affected by the economic environment and the static portfolio can earn a steady income in all economic environments. This is the value of BETA in the CAPM model.

Although All-Weather is a static strategy, it still has a lot of room to operate when it comes to stocks. So, in stock part, the Hurst strategy is used.

3.2.2. The Hurst Exponent

The Hurst Exponent is a measure of whether a time series has a long-term memory and it is widely used in research on stocks and foreign exchange. The Hurst Exponent (H) is distributed between 0 and 1. It also divides 0 to 1 into 3 intervals. If $H = 0.5$ it means that the values of the time series are random. In other words, the future is unpredictable. If $H > 0.5$, then it has trend and the future trend is consistent with the past. The closer H is to 1, the greater the persistence. If $H < 0.5$, then it is mean reversion and the future trend is opposite to the past. The closer H is to 0, the more reversible it is.

In this article, the Hurst Exponent is compared to the rise in stocks, specifically, momentum (MTM). Momentum is a tool used to measure the speed or rate of price change. Momentum helps investors determine the strength of a trend by showing how fast prices are moving in a period of time. It is especially important to note that when the MTM moves up from below 0 to above 0, it only indicates that the downtrend has slowed down, but not means it is over, and vice versa. However, combining the Hurst Exponent and momentum can solve this problem, because it can show how strong the trend is and how likely it is that this trend will continue in the future simultaneously. Taken together, there are four possibilities and here is the conclusion: If the momentum in the past month is positive, buy when $H > 0.5$ and sell when $H < 0.5$. If the momentum is negative, buy when $H < 0.5$ and sell when $H > 0.5$.

4. Results and Discussion

4.1. VaR calculation

Each of the three asset classes needs to be assessed for risk and risk is calculated through VaR. It is calculated by formula (1).

$$VaR = \sqrt{(\sum w_i^2 * VaR_i^2)} \quad (1)$$

Then, the risk contribution is calculated by formula (2).

$$Risk\ contribution = Asset\ class\ weight * Asset\ class\ VaR \quad (2)$$

4.2. Momentum and Hurst Exponent calculation

According to the strategy mentioned before, there are two factors: Momentum and Hurst Exponent. Momentum is calculated by formula (3).

$$Momentum = V - V_x \quad (3)$$

$V = \text{Last price}; V_x = \text{Closing price}; x = \text{Number of days ago}$

Although as previously mentioned that MTM cannot indicate whether it will grow or fall, it shows the Intrinsic potential.

There are many ways to calculate the Hurst Exponent: Variance aggregation method, Periodogram method, etc. The author has used the R/S analysis to calculate it. It is calculated by formula (4).

$$(R/S)_n = C_n^H \quad (4)$$

R/S analysis has 8 steps:

(1) Split the data into time series of various sizes. The selection of ranges can be determined according to the characteristics of the data and the needs of the study, and the amount of data in each range should be large enough to ensure the reliability of the statistical results.

(2) Calculate the mean for each range.

$$mean_s = m_s = 1/n \sum_{i=1}^n X_i \quad (5)$$

(3) Calculate the deviation for each range.

$$Y_t = X_t - m \quad (6)$$

(4) Calculate the widest difference between the deviations.

$$R_t = \max(Y_1, Y_2, Y_3, \dots, Y_t) - \min(Y_1, Y_2, Y_3, \dots, Y_t) \quad (7)$$

(5) Calculate the standard deviation for each range.

$$\sigma = \sqrt{1/t \sum_{i=1}^t (x_i - m)^2} \quad (8)$$

(6) Calculate the R/S value for each range.

$$(R/S)_t = R_t / \sigma_t \quad (9)$$

(7) For each time series, the R/S values of the individual ranges were averaged to obtain Average R/S (ARS).

$$ARS = 1/n [Range(1/n).1 + Range(1/n).2 + \dots + Range(1/n).n] \quad (10)$$

(8) Calculate the Hurst Exponent.

$$\log ARS = \log C + H \log(n) \quad (11)$$

A linear regression of the above equation can calculate the value of H.

4.3. Results

Regression of the above equation can calculate the value of H.

The VaR calculated is listed in table 2. Assuming a 95% confidence level, VaR of Stocks, United States treasury bonds, TIPS are 5.27%, 0.87%, 1.32%, separately.

Table 2. The VaR of each asset.

Assets	VaR
Stocks	5.27%.
United States treasury bonds	0.87%
TIPS	1.32%

Then, through risk equalization, the final ratio of the three asset classes is 10:52:38. The overall VaR of the portfolio after the reallocation was 1.481%, which is 39.84% lower than the original 2.4618%.

The momentum of the portfolio can be derived from the formula (2) and is shown in the figure 2.

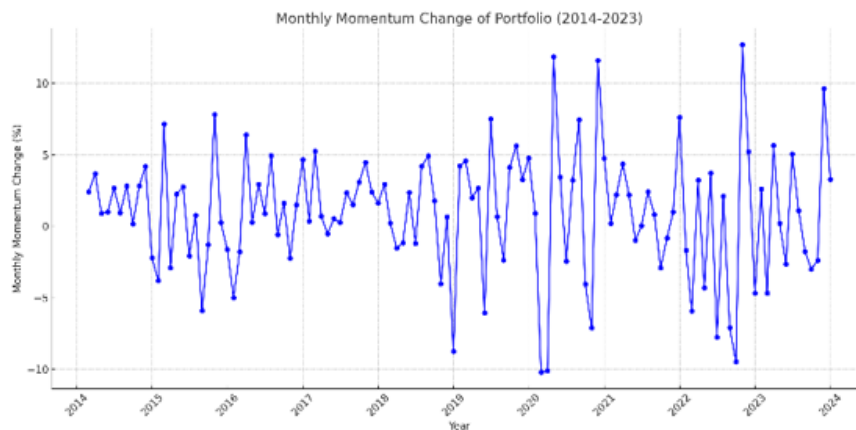


Fig 2. Monthly Momentum Change of Portfolio.

The H of portfolio is shown in figure 3.

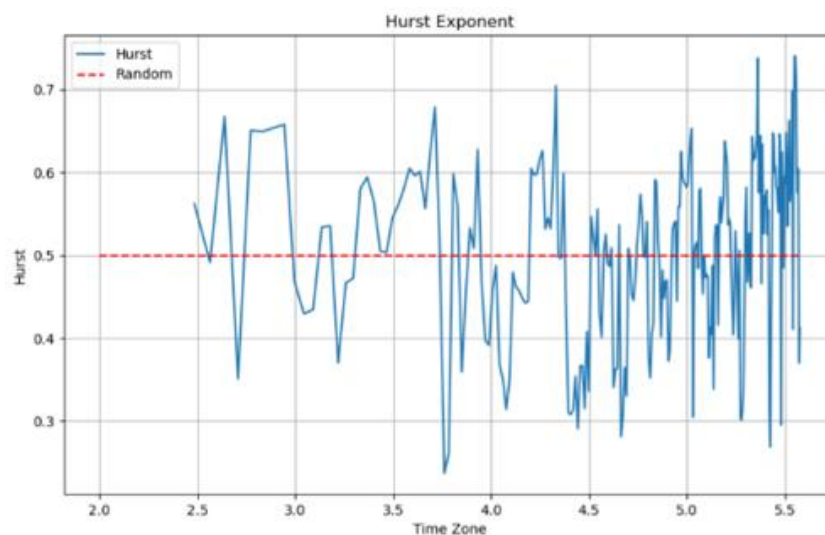


Fig 3. Hurst Exponent.

Buying these 18 stocks with equal weighting and setting a stop loss of 3%, Over the 10-year period from the beginning of 2014 to the end of 2023, the strategy (before transaction costs and slippage) would have an annualized return of approximately 17.82%, maximum retracement of 12%, and a Sharpe ratio of 0.9%.

The final return of the portfolio is 4.1654% annually.

In this paper, compared with the results in the research of Li [5], the returns are less in the case of using only the HURST Exponent. The reason for this is that CSI 300 has a value-oriented investment style compared to S&P 500, and its P/E ratio is relatively low. As mentioned earlier, the lower the P/E ratio in the same industry, the higher the future gains will be. However, it is worth mentioning that the maximum retracement is significantly smaller than Li's result because China's A-share market is relatively late in its development and the market volatility is higher, thus the risk of CSI 300 is also higher. Also, the length of the selected time series is a big factor.

If the All-Weather portfolio is also taken into account, for Wang's study, the risk shown in this paper is even lower because the risk parity methodology is used, which allows the risk in each period to be spread evenly across the different asset classes and greatly reduces uncertainty.

4.4. Further discussion: performance of strategy in GFC

The paper further discusses the resilience of diversification strategies during economic downturns, as evidenced by the 2008 financial crisis. By means of the Hurst Exponent method the return on equities in 2008 was -27.672%, but the equity investment represented only 10% of the portfolio. As

stated in section 4.2, a simple calculation gives the return on United States treasury bonds versus TIPS in a portfolio. The table 3 shows the average current year return on United States treasury bonds and TIPS for the 10 years prior to the economic crisis. The year with the lowest return was 2002, when the portfolio based on the strategy of this paper would have had a return of about 0.2318% during the crisis if it had been bought in that year. Whereas, if bought in 2000, there would have been a return of 1.5284%.

Table 3. The return of United States treasury bonds and TIPS.

Year	United States treasury bonds	TIPS	Returns
1998	4.67%	3.01%	3.5722%
1999	5.33%	3.42%	4.0712%
2000	5.82%	3.34%	4.2956%
2001	4.96%	2.97%	3.7078%
2002	4.05%	2.35%	2.9990%
2003	4.26%	2.48%	3.1576%
2004	4.67%	2.70%	3.4544%
2005	4.38%	2.64%	3.2808%
2006	4.83%	2.53%	3.4730%
2007	4.67%	2.10%	3.2264%

5. Conclusion

This study delves into the application of risk parity strategies in asset allocation and uses the Bridgewater Fund's All-Weather strategy as a proxy for the risk parity model. By classifying economic environments into four categories, the strategy aims to optimize portfolios through equal risk allocation, ensuring stable income in various economic environments. In addition, this study combines the Hurst Exponent and Momentum strategies to measure and forecast the performance of equity and fixed income assets. The results of the study show that by utilizing a combination of these strategies, it is possible to effectively increase overall portfolio returns while reducing risk. One caveat is that this paper, in its quest to minimize risk, inevitably leads to a significant reduction in returns. For investors with a higher risk appetite, the investment ratio can be changed appropriately to achieve the desired return.

The main significance of this study is that the combination of the two methods allows for a more accurate investment in the stock market over the long term and a less risky investment in the short term. Long-term performance, as verified above as well, reducing short-term risk can be demonstrated in section 4.5. However, although portfolio performed well in financial crisis, the portion of the investment using the Hurst Exponent still loses a lot. Unfortunately, while the combination of the All-Weather Portfolio and the Hurst Exponent can be used to a large extent to achieve profitability in all economic phases and have some ability to predict the ups and downs of the stock market, they do not have the means to cope with dramatic changes in the short term, and they are less flexible. Firstly, it is because accurate calculation of the Hurst Exponent requires data from longer time series. For short-term data, the calculated Hurst Exponent may not be sufficiently accurate or reliable. Secondly, the Hurst Exponent is calculated based on historical data and assumes that past market behavior will repeat itself in the future in the same or similar patterns. However, changes in market conditions and the economic environment may cause historical patterns to no longer apply. In other words, it cannot focus on news or changes in market emotions. Because of the above two points, the HURST Exponent is lagging and responds poorly in the face of unexpected situations, so this method did not succeed in predicting the economic and financial crisis of 2008. With the help of the All-Weather portfolio, there are some profits to be made.

Thus, when using this method, investors should consider additional indicators as an aid to gain a more comprehensive and in-depth understanding of the market.

References

- [1] Zhang, T. Empirical study of risk parity strategy in asset allocation. University of International Business and Economics, 2019.
- [2] Wang S-Y. Research on investment strategies of hedge funds. Northeast University of Finance and Economics, 2021.
- [3] Zhang L. Momentum effect: Causes explanation and strategy design. Shandong University of Finance and Economics, 2023.
- [4] Yang S-W, Zhang S-P. Application of R/S analysis and time series similarity on security index forecasting. Information Systems Engineering, 2016, (09): 130-133.
- [5] Li M-H. Research on Quantitative Investment Strategy Based on Hurst Exponent. Modern Information Technology, 2023, 7 (22): 83-87+91.
- [6] HUO Y-Y. Long memory analysis of CITIC S&P stock index. Jinan University, 2015.
- [7] Nirhale, Nikhil. Estimation of the Hurst Exponent in Fractional Brownian Motion Driven Volatility Using High Frequency Data and Option Price. ProQuest Dissertations and Theses Full-text Search Platform, 2018.
- [8] Huang W-Q, Tang F.J... Trend and persistence of bond market trend from Hurst Exponent. Bond, 2017, (12): 62-64.
- [9] Yu J-G, Wu C-F. Financial Market Risk, Financial Market Ineffectiveness and Multiple Fractals-A Comparative Analysis Based on CSI 300 Stock Index Futures and Hang Seng Stock Index Futures. Shanghai Finance, 2015, (05): 67-78+95.
- [10] Sun L-H, Ren B. Application of Hurst Exponent in Hebei Province SSE Stocks. Journal of Hebei University of Economics and Trade (General Edition), 2011, 11 (01): 75-78.