# 2025 Recommendation for Internal Capital Deployment

Ludvig Strömberg

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## Executive Summary

The Treasury and Risk Control divisions tasked the analysis with identifying an investment strategy for the 2025 operating year that balances the bank's internal capital preservation and capital-efficiency requirements for managing a portion of its surplus capital. This review considered both static buy-and-hold allocations and dynamic CPPI-based strategies under recession, base, and expansion macro conditions.

Based on the 2025 scenario-based simulations, we recommend CPPI(3) as the strategy that best satisfies the bank's objectives. This recommendation is underpinned by three key reasons, being that CPPI(3):

- **Meets all downside capital-protection objectives**—VaR, Expected Shortfall, and capital-breach probability—under both baseline and stressed market conditions, while buy-and-hold and higher risk CPPI strategies either fail or risk failing to varying degrees.
- **Offers competitive upside exposure** relative to viable alternatives, offering stronger expected return and expansion asymmetry than lower-risk CPPI's, while maintaining substantially lower sensitivity to downside constraint violation than more exposed CPPI's.
- **Demonstrates superior risk-adjusted performance** under the bank's internal risk-budget framework, exhibiting tight VaR/ES protection and the strongest balance of upside participation to risk-objective security.

**Recommendation**: Use CPPI(3) as the investment strategy to manage the surplus capital, ensuring strong protection against adverse market conditions while retaining meaningful participation in potential market upside.

## 1 Scenario

As of 2024-12-31, a bank's Treasury and Risk Control divisions must determine how a portion of the bank's surplus liquidity should be managed for the 2025 operating year. The recent global environment is rife with macro-political and policy uncertainty entering 2025, with a financial climate defined by sharp downturns paired with strong expansion periods across major markets. This backdrop necessitates strategy that is able to participate in persisting market momentum, while being stress-resilient to potential crashes. The portfolio will support internal capital buffers, liquidity coverage, and capital efficiency preferences in order to protect balance-sheet resilience while not forgoing upside participation.

As such, the portfolio has received certain internal objectives on Value-at-Risk (VaR), Expected Shortfall (ES), as well as probabilistic goals for running capital levels ($W_t$) and terminal return ($r_T$), The starting capital amount is $\$1,000,000$, and the portfolio has the following objectives to the end of 2025[1]:

i. $\text{VaR}_{95\%} \leq \$120,000$,
ii. $\text{ES}_{95\%} \leq \$150,000$,
iii. $\mathbb{P}(W_t \text{ breaching } \$900,000) \leq 25\%$,
iv. $\mathbb{E}[r_T] \geq 5\%$,
v. $\mathbb{P}(r_T \geq 8\%) \geq 40\%$.

Beyond these objectives, we make general analytical risk-performance assessments in order to gain holistic perspectives and delineations. Investments are made in a risky and a riskless asset class and our task is to recommend the strategy that best supports the bank's objectives.

## 2 Methodology

### 2.1 Data

We assume SPY as our risky investment, and obtain data (retrieved from Yahoo Finance) from the recent 5 year period—2020 through 2024—initializing our projective analysis at the start of 2025. We use this data estimate realistic expected future conditions, equity drift and volatility. In order to infer how sensitive our analysis is to different future possibilities, we create two scenarios in addition to the baseline expectation: (1) a recession scenario based on the segment in year 2022, and (2) an expansion scenario based on the segment in year 2024. These expansion/recession conditions will be assumed as best/worst-case scenarios to assess the robustness and profile of the strategies and their analysis.

Further, we let the Federal Funds Rate (FFR) imply expected risk-free rate of returns. We obtain current data from FRED and projections of the FFR targets from the Summary of Economic Projections (SEP) issued by the Federal Open Market Committee (FMOC) on December 18, 2024. We use the current upper and lower target bounds to compute the current median FFR target, and use linear interpolation to get a smooth transition from today's level (4.4%) to the projected level at the end of 2025 (3.9%). This captures the committee's expectations of policy and macro-structures, and this FFR forecast will represent the expected short rate, which we let approximate the short-term risk-free asset returns (e.g. from rolling Treasury

[1] We account this case in USD for convention and convenience

Bills). Further, we set a high-rate scenario transitioning up to 5% and a low-rate scenario down to 1% for sensitivity testing on interest rate risk. These are rate levels that have been observed in the recent years.

### 2.2 Models & Simulation

We simulate SPY prices as geometric Brownian motions, where we derive the regime-specific drift and diffusion parameters from the sample mean return $\bar{r}$ and sample standard deviation of returns $s$ estimated from the corresponding scenario data. We obtain the following market scenarios:

- Baseline Scenario: $\{\bar{r} = 13.4\%,\ s = 20.2\%\}$,
- Recession Year: $\{\bar{r} = -18.5\%,\ s = 23.2\%\}$,
- Expansion Year: $\{\bar{r} = 23.8\%\ s = 12.3\%\}$,

in addition to those we will have for the low rate and high rate scenarios within baseline market parameters to test marginal rate sensitivity. We simulate a range of Buy-and-Hold (BH) as well as Constant Proportion Portfolio Insurance (CPPI) strategies, where the equity/cash proportions for the BH's are 40/60, 60/40, 80/20, and 100/0, and the CPPI multipliers are 2, 3, 4, and 5. Since it is our objective is to have VaR $\leq \$120,000$, we let the floor of the CPPI's be (the present value of) $\$880,000$. We reallocate weekly, and assume that transaction costs and other unaddressed market frictions are negligible.

We simulate each strategies on 100,000 market price paths in each scenario and compute the objective metrics for comparison. In addition, we also choose to track the median, Omega ratio ($\Omega$) and the Upside Potential ratio (UPR) of the terminal returns to get additional points of view on the upside vs downside profile of our results. The Omega ratio indicates the favorability across the full distributional shape, whereas UPR focuses on the expected upside capture per unit of downside risk. Since we have the expected return objective of 5%, we use this as the threshold argument for both of these ratios.

## 3 Results & Analysis

Figure 1 provides a visual illustration of the results. The first thing we see is that the effects of interest rate scenarios are very small, materially insignificant in most cases in comparison to market uncertainty. CPPI strategies have much more controlled VaR and ES compared to BH strategies, and the probability of breaching running capital level requirement explodes as both strategy types become more risk aggressive. Similarly, the CPPI strategies have less volatile median and expected returns, whereas the BH strategies somewhat higher overall, leading to the CPPI's having much more downside control although all strategies naturally fail the expected return criteria to a greater or lesser extent in the recession scenario. The case is similar for (v) but with more uniform sensitivity across the board. Both utility ratios show extreme sensitivity since volatility constricts in the expansion scenario with very high returns, and the recession scenario essentially erodes the expected upsides.

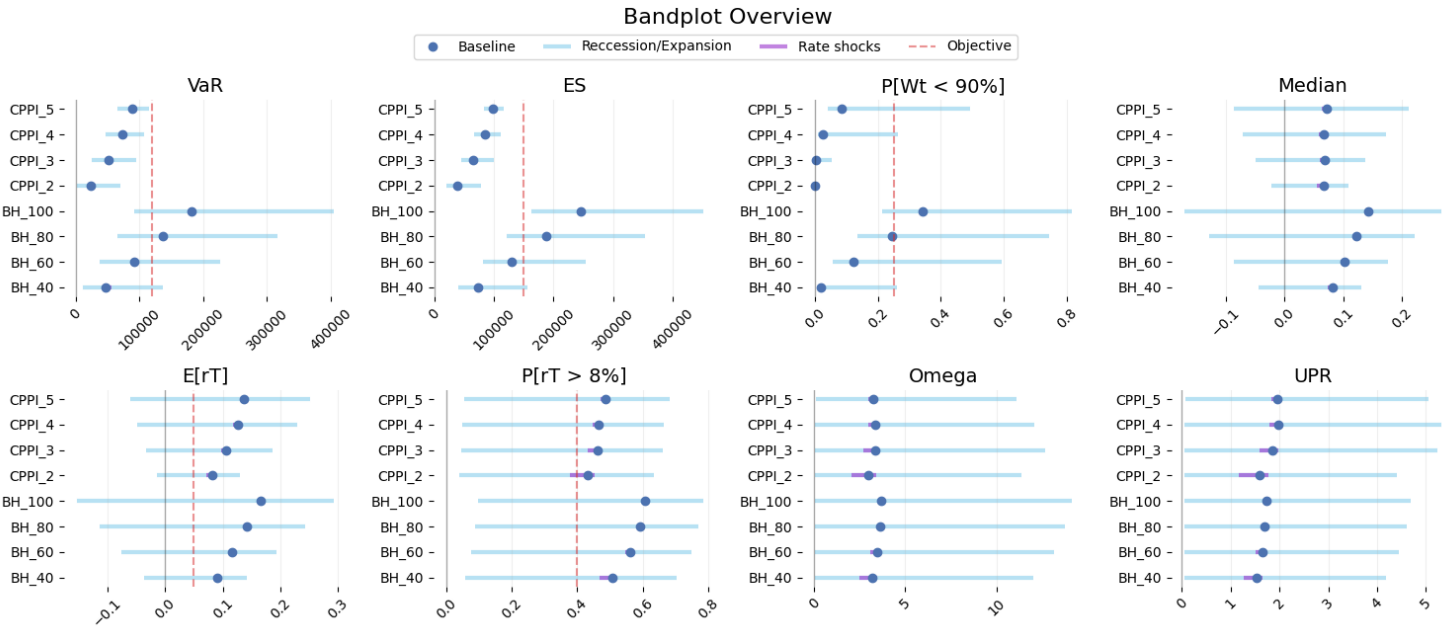


Figure 1: Band plot overview, locating the baseline results and visualizing sensitivity ranges of the low/high rate scenarios as well as recession/expansion market scenarios. Note that names are simplified, but we have, from left to right and top to bottom: (i), (ii), (iii), Median, (iv), (v), Omega ratio, UPR.

We find that BH(100) and BH(80) violate the downside constraints (i), (ii) and (iii) outright, while BH(60) quickly fails as market conditions worsen from baseline and BH(40) marginally fails in the worst case scenario. Immediately, from this, we can see that the volatility to market conditions make BH(60+) unviable. Similarly CPPI(5) unacceptably violates the running capital level requirement in adverse conditions. CPPI(4) also risk failing (iii) marginally, while CPPI(2) and CPPI(3) are significantly less sensitive to market stress and are able to comfortably meet all downside risk objectives.

All strategies fail to meet (iv) and (v) in stressed market conditions, with CPPI(2) also risking to fail (v) if interest rates see a significant decline back down toward the 1% level. CPPI(4) has good expected return, but pays for it by risking to fail (iii). CPPI(3) is very similar to CPPI(4) in median and (v) while being more noticeably lower in expected return, whereas CPPI(2) appears overly safe for our risk-appetite and capital-efficiency preferences.

Table 1 contains the numerical results for the baseline projection. Omega ratios indicate that CPPI(3) and CPPI(4) strike the best balance of expected profit to expected losses, with better scores than CPPI(2) and BH(40), and we further see that the upside potential maximizes around CPPI(4). We additionally look at the median of terminal returns, since CPPI's have an inherently asymmetrical profile, and the mean gets skewed by outliers of disproportionately positive results in the high upward-momentum cases. Our results illustrate this, with the median returns being substantially lower for the CPPI strategies compared to BH strategies. This also plays a role in the ratios, which are inherently based on expectations.

Table 1: Baseline scenario, numerical results of objective and performance metrics. Note that are partly simplified, but we have, from left to right: (i), (ii), (iii), Median, (iv), (v), Omega ratio, UPR.

| | $\text{VaR}_{95\%}$ | $\text{ES}_{95\%}$ | $\mathbb{P}(W_t < 90\%)$ | Median | $\mathbb{E}[r_T]$ | $\mathbb{P}(r_T > 8\%)$ | $\Omega$ | UPR |
|---|---|---|---|---|---|---|---|---|
| BH(40) | \$47,676 | \$73,229 | 1.7% | 8.2% | 9.1% | 50.7% | 3.168 | 1.539 |
| BH(60) | \$92,224 | \$130,553 | 12.3% | 10.2% | 11.6% | 56.3% | 3.449 | 1.643 |
| BH(80) | \$136,772 | \$187,877 | 24.5% | 12.2% | 14.1% | 59.1% | 3.600 | 1.699 |
| BH(100) | \$181,320 | \$245,202 | 34.2% | 14.2% | 16.6% | 60.8% | 3.694 | 1.733 |
| CPPI(2) | \$24,638 | \$38,659 | 0.0% | 6.7% | 8.3% | 43.2% | 2.978 | 1.588 |
| CPPI(3) | \$51,354 | \$65,679 | 0.1% | 6.9% | 10.6% | 46.2% | 3.326 | 1.863 |
| CPPI(4) | \$72,861 | \$85,343 | 2.3% | 6.6% | 12.6% | 46.6% | 3.349 | 1.974 |
| CPPI(5) | \$89,040 | \$98,845 | 8.6% | 7.1% | 13.7% | 48.6% | 3.245 | 1.964 |

In Table 2 we can compare the numeric ranges, of which of course the recession side is of greatest focus. This is complemented by Table 3, which shows the numerical amounts to which the objective constraints are violated in the recession scenario. We see that both CPPI(3) and CPPI(4) have very limited potential violations. Although CPPI(4) only violates the probability constraint in (iii) by 1.5 percentage points (pp), we know that the 0.0 pp violation CPPI(3) makes is with significant margin, where the probability of capital level breach is only 5.4% for CPPI(3) v.s. 26.5% for CPPI(4). BH(40) has a 26% probability, for a 1 pp violation, comparably to CPPI(4). The VaR for the CPPI strategies are below the objective in the worst scenario, and we further see that the they exhibit very strong tail suppression, leading ES to track VaR very tightly. BH(40) marginally violates both VaR and ES in the recession scenario, putting VaR at \$137,233 for a \$17,233 breach, and ES at \$155,789 for a \$5,789 breach.

The upside profile is very similar for CPPI(3) and CPPI(4). Although the median differs in the baseline case, the ranges are almost identical across the tail scenarios. On the other hand, in expected return CPPI(3) is higher in the baseline case and has superior scenario range, from the same lowest point, to a substantially higher upward mobility. CPPI(4) higher expected return but at higher uncertainty, making both bigger breaches in the worst case as well as bigger excesses in the best case.

Table 2: Ranges across recession → expansion, of objective metrics and median terminal return included. Note that names are simplified, but we have, from left to right and top to bottom: (i), (ii), (iii), Median, (iv), (v).

| | $\text{VaR}_{95\%}$ | $\text{ES}_{95\%}$ | $\mathbb{P}(W_t < 90\%)$ | Median | $\mathbb{E}[r_T]$ | $\mathbb{P}(r_T > 8\%)$ |
|---|---|---|---|---|---|---|
| BH(40) | \$137,223 → \$11,872 | \$155,789 → \$40,219 | 26.0% → 0.5% | -4.3% → 13.2% | -3.6% → 14.2% | 5.9% → 70.2% |
| BH(60) | \$226,545 → \$38,518 | \$254,393 → \$81,038 | 59.3% → 5.6% | -8.6% → 17.7% | -7.5% → 19.3% | 7.8% → 74.8% |
| BH(80) | \$315,866 → \$65,164 | \$352,997 → \$121,857 | 74.4% → 13.6% | -12.8% → 22.2% | -11.4% → 24.3% | 8.9% → 77.1% |
| BH(100) | \$405,188 → \$91,810 | \$451,601 → \$162,676 | 81.8% → 21.5% | -17.0% → 26.7% | -15.3% → 29.3% | 9.6% → 78.5% |
| CPPI(2) | \$70,161 → \$2,410 | \$77,547 → \$19,650 | 0.0% → 0.0% | -2.2% → 11.0% | -1.3% → 12.9% | 4.0% → 63.3% |
| CPPI(3) | \$94,409 → \$25,795 | \$99,821 → \$45,350 | 5.4% → 0.0% | -4.8% → 13.8% | -3.4% → 18.6% | 4.8% → 66.2% |
| CPPI(4) | \$107,622 → \$47,714 | \$110,983 → \$66,759 | 26.5% → 0.8% | -7.0% → 17.2% | -4.9% → 22.8% | 4.9% → 66.5% |
| CPPI(5) | \$114,440 → \$66,377 | \$116,265 → \$83,301 | 49.4% → 3.9% | -8.7% → 21.2% | -6.0% → 25.2% | 5.5% → 68.2% |

Table 3: Objective constraint breaches in the worst case scenario (recession regime). Note that names are simplified, but we have, from left to right and top to bottom: (i), (ii), (iii), (iv), (v)

| | $\text{VaR}_{95\%}$ | $\text{ES}_{95\%}$ | $\mathbb{P}(W_t < 90\%)$ | $\mathbb{E}[r_T]$ | $\mathbb{P}(r_T > 8\%)$ |
|---|---|---|---|---|---|
| BH(40) | \$17,223 | \$5,789 | 1.0% | 8.6% | 34.1% |
| BH(60) | \$106,545 | \$104,393 | 34.3% | 12.5% | 32.2% |
| BH(80) | \$195,866 | \$202,997 | 49.4% | 16.4% | 31.1% |
| BH(100) | \$285,188 | \$301,601 | 56.8% | 20.3% | 30.4% |
| CPPI(2) | \$0 | \$0 | 0.0% | 6.3% | 36.0% |
| CPPI(3) | \$0 | \$0 | 0.0% | 8.4% | 35.2% |
| CPPI(4) | \$0 | \$0 | 1.5% | 9.9% | 35.1% |
| CPPI(5) | \$0 | \$0 | 24.4% | 11.0% | 34.5% |

## 4 Recommendations

We recommend CPPI(3) as the best strategy by which to manage the portfolio in order to support the bank's risk-objectives and maintain competitive exposure to upside participation in 2025, as it demonstrates the best ability to ensure liquidity and capital requirements across scenarios.

We find that CPPI(3) generally dominates BH(40), being the best viable BH, by obtaining similar upside utility, with much more limited risk and better protection of downside capital objectives. We further see that CPPI(4) has diminishing upside utility from CPPI(3), in contrast to the additional sensitivity to market conditions and consequent risk of breaching the running capital level requirement. Our analysis therefore concludes that CPPI(3) is the best strategy to manage the portfolio.