Alpha Pods Take-Home Assignment Report

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Introduction

This report details the methodology and results for the three tasks in the Alpha Pods take-home assignment. The project progresses from replicating a baseline CVaR optimization strategy to enhancing it with a machine learning-based regime-aware framework, and finally, incorporating alternative data to generate alpha.

Consolidated Performance Metrics (2020-2024)

	Regime-Aware CVaR (B)	Hybrid ML Alpha (C)
Cumulative Returns	1.12513	1.71255
Annual Return	0.163004	0.221274
Annual Volatility	0.171087	0.171076
Sharpe Ratio	0.968496	1.25443
Max Drawdown	-0.280429	-0.262783
Calmar Ratio	0.581265	0.842042
Sortino Ratio	1.38782	1.84127
Alpha (annual)	0.0805562	0.118544
Beta	0.652349	0.651573
Information Ratio	0.242999	0.453619
Skewness	-0.254149	-0.13775
Kurtosis	3.45202	3.78519

[image]

Task A: Baseline CVaR Index

The baseline strategy implements the CVaR optimization as described in the CLEIR paper. The portfolio is rebalanced quarterly to minimize the 95% Conditional Value-at-Risk of the tracking error against an equal-weight benchmark. The optimization is subject to constraints including a 5% maximum weight per asset and a 10 bps transaction cost.

Task B: Regime-Aware Model - Method Summary

The primary innovation of Task B was to enhance the baseline CVaR portfolio strategy with a dynamic risk management framework capable of adapting to changing market conditions. The core of this enhancement is a sophisticated regime detection model that quantitatively assesses the market environment, allowing the portfolio optimizer to adjust its risk posture in

real-time.

Our methodology is centered on the `EnsembleRegimeDetector`, a model designed for robustness and clarity. It produces a continuous probability score (from 0.0 to 1.0) indicating the likelihood of the market being in a "Risk-Off" state. This is achieved by combining the signals from two distinct sub-models, each capturing a different facet of market behavior. The first is a trend-following model based on Simple Moving Averages (SMA), which identifies the primary market direction and carries a 70% weight in the final score. The second is a Mean Reversion Speed (MRS) model, which measures market volatility and choppiness, contributing the remaining 30%.

This blended approach provides a more nuanced view than a single model could. It can effectively distinguish between a stable, low-volatility downtrend and a chaotic, high-volatility market, assigning a higher "Risk-Off" probability to the latter. This probabilistic output is then fed directly into our `RegimeAwareCVaROptimizer` at each quarterly rebalance.

The optimizer is configured with two distinct parameter sets: a `RISK_ON` profile (lower risk aversion, higher concentration limits) and a `RISK_OFF` profile (high risk aversion, strict diversification). It dynamically interpolates between these two profiles based on the regime probability. For instance, a 75% "Risk-Off" probability will shift the optimizer's parameters three-quarters of the way towards the defensive `RISK_OFF` settings. This allows the portfolio to fluidly adapt its risk posture, becoming progressively more defensive as market turbulence increases, rather than making abrupt, binary changes.

This adaptive framework proved highly effective during the 2020-2024 backtest period, successfully navigating the COVID crash, the subsequent bull market, and the 2022 downturn. By systematically adjusting its risk-taking based on a quantitative assessment of the market environment, the strategy successfully enhanced the risk-adjusted returns of the baseline model.

Task B: Regime Model Interpretability

[image]

Task C: Alpha-Aware Strategy

This strategy enhances the CVaR optimizer by incorporating alpha signals derived from alternative data. We sourced fundamental signals (e.g., P/E ratio, ROE, Market Cap) from the Financial Modeling Prep (FMP) API. These signals were combined into a single alpha score for each asset. The optimizer's objective function was modified to not only minimize CVaR but also to maximize the portfolio's exposure to these positive alpha signals, effectively tilting the portfolio towards stocks with stronger fundamental characteristics.

Reflections & Conclusion

This project successfully demonstrated an end-to-end quantitative research workflow. The baseline CVaR model provided a solid foundation. The regime-aware enhancement (Task B) proved effective, showcasing how a simple SMA crossover can identify high-volatility periods and allow the strategy to adapt defensively. The alpha-aware model (Task C) showed the potential of integrating alternative data, though its performance indicates that more sophisticated signal combination and risk management are required to fully exploit its

potential.

Key learnings include the importance of robust data pipelines, the challenges of feature engineering for financial markets, and the necessity of a rigorous backtesting framework. The results highlight that while complexity can add value, simple, interpretable models often provide the most robust performance enhancements.