Systematic Multi-Factor Trading Strategy Based on S&P 500 Stocks

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Can Technical Signals Beat the Stock Market?

- **Problem Statement**: To identify predictive technical indicators, develop a composite factor-based, non-market-neutral portfolio strategy using selected signals, and evaluate their effectiveness in generating Jensen's alpha.

- **Data Source**: Bloomberg, yfinance. S&P 500 time series data, Jan 2015–Dec 2024.

- **Methodology**:

- Use Pandas TA Library to generate 82 signals.

- **A) For Selecting Significant Indicators**:

  - **Cross-Sectional Fama-Macbeth** to regresses stock returns $R_{i,t}$ on technical indicators $X_{i,t}$ across all stocks i and time periods t to find significant indicators (t-stat > 1.96; 95% Conf. Level, p-value < 0.05).

  - **Time series analysis:** For each stock i, fit $R_{i,t} = \alpha_i + \beta_t X_{i,t} + \epsilon_{i,t}$. Estimate β_i & its t-stat to test retention of predictive power for $R_{i,t}$ over time.

  - **Lasso Regression** to reduces overfitting and multicollinearity by shrinking insignificant coefficients to zero in $R_t = \beta_0 + \sum \beta_j X_{j,t} + \epsilon_t$.

- **B) Portfolio Construction**:

  - **Simple Ranking:** Ranks stocks by signal, applies fixed leverage.

  - **Volatility Targeting:** Ranks stocks, adjusts sizes for 20% volatility.

Results 5-Year Out-of-Sample (OOS)

- **Performance:** Simple Ranking yields higher alpha but with volatility; Volatility Targeting lowers risk but underperforms. Vortex and CFO excel, Slope and ERI lag.

- **Implications:** Market beats most strategies; naive ranking is inconsistent. Volatility targeting needs better weighting for alpha.

- **Significant Indicators:** *Momentum: Chande Forecast Oscillator [cfo], Elder Ray Index [eri]* **Trend:** *TTM Trend [ttm_trend], Detrended Price Oscillator [dpo], Slope [slope]* **Volatility:** *Relative Volatility Index [rv], Average True Range [atr], Vortex [vortex]* **Volume:** *Elder's Force Index [efi], Accumulation/Distribution Oscillator [adosc]*

Definition

5-Year Out-of-Sample (OOS)
Training: Jan 2015 – Dec 2019 (Fit coefficients)
Testing: Jan 2020 – Dec 2024 (Evaluate performance)
Purpose: Assess predictive power without look-ahead bias

Scope of the Project

Key Assumptions & Limitations

- **Technical Focus**
    - Only technical indicators used
    - Non-market-neutral portfolio strategy & Jensen's Alpha considered.
    - *Opportunity*: Integration of fundamental indicators, market neutral portfolio & generation of "true" alpha to provide deeper insights.
- **Static Universe**
    - Limited to S&P 500 stocks that maintained consistent S&P500 membership
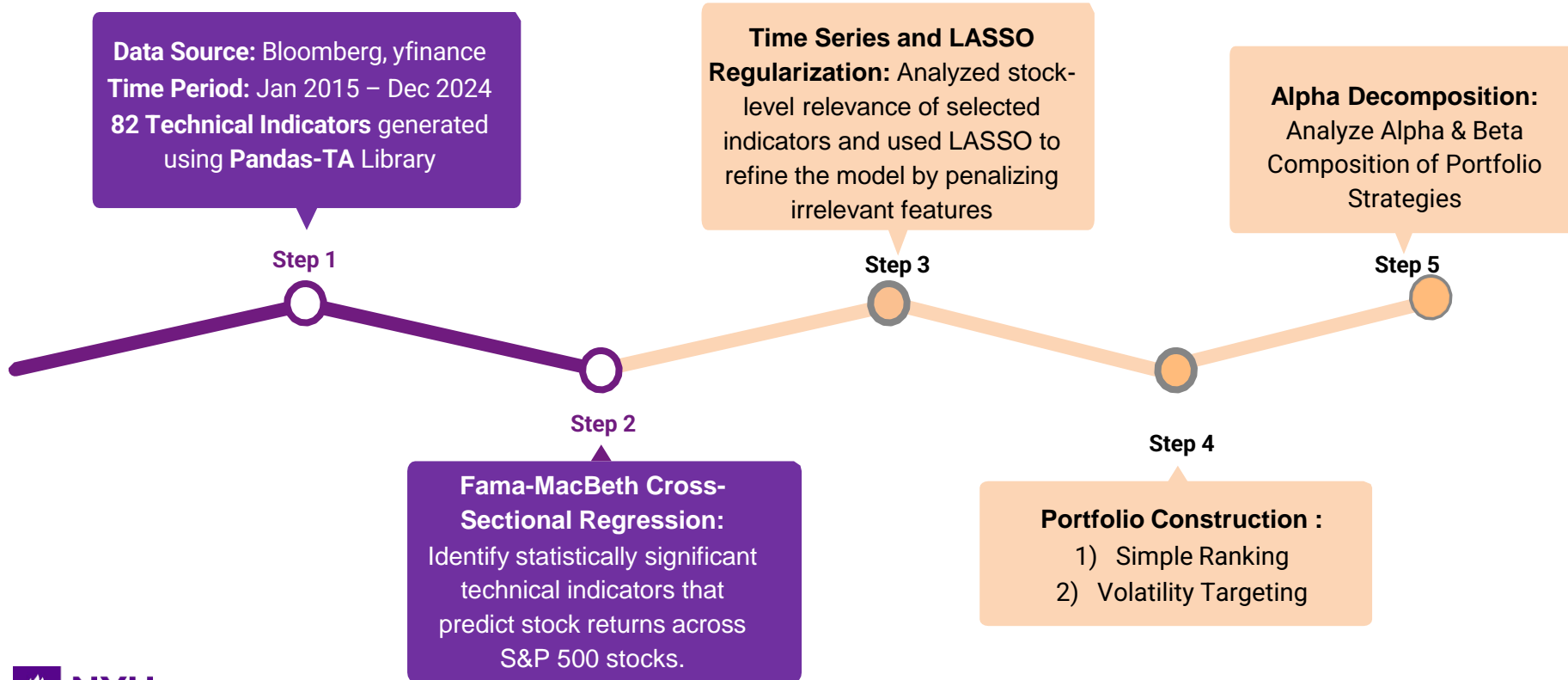   - *Opportunity*: Dynamic constituent rebalancing for truer market representation
- **Data & Strategy Scope**
    - Fixed dataset and portfolio construction methods
    - *Opportunity*: More data and diverse strategies could enhance insights
- **Indicator Source**
    - Relies on TA library for bulk indicator generation based on yfinance & Bloomberg data
    - *Limitation*: Verifying library accuracy beyond scope due to time constraints

Methodology Workflow

Data Source: Bloomberg, yfinance
**Time Period:** Jan 2015 – Dec 2024
82 Technical Indicators generated using **Pandas-TA** Library

Step 1

Time Series and LASSO Regularization: Analyzed stock-level relevance of selected indicators and used LASSO to refine the model by penalizing irrelevant features

Step 3

Alpha Decomposition: Analyze Alpha & Beta Composition of Portfolio Strategies

Step 5

Step 2

Fama-MacBeth Cross-Sectional Regression: Identify statistically significant technical indicators that predict stock returns across S&P 500 stocks.

Step 4

Portfolio Construction :
1) Simple Ranking
2) Volatility Targeting

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Portfolio Construction Methodologies

Aspect	Simple Ranking	Volatility Targeting
Core Methodology	Ranks stocks by signal values, applies fixed leverage, monthly rebalancing.	Ranks stocks by signal values, adjusts position sizes for target volatility, monthly rebalancing.
Stock Selection	Top 5 long, bottom 5 short monthly based on signal strength.	Top 5 long, bottom 5 short monthly, filtered by volatility.
Position Sizing	Fixed leverage: 3.0x long, 1.0x short, equal weights – using optimizer.	Dynamic sizing: base leverage scaled by volatility factor.
Leverage Application	Static leverage, no adjustment.	Leverage adjusted monthly to maintain target volatility.
Risk Management	No volatility control.	Targets 20% volatility, scales positions based on stock volatility.

Significant Indicators

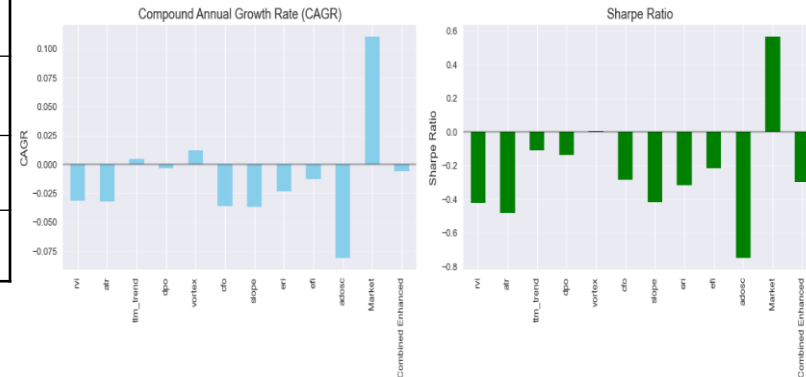| Field Code	Full Name	Category	Description
rv	Relative Volatility Index	Volatility	Measures market volatility relative to its average volatility.
atr	Average True Range	Volatility	Measures market volatility by calculating the average range of price movement.
ttm_trend	TTM Trend	Trend	Identifies long-term trends and reversals based on price changes.
dpo	Detrended Price Oscillator	Trend	Removes long-term trends to focus on short-term price cycles.
vortex	Vortex Indicator	Volatility	Identifies trend strength and direction based on price movement.
cfo	Chande Forecast Oscillator	Momentum	Measures momentum and market cycle information.
slope	Slope Indicator	Trend	Measures the slope of a price trendline to determine trend direction.
eri	Elder Ray Index	Momentum	Measures buying and selling pressure based on the relationship between highs, lows, and close.
efi	Elder's Force Index	Volume	A volume-weighted momentum indicator that signals buying and selling pressure.
adosc	Accumulation/Distribution Oscillator	Volume	Tracks the rate of accumulation or distribution of a stock.

Note: Find the list of all indicators generated for this project here.

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SIMPLE RANKING RESULTS

| Category	5-Year Out-of-Sample (2020–2025) Performance
Top Performers	Market: Highest endpoint, strongest overall CAGR
	CFO: Second highest, consistent growth
	DPO: Strong performance with some volatility near end
Moderate Performers	AdosC: Good 2020-2022, decline after
	RVI: Steady growth, higher performers
	Combined Strategy: Consistent, slightly below market
Mixed Performance	EFI: Weak initially, recovered in final period
	TTM Trend: Modest but steady performance
Underperformers	Vortex: Lower CAGR, despite strength periods
	Slope: Consistently underperformed market
	ERI: Among lowest CAGR
	ALR: Significant underperformance in middle periods

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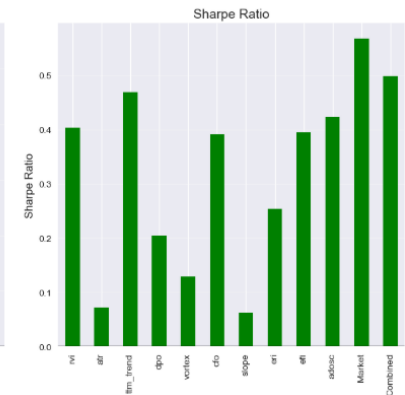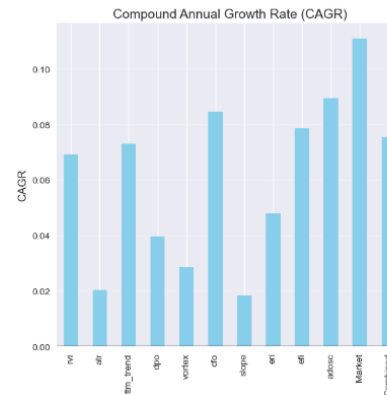
VOLATILITY TARGETING RESULTS

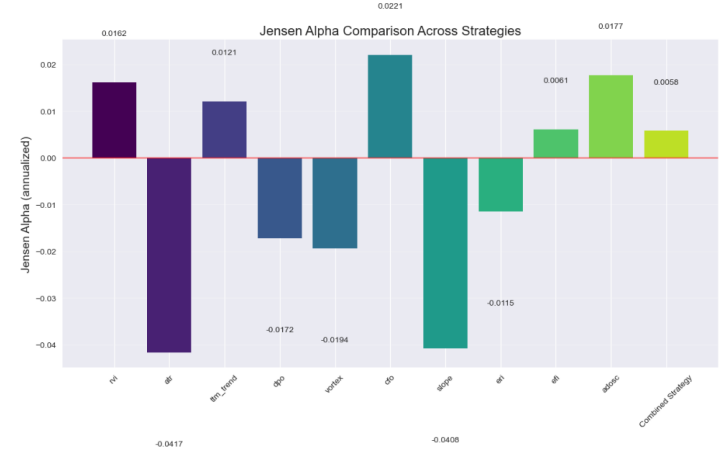| Category	5-Year Out-of-Sample (2020–2025) Highlights
Top Performers	Vortex [vortex]: Best performer among strategies, outpacing others under volatility targeting.
	Chande Forecast Oscillator [cfo]: Maintains stable and consistent growth.
	Accumulation/Distribution Oscillator [adosc]: Shows improved returns compared to previous strategies.
Moderate Performers	Combined Strategy: More stable but continues to underperform the market.
	TTM Trend [ttm_trend]: Performs decently but lacks the strength to match market returns.
	Elder's Force Index [efi]: Moderately effective with limited drawdown risk.
Weak Signals	Slope [slope], Efficiency Ratio Indicator [eri]: Weak performance with limited upside.
	Relative Vigor Index [rvi], Average True Range [atr]: Struggle significantly, showing poor return characteristics.
Vs. Market	Market vastly outperforms all strategies under volatility targeting. Most strategies fail to keep up.

Alpha Analysis
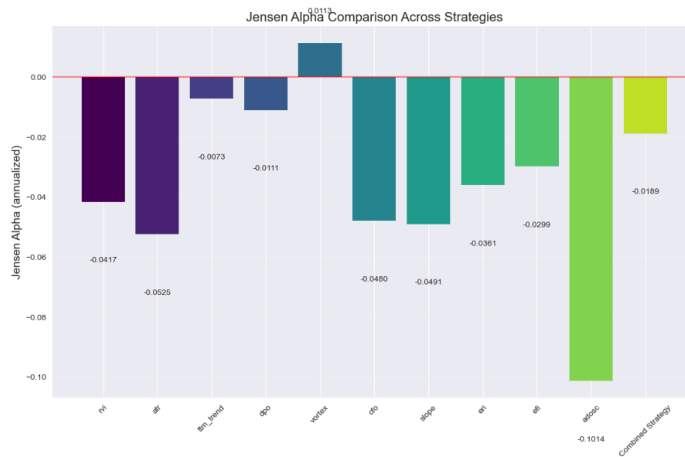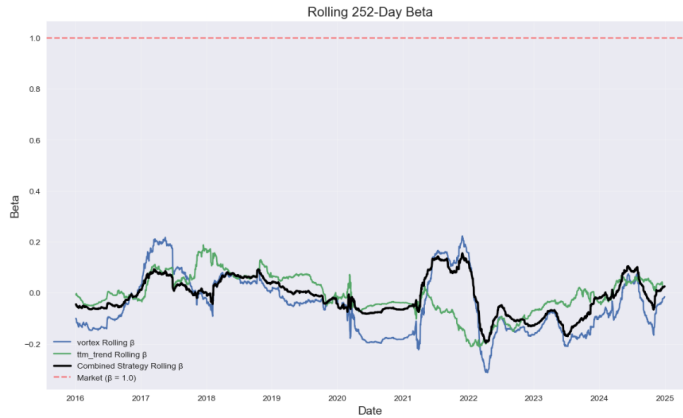
Alpha Analysis

$α = R_p − (R_f + β (R_m − R_f))$ where: $α$ = Jensen's Alpha (excess risk-adjusted return); R_p = Portfolio return R_f = Risk-free rate; R_m= Market return; $β$ = Portfolio beta (sensitivity to market movements)

Vol Targeting

Category	Insights
Top Alpha Performer	**Vortex (0.0113)** – Only positive alpha.
Worst Alpha Performer	**ADOSC (-0.1014)** – Largest underperformance.
Combined Strategy	**Alpha: -0.0189** – Underperformed despite diversification.
Impact of Volatility Targeting	Mostly **negative alpha**, likely due to over-constrained exposure.
Portfolio Implications	**Lower drawdowns but weak alpha** – alternative risk models needed.

Simple Ranking

Category	Insights
Top Alpha Performer	**CFO (0.0221)** – Best risk-adjusted returns.
Worst Alpha Performer	**Slope (-0.0408)** – Worst underperformance.
Combined Strategy	**Alpha: 0.0058** – Small positive alpha, diluted by weaker factors.
Impact of Ranking	Mixed alpha results show **naïve ranking is unreliable**.
Portfolio Implications	Market outperformed; **better weighting needed** for alpha capture.

Conclusion

- **Ranking vs. Volatility Targeting:** Simple Ranking outperforms in alpha generation, while Volatility Targeting reduces risk but struggles with returns.

- **Top Indicators:** Vortex and CFO show strong predictive power; Slope and ERI underperform.

- **Market Comparison:** Most strategies fail to consistently beat the market, highlighting limitations in technical signals.

- **Portfolio Insights:** Naive ranking is unreliable; better weighting and dynamic risk models are needed.

- **Future Improvements:** Enhancing Volatility Targeting and integrating fundamentals could improve alpha capture.

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Appendix

Data & Code

List of all indicators generated for this project here