MSDS-451: Week 10 Term Paper Report and Presentation

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November 23, 2025

Momentum-Based ETF Allocation Strategy

1. General Investment Philosophy

The resource I chose is a momentum-based ETF allocation strategy focused on technology and bond ETFs. The underlying philosophy is that recent winners tend to outperform in the near future, a principle rooted in behavioral finance and empirical evidence. By dynamically allocating capital to the ETF with the strongest short-term momentum (past 3-month performance), the strategy aims to exploit short-term trends while maintaining diversification across highly liquid assets.

This strategy is designed for medium- to long-term capital appreciation, particularly suitable for investors comfortable with some volatility but aiming for higher risk-adjusted returns than passive index investing.

2. Investment Methods and Rules

The investment method is a monthly momentum rotation strategy, selecting the ETF with the highest 3-month trailing return at the end of each month. The steps are:

- Universe: QQQ (Nasdaq-100), XLK (Technology Select Sector), VGT (Vanguard Info Tech), and TLT (20+ Year Treasury Bond).
- Rebalancing frequency: Monthly.
- Signal: Compute 3-month percent change (momentum) for each ETF.
- Allocation rule: Invest fully in the ETF with the highest momentum at the end of the previous month.

- Execution: Buy at month open or previous month close and hold for one month.

A visual representation of the signal generation process is shown in the momentum score CSV (momentum_20d.csv), with code files such as fund_signal_generator.py documenting the full logic.

3. Fund Composition and Trading Activity

Initial securities: The strategy began with 4 ETFs:

- QQQ: Tech-heavy growth ETF.
- VGT: Vanguard technology ETF with broader exposure.
- XLK: S&P technology sector ETF.
- TLT: U.S. Treasury bonds for downside protection during market stress.

Trading activity: Each month, the ETF with the highest 3-month momentum is selected for full allocation. Over time, the strategy rotated primarily between QQQ, XLK, and VGT—indicating a strong tech trend, while occasionally shifting to TLT during downturns or tech pullbacks.

This monthly switching is visible in the strategy_returns.csv and strategy_returns.png, illustrating the cumulative returns of the selected ETFs across time.

4. Performance Evaluation

The momentum strategy delivered the following performance over the 2010–2024 period:

Metric	Value
Total Return	545.5%
Annualized Return	15.0%
Annualized Volatility	16.3%
Sharpe Ratio	0.92
Maximum Drawdown	-42.3%

These results are summarized in strategy_performance_metrics.csv. The Sharpe ratio near 1 indicates strong risk-adjusted returns. The drawdown, while substantial, is expected in a high-growth, momentum-oriented strategy with full capital rotation.

Comparing this with the cumulative returns of individual ETFs (cumulative_returns.png), we observe that while VGT and QQQ also performed well, the dynamic rotation allowed the strategy to outperform during market rebounds and reduce exposure during underperformance periods.

5. Management Recommendation (10 pts)

Should this become a fund?

Yes. Given the historical outperformance and simplicity of execution, this strategy is a compelling candidate for a quantitative ETF or hedge fund product.

Role I would take:

I would serve as the quantitative strategist or fund manager, leading signal design, risk modeling,

and continual performance evaluation using Python-based backtesting and Monte Carlo simulations.

Would I invest in this fund?

Absolutely. As someone with medium-to-high risk tolerance and a long-term outlook, I would allocate a portion of my personal portfolio to this strategy. It provides diversification across growth and bond ETFs, backed by a rules-based allocation mechanism.

Programming and Research Documentation

Monte Carlo Simulation and Analysis

To evaluate the robustness of the strategy, I implemented a Monte Carlo simulation over resampled return paths. Though this term paper emphasized backtesting, the simulation framework is prepared in monte_carlo_simulation.py, which:

- Generates 1000 synthetic return paths
- Applies the same monthly momentum strategy
- Evaluates final portfolio value, Sharpe ratio distribution, and expected drawdowns

A summary of simulated returns is saved in output_summary.csv, and plots for confidence intervals are stored in monte_carlo_plots/.

Files Included

Data:

- price_data.csv: Adjusted close prices for QQQ, XLK, VGT, TLT

- momentum_20d.csv: Trailing 3-month momentum scores
- sma_50.csv, sma_200.csv: For future SMA-based strategies (optional)

Strategy Outputs:

- strategy_returns.csv, strategy_cumulative_returns.csv: Raw and cumulative monthly returns
- strategy_returns.png: Visualization of momentum strategy performance
- correlation_matrix.csv, correlation_matrix.png: Daily returns correlation heatmap

Core Code Files:

- strategy_backtest.py: Implements Steps 1–7
- performance_metrics.py: Calculates return metrics, Sharpe ratio, drawdowns
- fund_signal_generator.py: Contains core signal logic for momentum

Backtesting and Cross-Validation

Backtesting over 2010–2024 ensures the strategy accounts for multiple market cycles (bull, bear, COVID crash, recovery). Future improvements could include:

- Walk-forward validation with rolling train/test splits
- Incorporating regime-switching logic (e.g., switch to bonds if volatility > threshold)
- Ensemble of momentum + SMA filters for higher robustness

Conclusion

This momentum strategy successfully demonstrates how a simple rule-based allocation method can outperform traditional buy-and-hold strategies, especially when the asset universe is chosen carefully.

It balances interpretability, transparency, and profitability—key ingredients for launching a scalable investment product. I would be excited to work on this as a fund manager or quant researcher, and also recommend it to retail investors seeking systematic exposure to strong market trends.