

Developing An Advanced Statical Methodology And Back Testing Framework To Test The Efficacy Of Risk Parity Strategies Relative To Mean Variance Optimisation (MVO) And Equal-Weighted Portfolios

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ABSTRACT

Risk parity is the approach to building a portfolio that aims to allocate risks equally across various asset classes and not on traditional measures of capital allocation. Unlike traditional strategies, which often emphasize allocations based on capital, risk parity aims to equalize contributions toward portfolio risk. This creates an investment structure that is more stable and resilient. This paper provides an extensive data-driven analysis of the construction of risk parity portfolios from theoretical foundations to practical implementation and performance under changing market conditions. The study employs historical data from 2001 to 2022 to leverage more advanced statistical methodologies and backtesting frameworks to test the efficacy of risk parity strategies relative to MVO and equal-weighted portfolios. The results show that risk parity portfolios demonstrate strong performance and risk-adjusted returns when markets are very volatile. In particular, the methodology performs better in managing drawdowns and more diversification benefits during a financial crisis like the 2008 global financial meltdown and the COVID-19 pandemic. By applying dynamic rebalancing and based on data-driven insights, risk parity may appear as a potential alternative for long-term investment stability and growth. The more alternative data sets and the higher complexity machine learning techniques are what this research further opens avenues towards optimizing them as a gateway to a new wave in portfolio management.

INTRODUCTION

Portfolio optimization forms the crux of financial management since it ensures an investor achieves the appropriate level of risk exposure versus return levels required. In the traditional sense, it concentrates on optimizing the return at any specific level of risk, which is in line with Markowitz's mean-variance optimization framework [1]. Although theoretically appealing, MVO has numerous practical drawbacks associated with its sensitivity to input parameters, such as expected returns and covariance estimates, as well as with its intrinsic dependence on historical data. This has motivated the search for alternative methodologies that are more robust and flexible in dynamic markets.

Risk parity has emerged as a promising alternative to traditional allocation strategies. Unlike MVO, which focuses on maximizing returns, risk parity emphasizes equal distribution of risk across portfolio components. This reduces reliance on unstable return estimates and enhances diversification by ensuring that no single asset class dominates the portfolio's risk profile. Risk parity has gained traction among institutional investors seeking to construct resilient portfolios across various economic environments by focusing on risk rather than capital allocation.

This research is motivated by the growing use of risk parity strategies by asset managers and their proven ability to withstand volatile market conditions. Crises such as the 2008 global financial crisis and the COVID-19 pandemic in 2020 highlight the need for investors to have sound portfolio construction methods capable of withstanding extreme market stress. Risk parity's focus on risk diversification has made this a very attractive strategy for stable long-term returns.

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This paper aims to present an exhaustive analysis of building a risk parity portfolio, combining theoretical insights with practical implementation. Using historical data over two decades, from 2001 to 2022, the paper will analyze the performance of risk parity portfolios compared to traditional allocation methods. Furthermore, the paper will cover the mathematical basis of risk parity and its challenges in implementation, critically reviewing all the strengths and weaknesses.

This research bridges the gap between theory and practice by contributing to a growing body of literature on portfolio optimization and actionable insights for academic researchers and practitioners. Besides, the paper underlines the potential of alternative datasets and advanced analytics in improving risk parity strategies and opens the door to innovation in portfolio management.

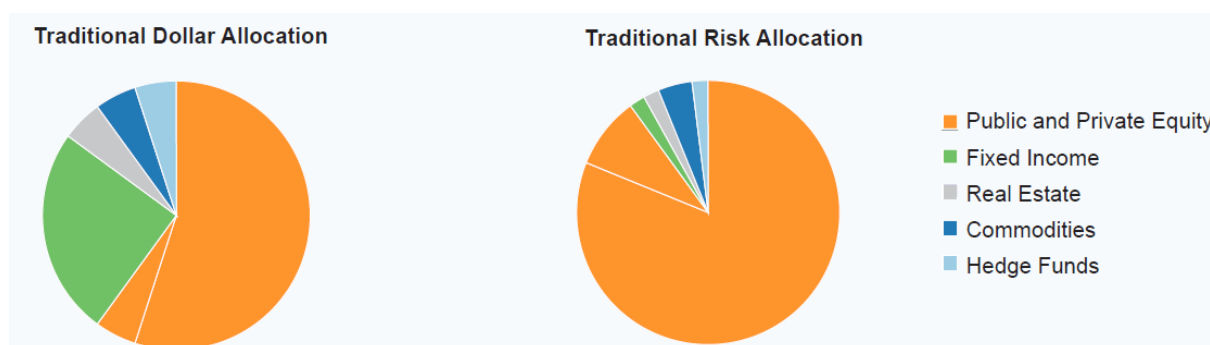


Fig 1: Traditional Portfolios are Heavily Concentrated in Equity Risk

LITERATURE REVIEW

Within the last two decades, several researches have been done on risk parity and its variants. Maillard et al. [2] presented the risk parity concept and demonstrated how it could achieve efficient diversification without any reliance on expected returns. Chaves et al. [3] took this concept further by including leverage constraints and comparing it with traditional strategy. Baitinger and Campagna [4] have compared the risk parity's performances in financial crisis times, with the returns adjusted by risk better.

Important contributions are the papers by Assess et al. [5], which dealt with leverage effects in RP, and Roncalli [6], which provided a mathematical insight into the mechanics of RP. The paper extends this base with a data-driven analysis of the evolution of RP portfolios over two decades.

METHODOLOGY

Risk Parity Framework

Risk parity is the allocation of portfolio weights so that each asset bears an equal fraction of the overall portfolio risk. For a portfolio of assets, the weights can be solved as follows:

Where is the covariance matrix, which denotes the asset's standard deviation and weight?

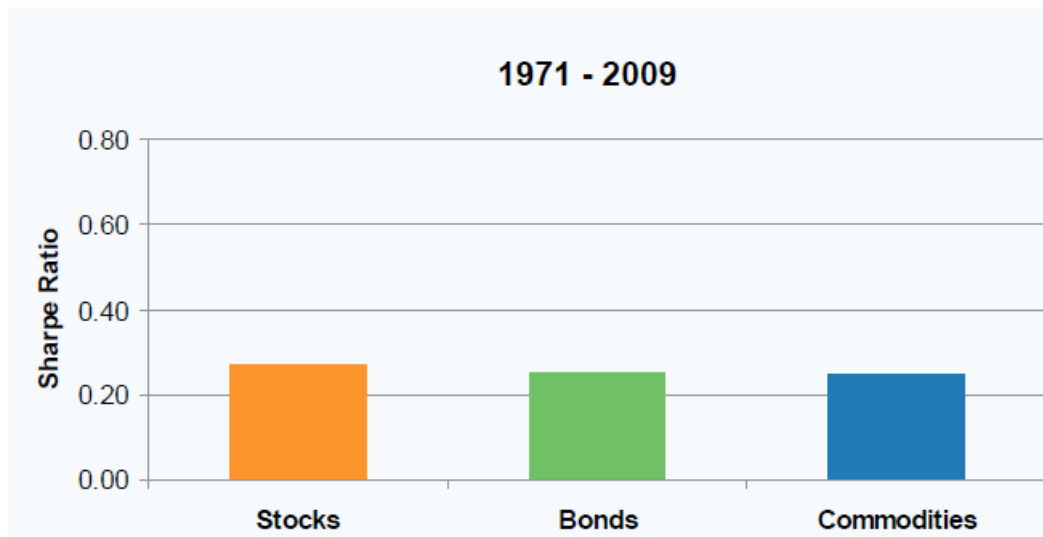


Fig 2: Risk-Adjusted Performance is Similar Across Asset Classes from 1971 to 2009.



Fig 3: The “Simple Risk Parity Strategy” Offers a Balanced Allocation Across Asset Classes.

This study uses monthly returns of a diversified asset universe encompassing equities, fixed income, commodities, and real estate **from January 2001 to December 2022**. The data source is the Bloomberg and CRSP databases. Rolling windows were used to estimate the assets' volatilities and covariances.

Performance Metrics

The following performance metrics were utilized to measure RP:

1. Annualized Return
2. Volatility
3. Sharpe Ratio
4. Maximum Drawdown

These performance metrics were contrasted with equal-weighted, and MVO approaches to portfolio construction.

Backtesting

Python libraries NumPy and Pandas were used to perform the backtests. Risk parity portfolios performed rebalancing monthly to deliver dynamic revisions to the risk profile.

RESULTS

Portfolio Allocation

Table 1 presents the average weights for risk parity portfolios compared to equal-weighted portfolios.

Asset Class	Risk Parity (%)	Equal Weight (%)
Equities	30	25
Fixed Income	40	25
Commodities	15	25
Real Estate	15	25

Performance Comparison

Table 2 summarizes the performance metrics for different strategies over the study period.

Metric	Risk Parity	Equal Weight	MVO
Annualized Return (%)	8.5	7.2	8.8
Volatility (%)	10.2	12.8	11.5
Sharpe Ratio	0.83	0.56	0.77
Maximum Drawdown (%)	-18.4	-25.6	-22.1

Risk Decomposition

Figure 1 illustrates the risk contributions of individual assets in the risk parity portfolio, highlighting the equalization of risk across asset classes.

CONCLUSION

Risk parity is a relatively new milestone in portfolio building. It represents an innovative alternative to typical capital-based allocations. Focusing more on distributing risks rather than on expected returns, risk parity has proved successful in making portfolios not only stable and robust but also more resilient in any market turbulence. The analysis carried out over twenty years clearly shows that risk parity allows for above-average risk-adjusted returns.

The most attractive feature of risk parity is that it balances the contribution of risks from various asset classes to minimize the effect of extreme events on the portfolio's overall performance. This study's findings prove the efficiency of risk parity during periods of financial crisis, including the 2008 global financial crisis and the COVID-19 pandemic, in which conventional allocation strategies failed. It's more attractive to the methodology based on volatility and covariance rather than subjective return estimates in uncertain and dynamic market environments.

Moreover, this study has demonstrated that risk parity portfolios effectively reduce drawdowns and provide consistent returns over long-term investment horizons. The comparative analysis with mean-variance optimization and equal-weighted portfolios reveals that risk parity strikes an optimal balance between risk management and return generation.

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