Evaluating the Efficacy of CPPI Strategies in Risk Management

Introduction to CPPI

Constant Proportion Portfolio Insurance (CPPI) can be best classified as a "Risk Overlay" strategy. This classification stems from the strategy's core mechanism of using dynamic reallocation between risky and safe assets to manage and hedge the portfolio's risk.

The strategy became popular as a simple and systematic overlay strategy that provides portfolio protection while maintaining exposure to upside potential. The fundamental idea behind CPPI is to dynamically adjust the exposure between a risky asset (like equities) and a conservative asset (like bonds or cash), based on the fluctuations in the market value of the portfolio. The key parameters of the basic versions are the predefined floor value, below which the value of the portfolio should not fall, and the multiplier, which determines how aggressively the portfolio can invest in the risky assets relative to the cushion—the difference between the current portfolio value and the floor value. As the market value of the risky assets increases, the cushion expands, allowing for increased investment in these assets. Conversely, if the value of the risky assets declines, the investment is reduced to protect the floor value.

$$E_t = m \times (V_t - F)$$

Et is the exposure to the risky asset at time t.
m is the multiplier, which determines the level of exposure to the risky asset.
Vt is the total portfolio value at time t.
F is the floor value, below which the value of the portfolio should not fall.

How CPPI Works

The theoretical foundation of CPPI is rooted in the principles of option pricing theory. It mimics the payoff structure of a put option, where the investor's portfolio is insured against falling below a certain level (the floor). The strategy behaves similarly to owning a portfolio of risky assets combined with a protective put option. This theoretical basis draws heavily from the Black-Scholes option pricing model, where dynamic rebalancing

mimics the option's protective features without the need to actually purchase options. By adjusting the allocation between risky and safe assets as the market value of the portfolio changes, CPPI effectively creates a synthetic put option, providing downside protection while allowing for participation in upward market movements. This method leverages the concept of leveraging and derisking based on preset rules, which helps maintain a balance between risk and return, thus maximizing the portfolio's growth potential within a controlled risk framework.

Investment Thesis

The CPPI strategy doesn't exploit market inefficiencies in the traditional sense—such as mispriced securities or arbitrage opportunities—but rather capitalizes on the inefficiencies of market timing and investor psychology. Here's how it potentially generates alpha compared to a buy-and-hold strategy:

1. Market Timing Efficiency:
    - CPPI inherently adjusts the portfolio's exposure to risky assets based on the market's movements, effectively timing the market without the need for predictive forecasts. In volatile markets, this allows CPPI to reduce exposure to risky assets when market prices are falling, thereby protecting the portfolio from severe losses. Conversely, when markets are rising, CPPI increases investment in risky assets, which can enhance returns.
    - This dynamic rebalancing strategy often performs better than a buy-and-hold approach in responding to cyclical market trends, particularly in times of high volatility. It takes advantage of the regular fluctuations in market prices by maintaining a disciplined approach: it buys more when the prices are low and sells more when the prices are high.
2. Psychological Inefficiency:
    - Investor behavior is often driven by emotional reactions to market movements, leading to suboptimal decisions such as panic selling during downturns or exuberant buying in rising markets. CPPI's mechanical nature removes emotional bias from the investment process, adhering strictly to predefined rules for asset allocation based on the portfolio's performance relative to its floor.
    - By systematizing the investment process, CPPI mitigates the risk of emotional trading, which can erode returns in a buy-and-hold strategy during turbulent periods.

3. Loss Aversion Efficiency:
    - CPPI specifically addresses the psychological bias of loss aversion, where investors are disproportionately more sensitive to losses than to gains. The strategy ensures that the investor's exposure to downside risk is limited, providing psychological comfort and enabling more rational decision-making in other areas of asset management.
    - This protective feature can result in higher effective returns as it prevents the portfolio from suffering irrecoverable losses during market downturns, potentially leading to better long-term performance compared to a strategy that might experience significant drawdowns.

Critical Assumptions

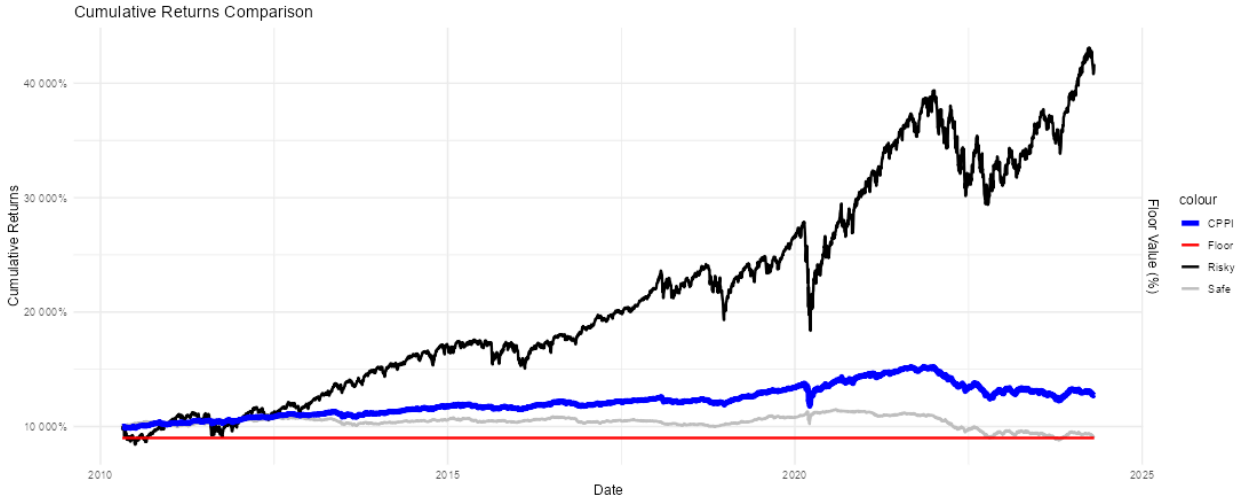
The effectiveness of CPPI hinges on several critical assumptions:

1. Stable and Predictable Floor Value: The strategy assumes that the floor value is stable and known in advance. Any miscalculation in setting the floor, or unexpected need for liquidity that forces the sale of assets below the floor value, can undermine the strategy's protective mechanism.
2. Continuous and Sufficient Market Liquidity: CPPI requires the ability to quickly and efficiently rebalance the portfolio according to the formula. This assumes that market conditions will allow for such transactions without significant slippage or transaction costs.
3. Moderate Market Volatility: While CPPI is designed to mitigate risks in volatile markets, extremely high volatility can lead to rapid depletion of the cushion, necessitating frequent and substantial rebalancing. This can increase transaction costs and may lock in losses if the rebalancing occurs during unfavorable market conditions.
4. Reliable Multiplier Effectiveness: The multiplier in CPPI is key in determining the investment level in risky assets compared to the cushion. Setting the multiplier too high can expose the portfolio to excessive risk in market downturns, which may lead to breaches of the floor. Conversely, a very low multiplier might not capture enough growth during market recoveries.

Performance Analysis

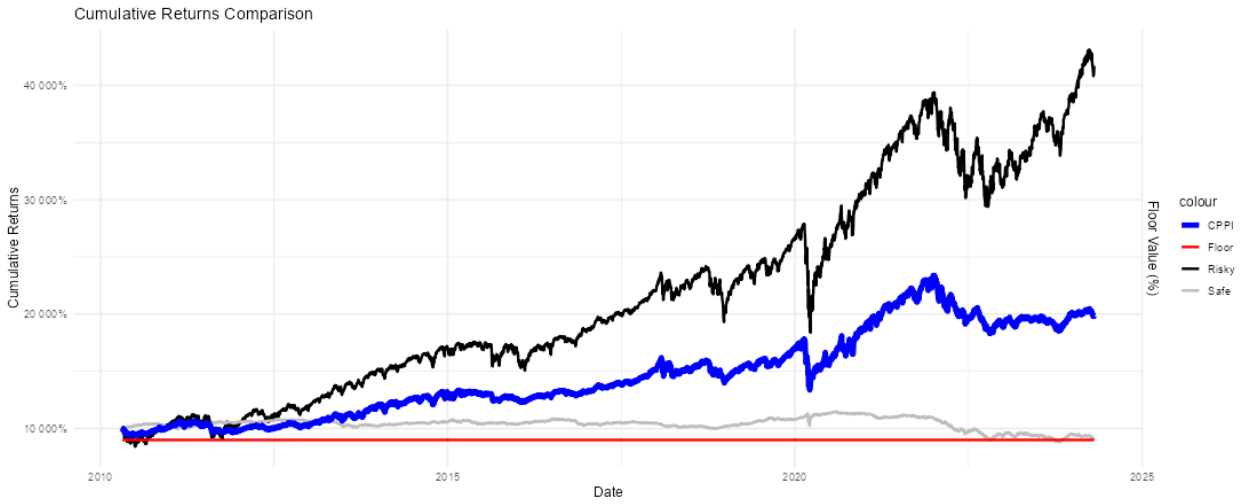
The strategy is live and accessible on AWS. Please test yourself. This interactive platform allows users to experience the CPPI strategy in real-time by adjusting variables such as the floor and multiplier. Users can analyze different configurations, such as:

Floor = 80%, Multiplier = 2



Floor = 90%, Multiplier = 2

Floor = 80%, Multiplier = 6



Floor = 90%, Multiplier = 6

Further Research

Future research could focus on refining the CPPI model by integrating machine learning techniques to optimize the floor and multiplier settings based on predictive market analytics. Additionally, examining the impact of incorporating alternative asset classes such as commodities or real estate could provide deeper insights into the strategy's adaptability and effectiveness in diverse financial environments. Comparative studies between CPPI and other risk management strategies under extreme market conditions would also enrich the existing body of knowledge, potentially leading to more robust portfolio insurance solutions.

- Mancinelli, Daniele, and Immacolata Oliva. "Constant or Variable? A Performance Analysis among Portfolio Insurance Strategies." *Risks* 2023, 11(6): 105. https://doi.org/10.3390/risks11060105.
    - The study by Mancinelli and Oliva provides a comprehensive comparison among three portfolio insurance strategies: constant proportion portfolio insurance (CPPI), time-invariant portfolio protection (TIPP), and exponential proportion portfolio insurance (EPPI). Employing a model-free analysis using bootstrapping techniques, the paper investigates the potential returns, risk exposure, downside protection, and market upside capture capabilities of these strategies. Results suggest that TIPP generally offers better downside protection but fails to fully capture market upsides, compared to CPPI. In contrast, EPPI tends to mirror CPPI in terms of market participation but offers less effective downside risk mitigation. The findings highlight that no single strategy consistently outperforms the others across different market conditions, rebalancing frequencies, or protection levels, illustrating the complex trade-offs involved in choosing a portfolio insurance strategy.
- Esipov, Sergei, and Igor Vaysburd. "Dynamic Investment Strategies: Portfolio Insurance Versus Efficient Frontier." Centre Solutions, a member of the Zurich Financial Services Group, One Chase Manhattan Plaza, New York, NY 10005, Martingale Technologies Inc, One Wall Street Court, Suite 300, New York, NY 10005. Link
    - The paper by Sergei Esipov and Igor Vaysburd explores dynamic investment strategies through a theoretical lens, developing a partial differential equation framework to analyze the profit and loss distributions of various strategies dependent on asset value and account balance dynamics. They examine strategies like the constant proportion portfolio insurance (CPPI) and compare them to dynamic efficient frontier models under different conditions, utilizing the concept of controlled downside and Sharpe ratio optimization. Their analysis reveals that while CPPI strategies typically show lower Sharpe ratios due to their design for controlled risk and limited downside, they may not capture high returns as efficiently as dynamic efficient frontier strategies, which can exhibit uncontrolled downside risks. The study highlights the complexity of selecting optimal investment strategies that balance risk and return, particularly under varying market conditions and investment horizons.
- Cont, Rama, and Peter Tankov. "Constant Proportion Portfolio Insurance in presence of Jumps in Asset Prices." *Columbia University Center for Financial*

Engineering, Financial Engineering Report No. 2007-10. Columbia University, 2007. http://ssrn.com/abstract=1021084.

- The paper by Rama Cont and Peter Tankov examines the behavior of Constant Proportion Portfolio Insurance (CPPI) strategies in environments where asset prices are subject to jumps, contrasting the more commonly modeled diffusion processes. Their research indicates that CPPI strategies, while effective in diffusion models with continuous trading, are susceptible to non-negligible downside risks in real markets due to potential price jumps. They introduce an analytically tractable framework for calculating the likelihood of breaching the portfolio's floor, the expected loss, and the distribution of losses when price jumps occur. This framework allows for the assessment of "gap risk" and proposes adjustments to the CPPI multiplier based on the investor's risk tolerance. Their model quantifies the increased gap risk as the multiplier increases and utilizes a Fourier transform method for computing various risk measures (like VaR and expected loss) for CPPI strategies. Their analysis highlights the crucial role of selecting the right multiplier and hedging options to manage the downside risk effectively, especially in volatile markets.

- Hoque, Ariful, Robin Kämmer, and Frieder Meyer-Bullerdiek. "Portfolio Insurance Strategies in a Low Interest Rate Environment: A Simulation-Based Study." *Journal of Finance and Investment Analysis*, vol. 7, no. 3, 2018, pp. 11-35. Scienpress Ltd. Link
    - In their study, Hoque, Kämmer, and Meyer-Bullerdiek investigate the effectiveness of various portfolio insurance (PI) strategies under conditions of low or negative interest rates through Monte Carlo simulations. They focus on strategies like buy-and-hold (B&H), Constant Mix, Stop Loss, Constant Proportion Portfolio Insurance (CPPI), and Time Invariant Portfolio Protection (TIPP). The research reveals that low interest rates significantly impact the performance rankings of these strategies, with CPPI showing particular strength under such conditions. The study highlights that while B&H and Constant Mix strategies maintain relatively good performance according to Sharpe and Treynor ratios, they perform poorly when evaluated with Sortino Ratio and Lower Partial Moment (LPM) measures, especially under negative interest rates. CPPI strategies, notably, adapt well to varying conditions due to their flexibility in managing risk and return through different multipliers, making them more robust against the challenges posed by low interest rates.