MSCI ANNUAL CONFERENCE ON **GLOBAL INVESTING AND RISK MANAGEMENT** WORKSHOP

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One America Square

London, UK

ROTATION STRATEGIES USING BARRA SES FACTORS

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AGENDA

1. INTRODUCTION
2. ROTATION STRATEGIES

IMPLIED VOLATILITY USE CASE

3. SIGNAL CONSTRUCTION
4. SIGNAL IMPLEMENTATION

MACRO BASED SCENARIO USE CASE

5. SIGNAL CONSTRUCTION
6. SIGNAL IMPLEMENTATION
7. Q&A

1. INTRODUCTION

INTEGRATED USE CASE WITH BARRA SUITE

Objective of this case study

Produce a sample use case combining the distinct tools and data provided in MSCI's Barra offering to come up with an integrated solution for factor rotation strategies

List of items and data used for the implementation

- Barra US Total Market Model (USDEEP)
- Barra Models Direct Flat Files
- Barra Optimizer through Barra PortfolioManager
- Performance Attribution engine in Barra PortfolioManager
- Publicly available market data –
  - Implied Volatility for S&P 100 – VXO
  - Composite Leading Indicators Index – CLI
- Mathworks MATLAB® – a 4th generation technical computing language

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WHY THE BARRA US DEEP HISTORY MODEL?

MSCI US DEEP

- **Comes with 40+ years of daily history back to 31 Jan 1975 including factor model data, factor descriptors and a security master.**
- **Broadest coverage, deepest history and highest data frequency** in the market for US equity factor data.
- Part of the US Total Market Equity Model suite and leverages the same data and methodology and innovations including **Systematic Equity Strategies research.**

> "Systematic Equity Strategies" (SES) refer to the systematic (i.e., computer-based or rules-based) implementation of fundamental or technical equity investment anomalies & strategies

- Capture previously hidden sources of risk and performance, resulting in greater transparency within portfolios
- Improve the accuracy and explanatory power of a risk model, especially during periods of economic crisis
- Bring new insights into portfolio construction
- Identify persistent market anomalies and track seasonal or market-timing opportunities
- Measure crowding, or popularity, of investment styles and strategies

STYLES AVAILABLE FOR FACTOR ROTATION

US Deep

US Total Market Equity Model Factors		
Long-Horizon & Low Turnover Factors	Size	Log of market capitalization
	Dividend Yield	Historical and predicted dividend yield
	Liquidity	Composite of share turnover, Amihud, and Pastor-Stambaugh measures
	Management Quality	Composite of asset growth, capital expenditure growth, and net issuance growth
	Profitability	Composite of gross profitability, gross margin, ROE, ROA, and asset turnover
	Mid Capitalization	Mid-capitalization effect
	Prospect	Composite of long-term stock skewness and recent drawdown
	Value	Composite of book-to-price, sales-to-price, cash flow-to-price and fundamental value
	Growth	Composite of earnings and sales growth measures
	Leverage	Composite of book and market leverage and debt-to–assets ratio
	Long-Term Reversal	5-year reversal excluding 1-year momentum
	Beta	Historical beta with Bayesian shrinkage
	Earnings Yield	Forward and trailing earnings-to-price, EBITDA/EV
	Earnings Quality	Composite of accruals, estimate dispersion, variability in sales, earnings, and cash-flows
	Residual Volatility	Composite of option implied volatility and CAPM idiosyncratic volatility
	Momentum	Stock momentum

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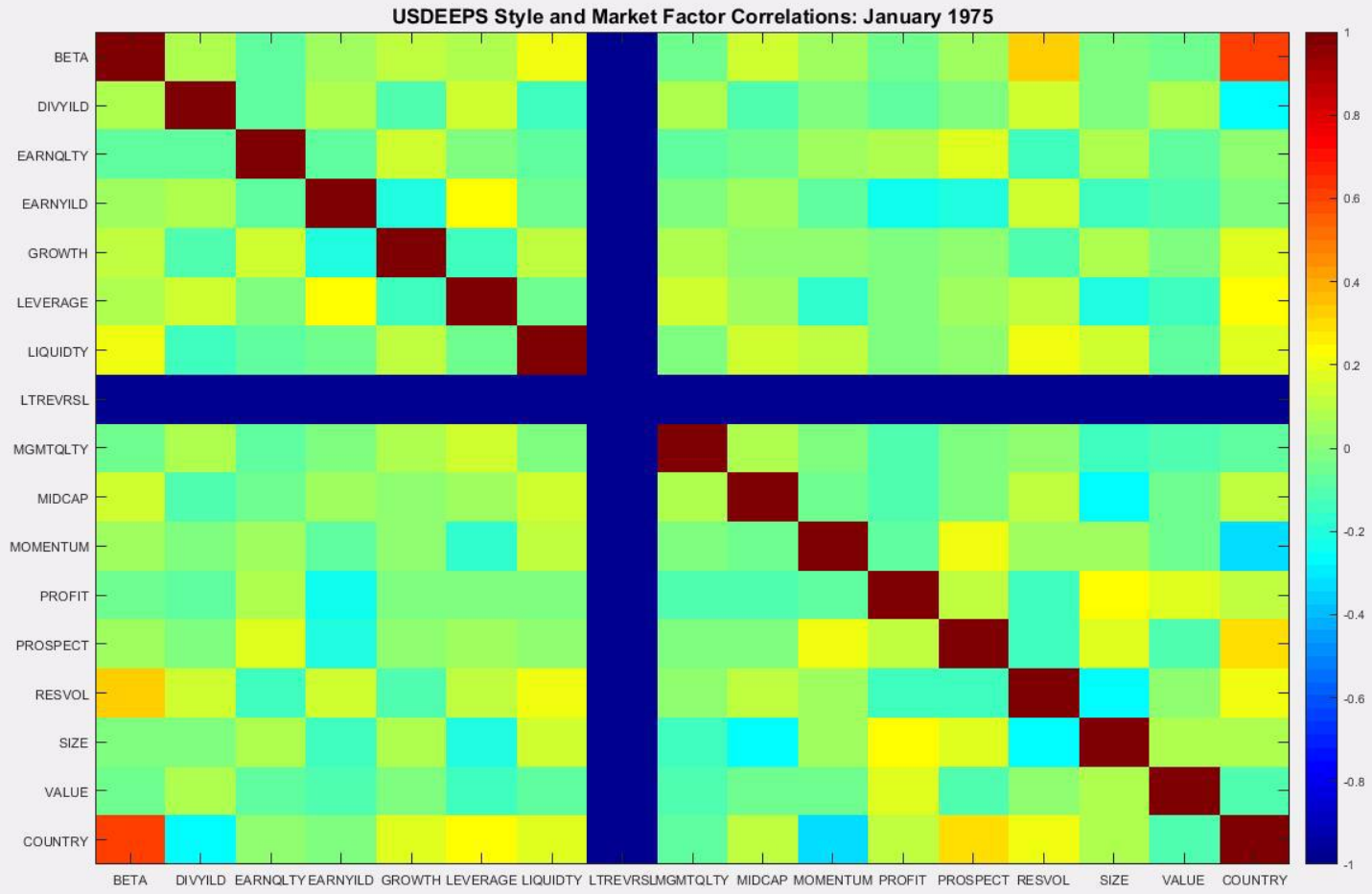
2. ROTATION STRATEGIES

DO STYLE FACTORS RELATIONSHIPS EVOLVE OVER TIME?



FACTOR ROTATION

Performance of factors are time-varying and this can present both opportunities and risks to the asset allocation process.

Maintaining diversification across the underlying risks represented by factors could lead to more stable performance.

There are different ways of grouping/rotating factors based on their characteristics.

Using Barra Total Market Model family, which incorporates a richer factor set that includes our suite of Systematic Equity Strategy (SES) factors, we looked at different rotation strategies.

Macro Based	Valuation Based	Risk Based
• Growth • Inflation	• Valuations • Cross-Sectional • Time-Series	• Correlations • Volatility

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IMPLIED VOLATILITY USE CASE

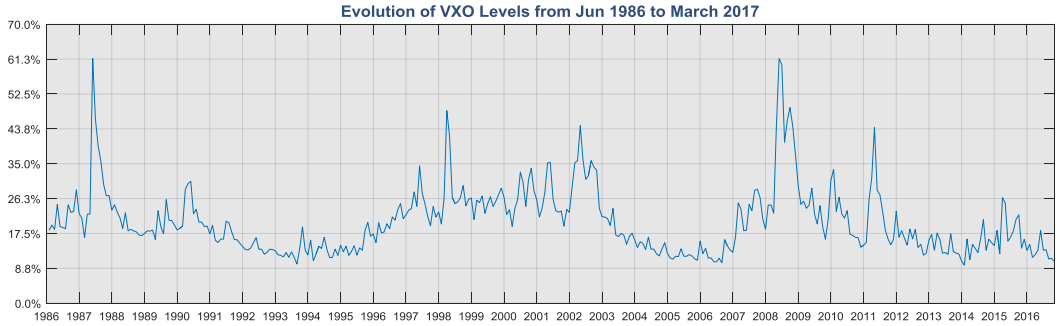
2. SIGNAL CONSTRUCTION

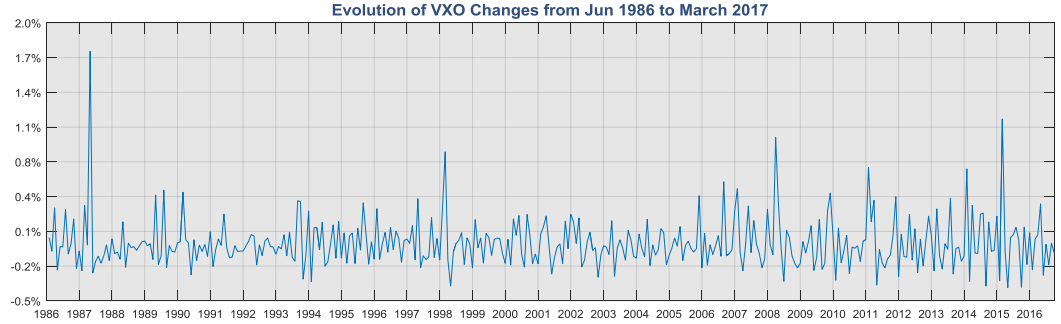
HOW TO COME UP WITH A ROTATION STRATEGY BASED ON IMPLIED VOLATILITY

Risk Based strategy

- Divide history of VXO levels into two periods
  - **In Sample / Model Training:** 1986 to 2005
  - **Out of Sample / Backtest Implementation:** 2006 to 2017
- Take VXO end of month levels
- Compute monthly changes

VXO is based on S&P 100 Option Prices and along with the VIX index is a key measure of market expectations of near-term (30 days) volatility for its underlying markets (S&P 100 and S&P 500)





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SIGNAL CONSTRUCTION

1986 to 2005 – in-sample (training period)

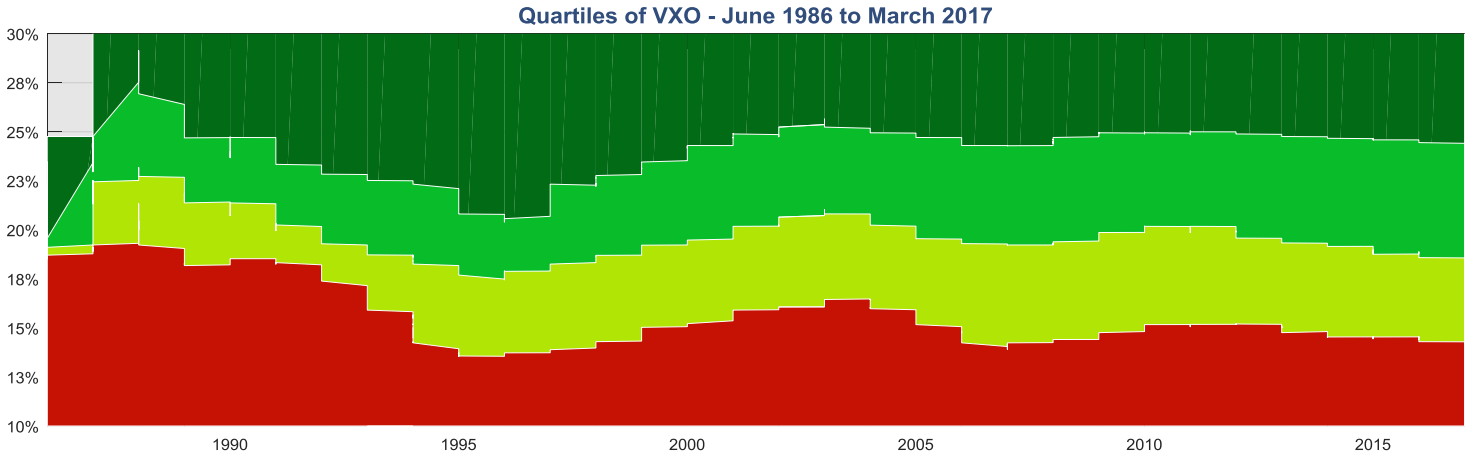
- Look for VXO levels and changes
- Compute Quartiles and use them as the threshold
- Assign t+1 monthly factor returns to VXO regimes (quartiles) in t
- Compute In-sample quartile average factor return
- Pick top 5 in-sample factors average return for each quartile

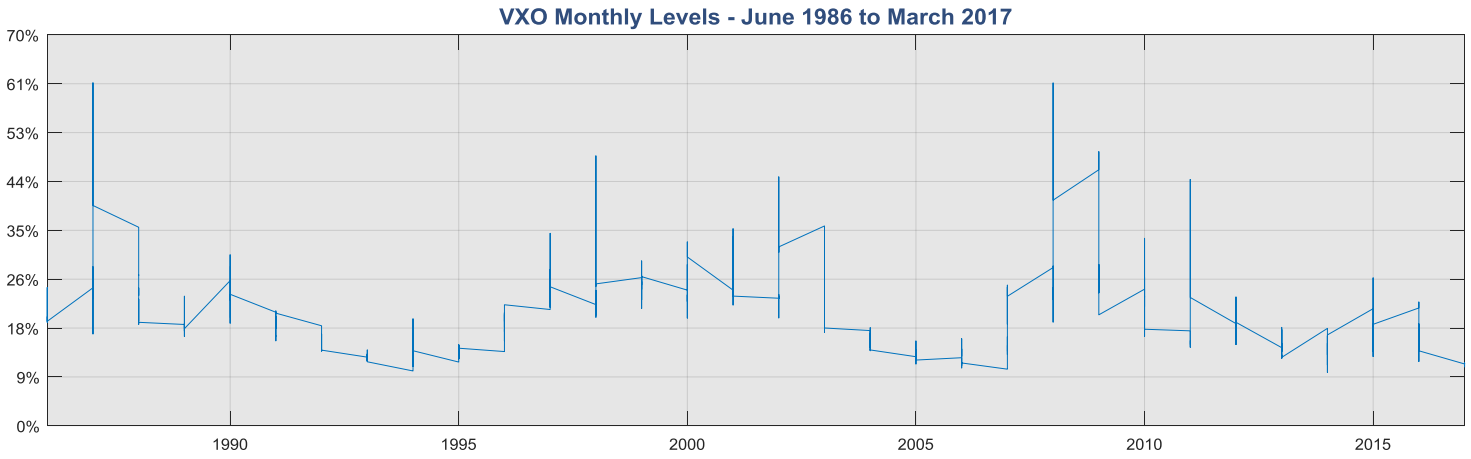
2006 to 2017 – out-of-sample (backtest period)

- Identify which quartile, VXO level in month t belongs to
- Look which set of (top 5) factors performed better in that specific quartile
- Assign weights to those factors Using different weighting schemes: (Equal Weight, Inverse of Variance)

	'USDEEPL_BETA'	'USDEEPL_DIVYILD'	'USDEEPL_EARNQLTY'	'USDEEPL_EARNYILD'	'USDEEPL_GROWTH'	'USDEEPL_LEVERAGE'	'USDEEPL_LIQUIDTY'	'USDEEPL_LTREVRSL'	'US
28-Apr-06	0	0	0	0.149549244	0	0	0	0.322920697	
31-May-06	0	0	0	0.154379963	0	0	0	0.367998695	
30-Jun-06	0	0	0	0.149555661	0	0	0	0.351087711	
31-Jul-06	0	0	0	0.156947006	0	0	0	0.337818791	

WHAT DOES THE SIGNAL LOOK LIKE?





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3. SIGNAL IMPLEMENTATION - VXO

SIGNAL IMPLEMENTATION USING BPM

- Download Universe Weights using BPM High Volume Reporting (MSCI USA – Monthly).
- Generate Out of sample factor weights at asset level for the whole universe.
- Load Asset Level Attribute via Upload Files module in BPM

Positions Report

Portfolio: MSCI USA - Monthly | Variant: | Date: 2006/03/31 | Analysis settings: USDEEP_USD_CASH

Holdings — Customize

	Asset ID	Asset Name	fw_BETA	fw_DIVYILD	fw_EARNQLTY	fw_EARNYILD	fw_GROWTH	fw_LEVERAGE	fw_LIQUIDTY	fw_LTREVRSL	fw_MGMTQLTY	fw_PROFIT	fw_MIDCAP	fw_MOMENTUM
1			0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
2	USA11I1	EBAY INC	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
3	USA2ND1	GOLDMAN SACHS GROUP INC	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
4	USA2TM1	JUNIPER NETWORKS INC	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
5	USA37C1	UNITED PARCEL SERVICE INC	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
6	USA3871	AGILENT TECHNOLOGIES INC	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
7	USA3MZ1	METLIFE INC	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
8	USA3TE1	JANUS CAP GROUP INC	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
9	USA42T1	AVAYA INC	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
10	USA42W1	DUN & BRADSTREET CORP DEL NEW	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
11	USA4HN1	ROCKWELL COLLINS INC	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
12	USA4I21	FIDELITY NATL INFORMATION SVCS	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
13	USA4JT1	ZIMMER BIOMET HOLDINGS	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
14	USAA1Y1	A D C TELECOMMUNICATIONS	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
15	USAA292	TYCO INTL LTD NEW	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
16	USAA311	AES CORP	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
17	USAA5F1	ABBOTT LABS	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
18	USAA821	ADOBE SYS INC	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
19	USAA9K1	ADVANCED MICRO DEVICES INC	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
20	USAAAB1	AETNA INC NEW	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
21	USAABM1	AIR PRODS & CHEMS INC	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
22	USAACG1	AMSOUTH BANCORPORATION	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
23	USAADF1	ALBERTSONS INC	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
24	USAAGR1	HONEYWELL INTL INC	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
25	USAAHK1	ALLTEL CORP	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
26	USAAIM1	ALTERA CORP	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
27	USAAJ41	ARCONIC INC	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
28	USAAJH1	AMBAC FINL GROUP INC	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
29	USAALO1	BEAM INC	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
30	USAANY1	AMERICAN ELEC PWR INC	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08
31	USAAO81	AMERICAN EXPRESS CO	0.05	0.00	0.00	0.20	0.00	0.00	0.00	0.43	0.00	0.24	0.00	0.08

OPTIMIZATION CASE – VXO LEVELS/CHANGES (LONG ONLY)

General Ops Settings

- Period: Jan-2006 - Mar-2017, Monthly Rebalance
- Benchmark: MSCI USA
- Objective: Max Utility, i.e. Expected Return - Risk
- Risk Model: USDEEPL

Specific Constraints

- Fully invested optimal portfolios
- 20% Max Turnover
- Benchmark+-2% Active weights

Active Exposures

- Styles in rotation
- b+-0.5 standard deviations
- Styles not rotated
- b+-0.2 standard deviations

***VXO Levels**

Additional constraint on tracking error

Max 10%

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OPTIMIZATION CASE – VXO CHANGES (LONG SHORT)

General Ops Settings

- Period: Jan-2006 - Mar-2017, Monthly Rebalance
- Benchmark: MSCI USA
- Objective: Max Utility, i.e. Expected Return - Risk
- Risk Model: USDEEPL

Specific Constraints

- Fully invested optimal portfolios
- 20% Max Turnover
- Benchmark+-2% Active weights

Total Risk Bound

- Max 10%

Dollar Neutral - Leverage Constraint

- 200% Long (Cash + Equites)
- 100% Short (Equities)

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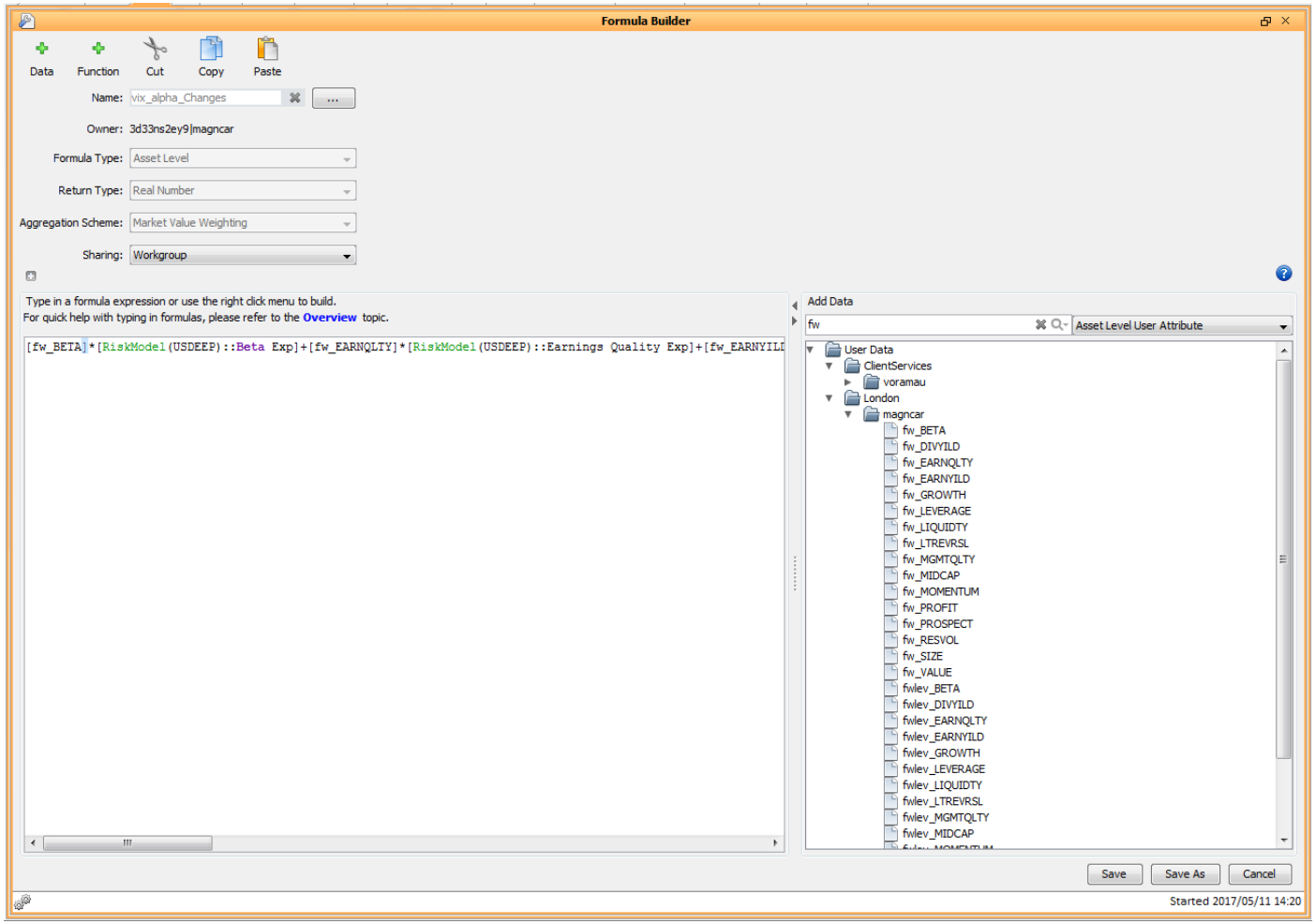
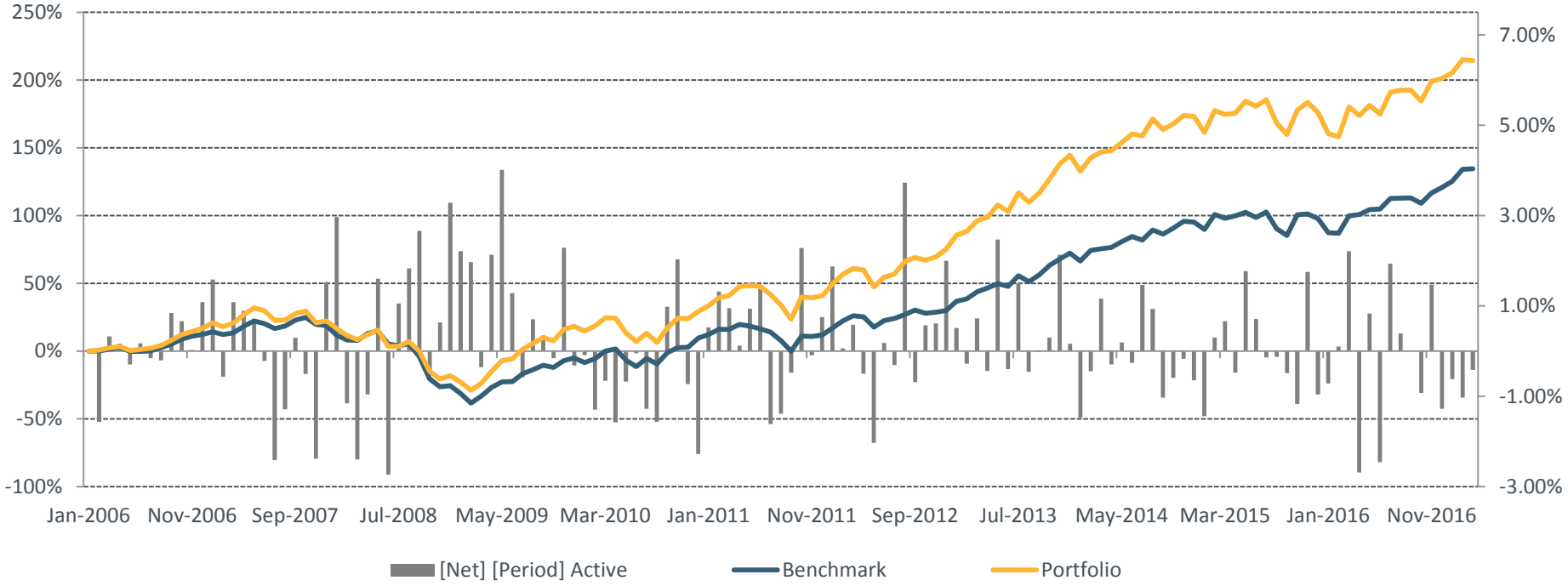
CREATING THE SIGNAL

Using FORMULA BUILDER we create the expected return vector based on:

- Loaded Factor Weights
- Risk Model Factor Exposures



BACKTEST - LO CHANGES



Cumulative Portfolio Return	214.32%
Cumulative Active Return	79.91%
Cumulative Benchmark Return	134.41%
Avg Turnover	19.14%
Avg # of Assets	52.57
Sharpe Ratio	0.62
Information Ratio	0.64
Active Risk (%)	4.47%
Beta	1.03

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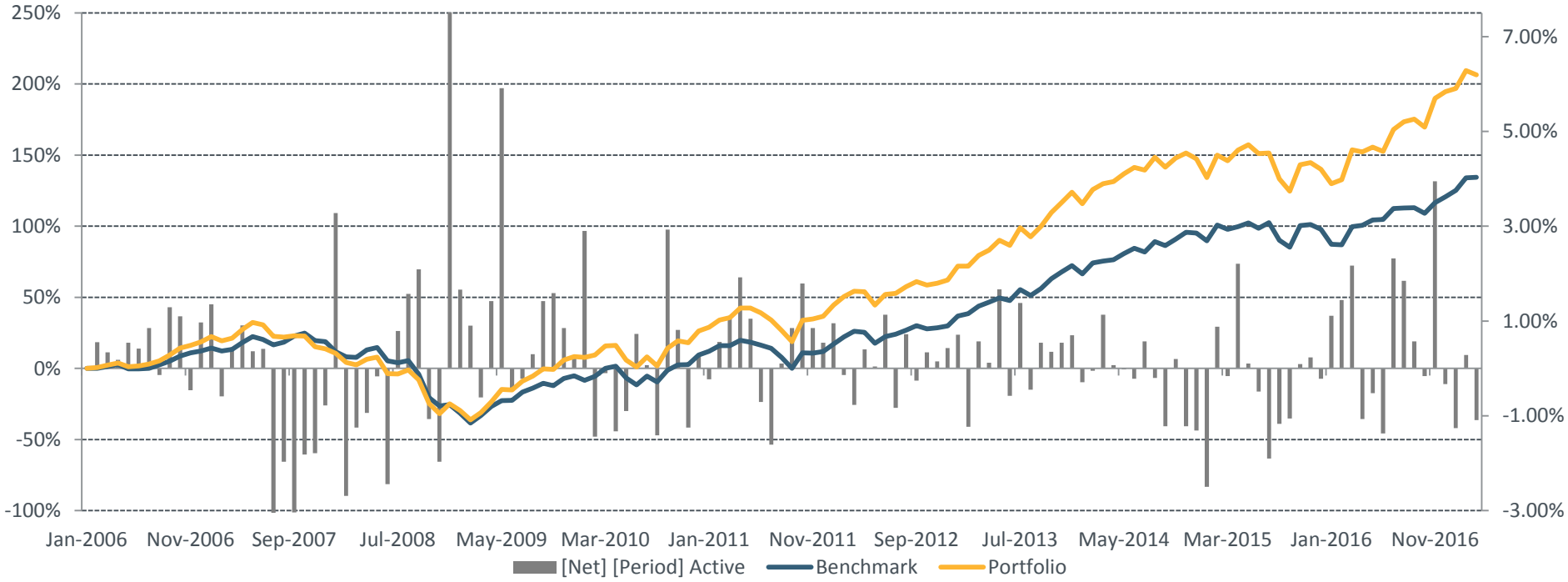
BACKTEST – LO LEVELS



Cumulative Portfolio Return	206.51%
Cumulative Active Return	72.11%
Cumulative Benchmark Return	134.41%
Avg Turnover	18.07%
Avg # of Assets	53.57
Sharpe Ratio	0.58
Information Ratio	0.49
Active Risk (%)	5.32%
Beta	1.07

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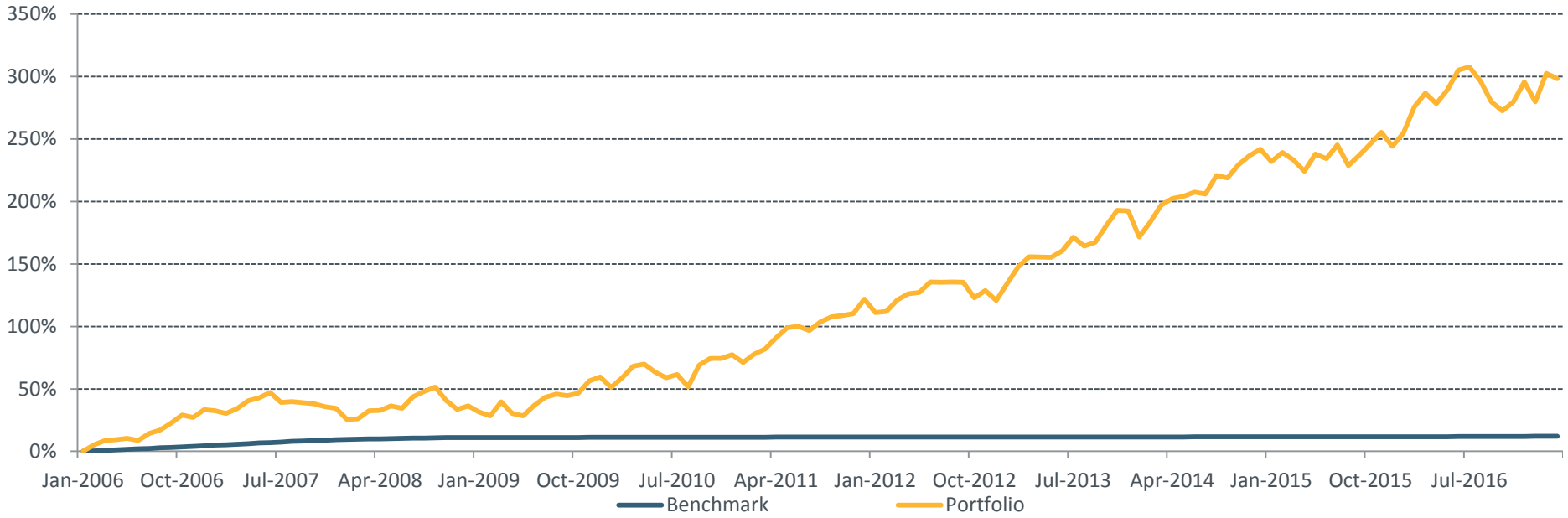
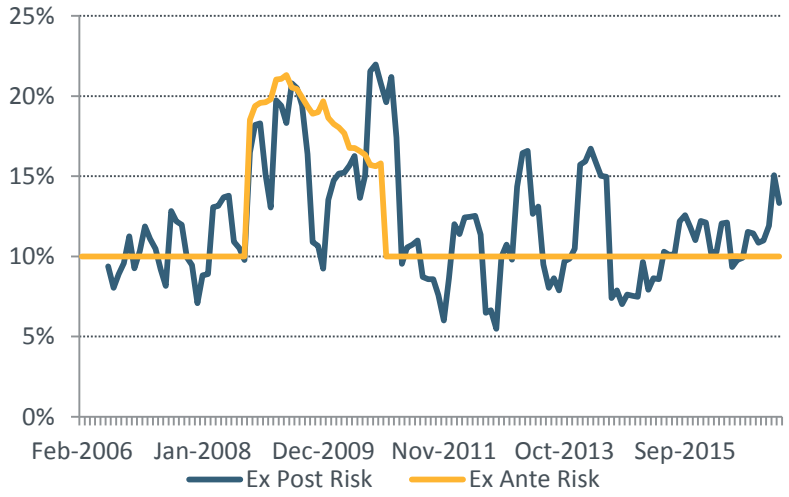
BACKTEST - LS CHANGES



Cumulative Portfolio Return	298.26%
Cumulative Active Return	286.10%
Cumulative Benchmark Return	12.16%
Avg Turnover	27.90%
Avg # of Assets	224.52
Sharpe Ratio	0.99
Information Ratio	0.99
Beta	0.00%
Avg Short (%)	-100.00%
Portfolio Risk (%)	12.24%



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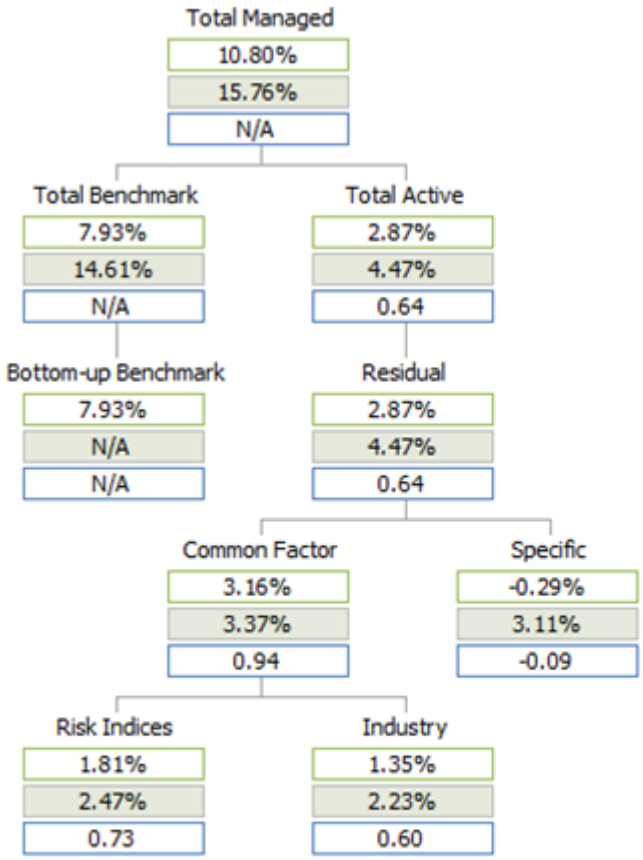
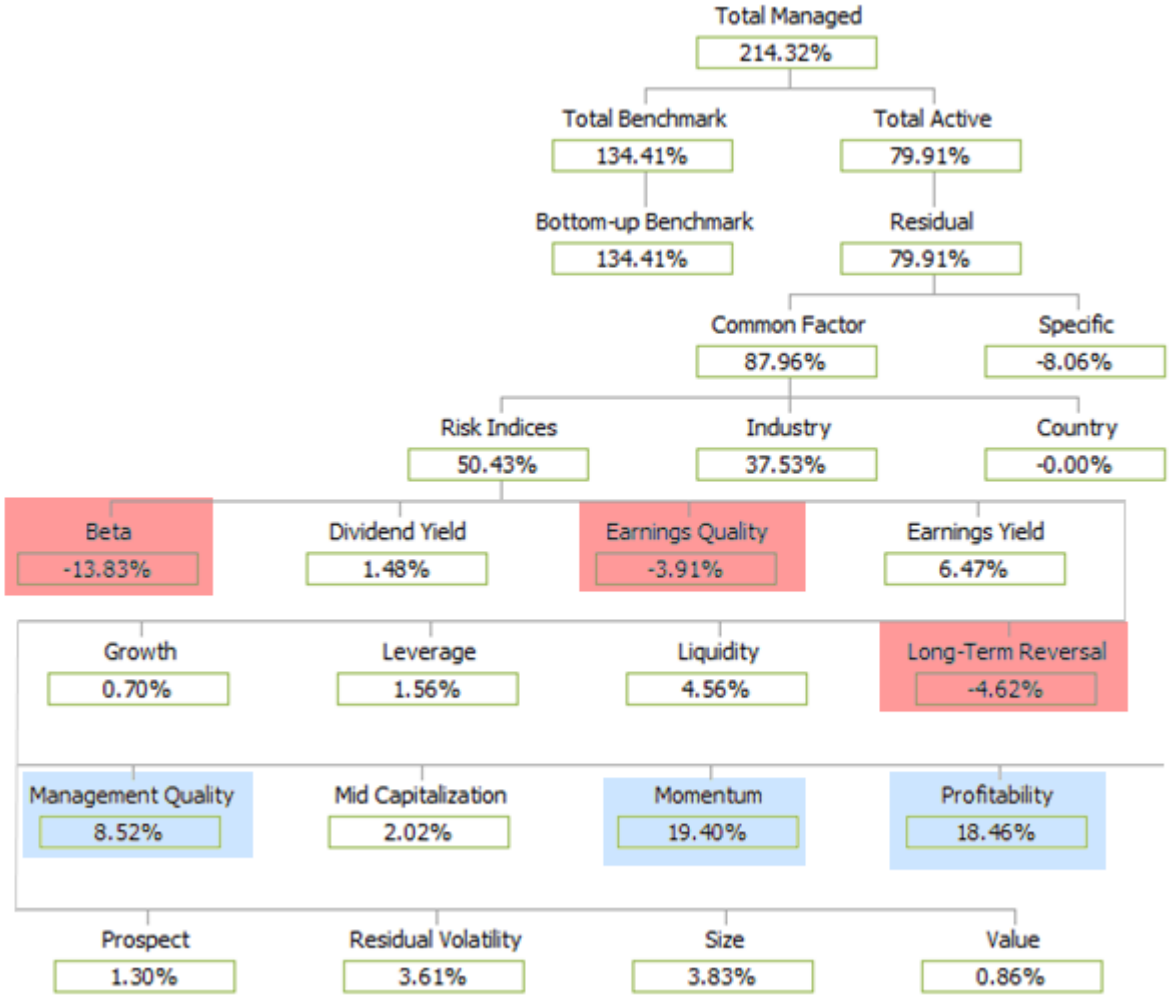
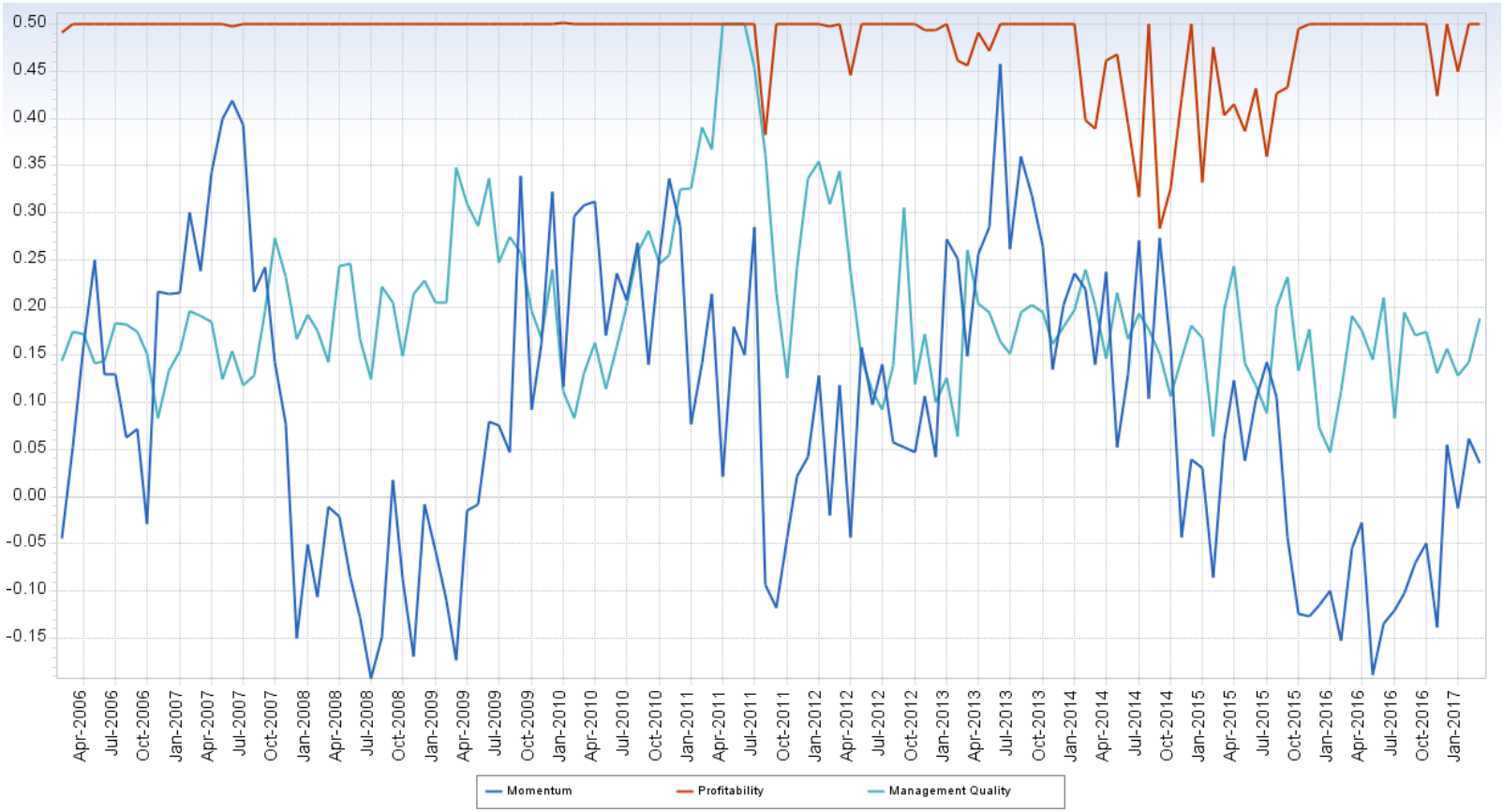
PERFORMANCE ATTRIBUTION – LO CHANGES



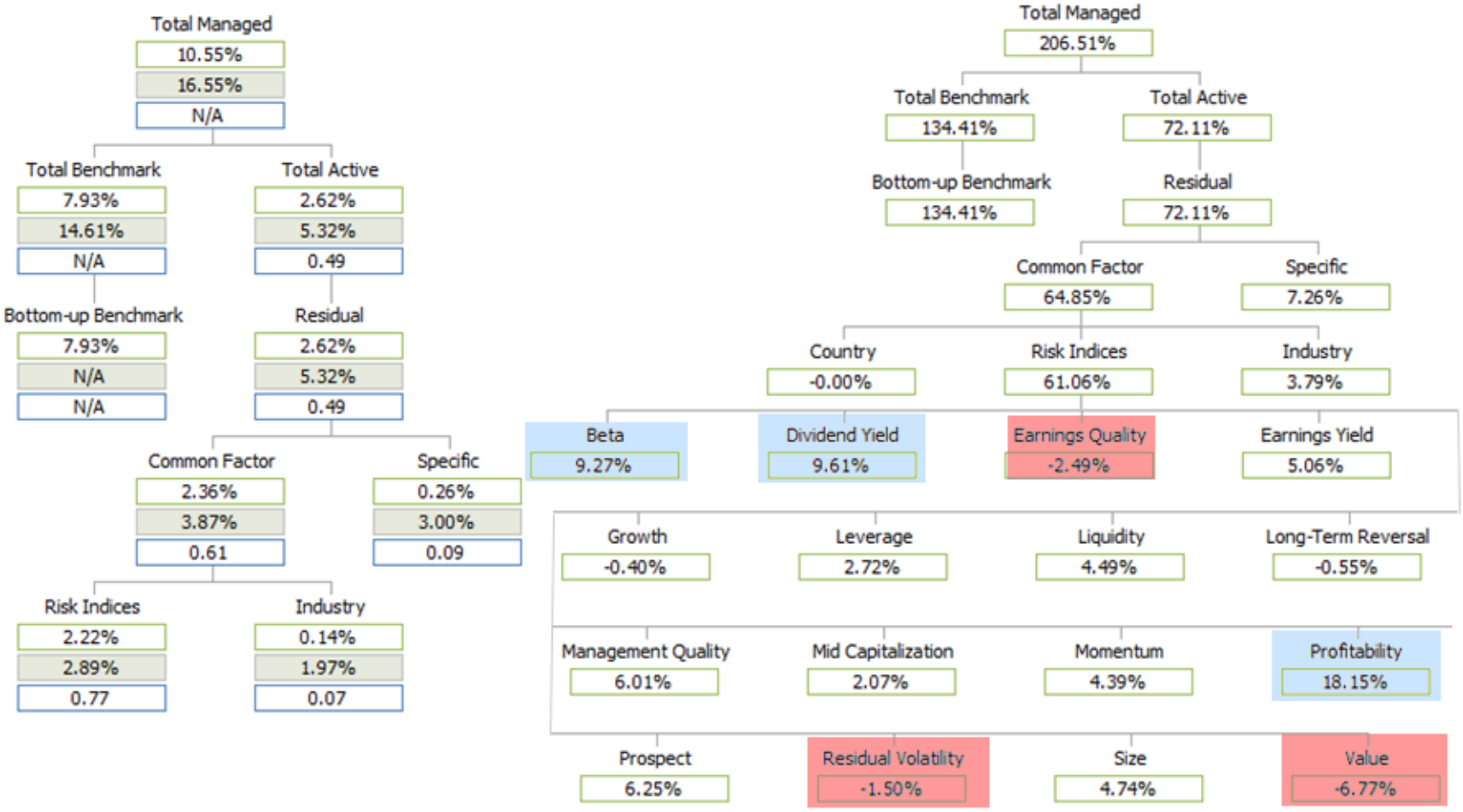


EXPOSURES – LO CHANGES

Top Contributors Active Exposures

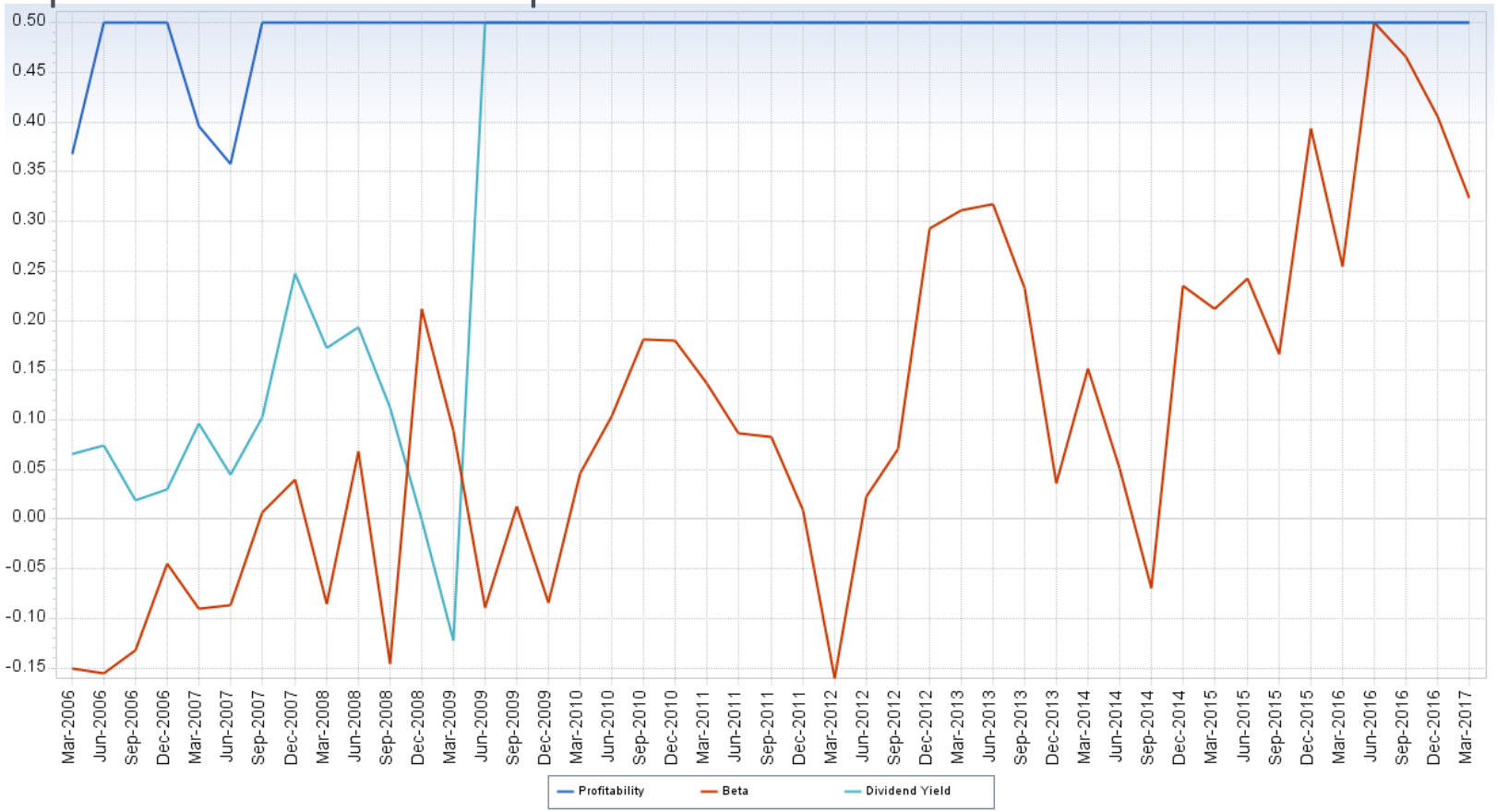


PERFORMANCE ATTRIBUTION – LO LEVELS

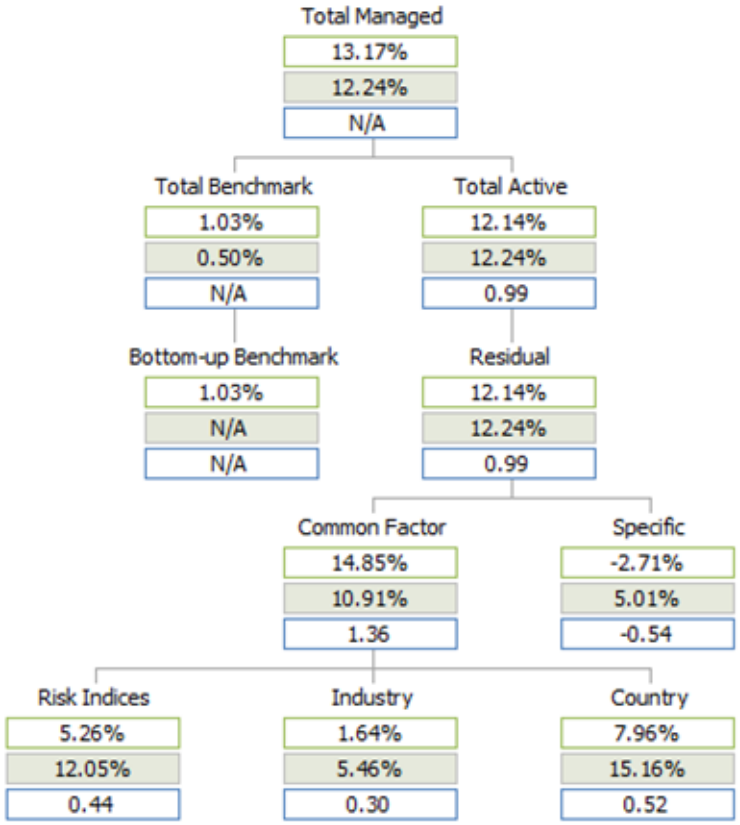


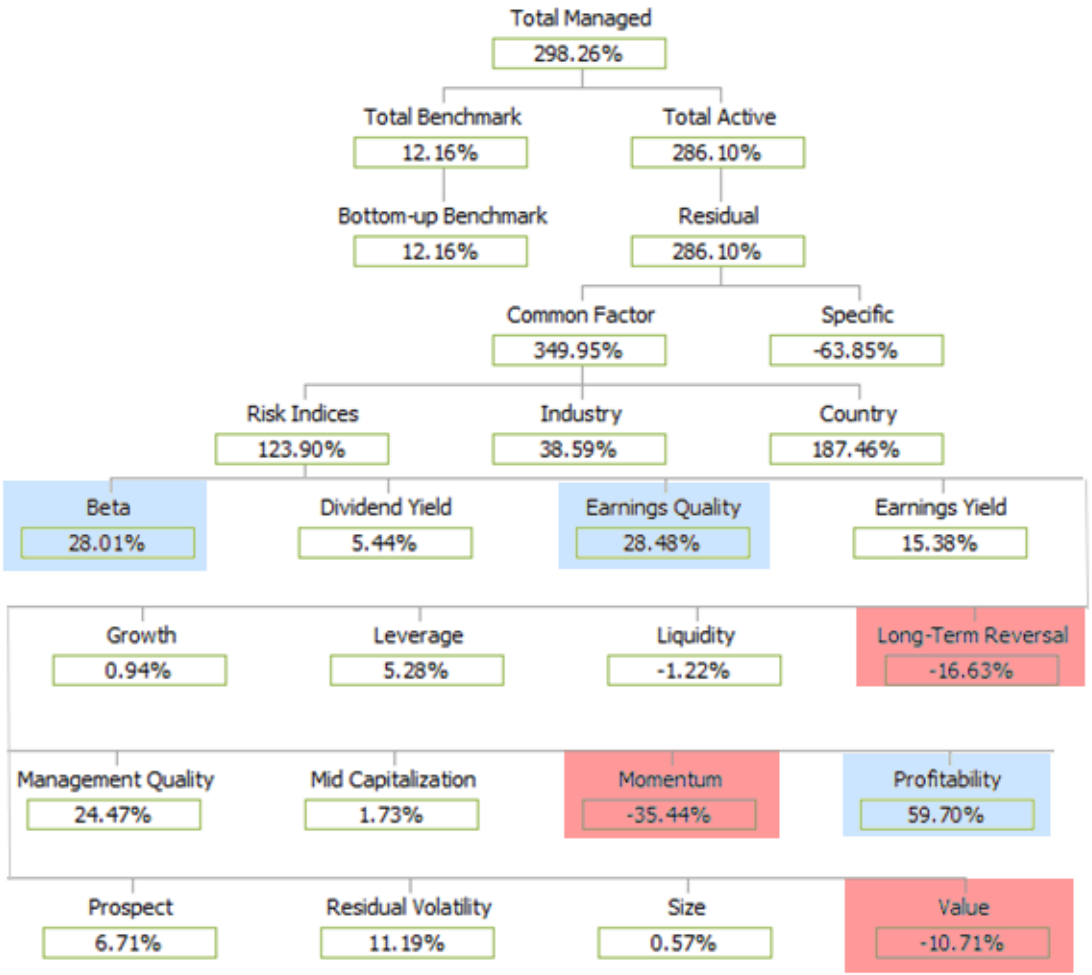
EXPOSURES – LO LEVELS

Top Contributors Active Exposures



PERFORMANCE ATTRIBUTION – LS CHANGES





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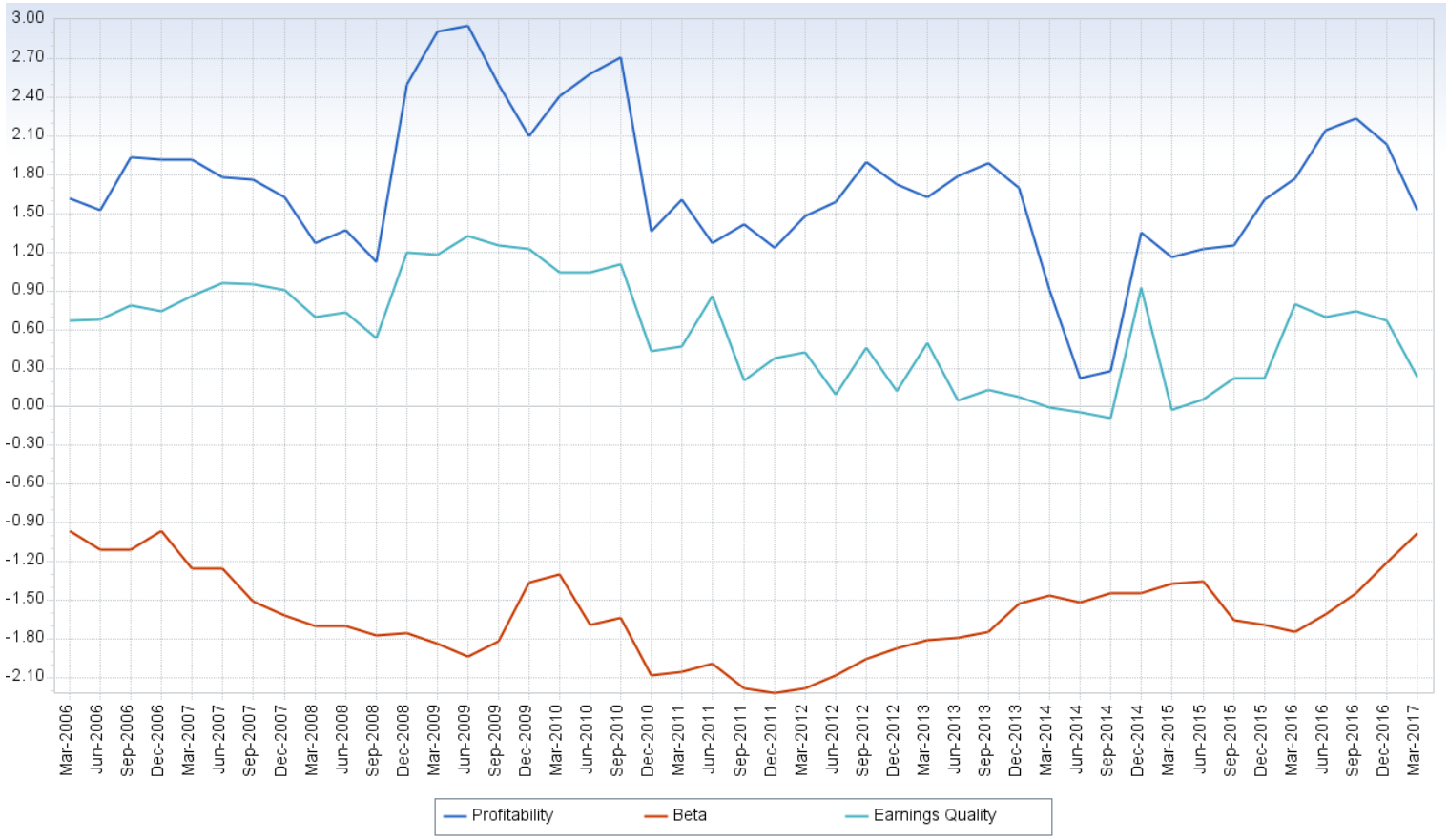
EXPOSURES – LS CHANGES

Top Contributors Portfolio Exposures



No Exposure Constraint applied to the Long/Short back test

4. SIGNAL IMPLEMENTATION (CLI)

CLI AS MACRO BASED ROTATION SIGNAL

Definition

CLI stands for Composite Leading Indicators

Designed by OECD

Aimed to provide early signals of turning points of business cycles

The lead time varies but is 3 - 9 months in average

Data for a given month t is available at month t+2. Reason why there is a two months lag between the reference date and the publication date

MACRO BASED USE CASE CONSTRUCTION STEPS

Identify and classify into quartiles, the quarterly changes in CLI indicator

Bucket historical style factor returns within each quartile and compute averages

Classify style factors, that get along together, into investment themes with different weighting schemes

- Inverse of Variance
- Equally Weighted
- Inverse of Variance Inflation Factor weighted

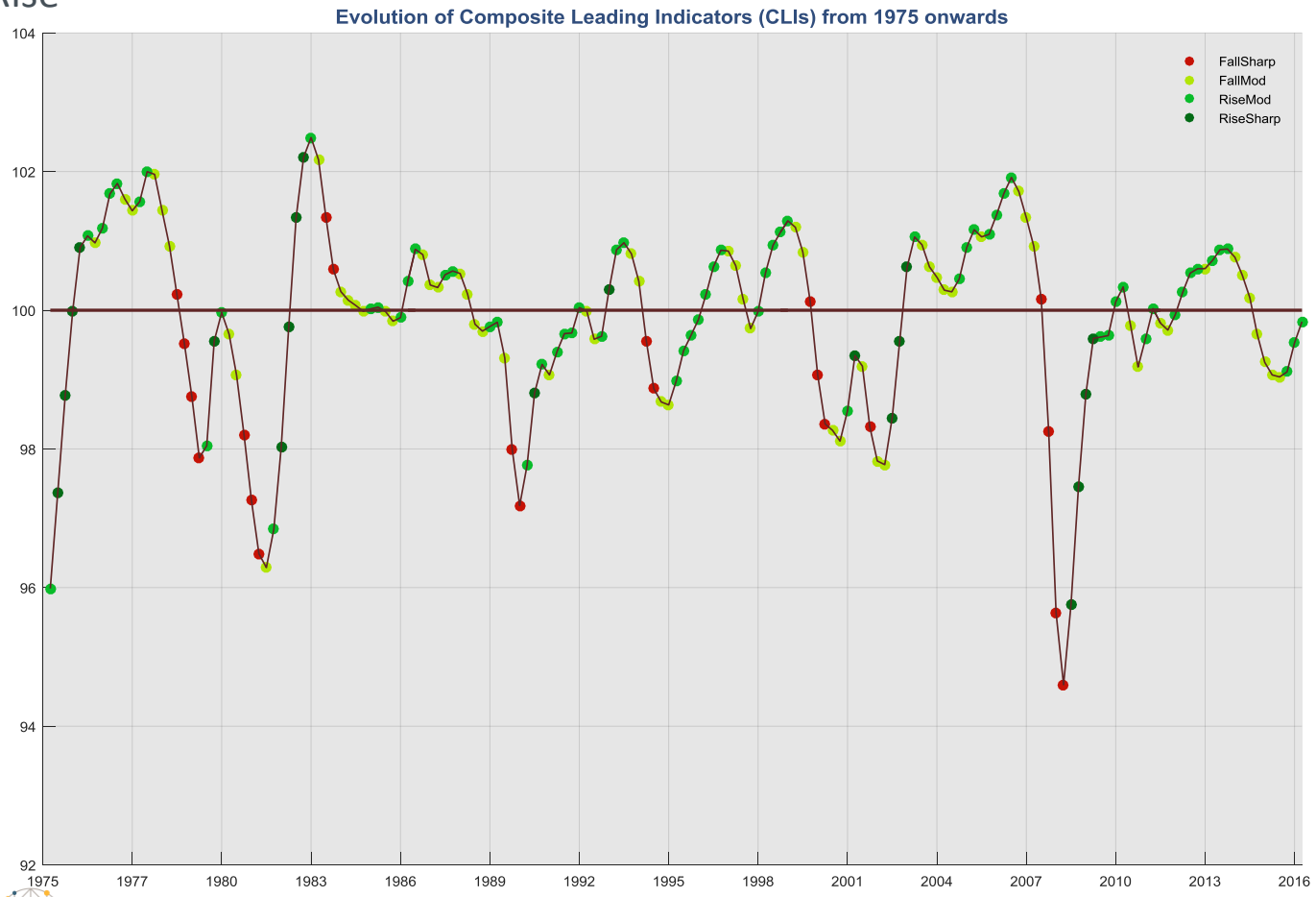
Compute average and cumulative returns of the quartiles by investment theme

Compute relative weights for each factor on each quarter and build sparse matrix of weights

CONSTRUCTION PROCESS - CLASSIFICATION

Retrieve historical quarterly data (slow moving signal) for CLI back to 1975

Classify the signal movements into 4 buckets: Sharp Fall, Moderate Fall, Moderate Rise and Sharp Rise



CONSTRUCTION PROCESS - CLASSIFICATION

Alternatively, we can look at the distribution of % changes (returns) of CLI and divide it into the 4 buckets:

Sharp Rise

$$CLI_{change} > \mu_{CLI} + \sigma_{CLI}$$

Moderate Rise

$$\mu_{CLI} < CLI_{change} \leq \mu_{CLI} + \sigma_{CLI}$$

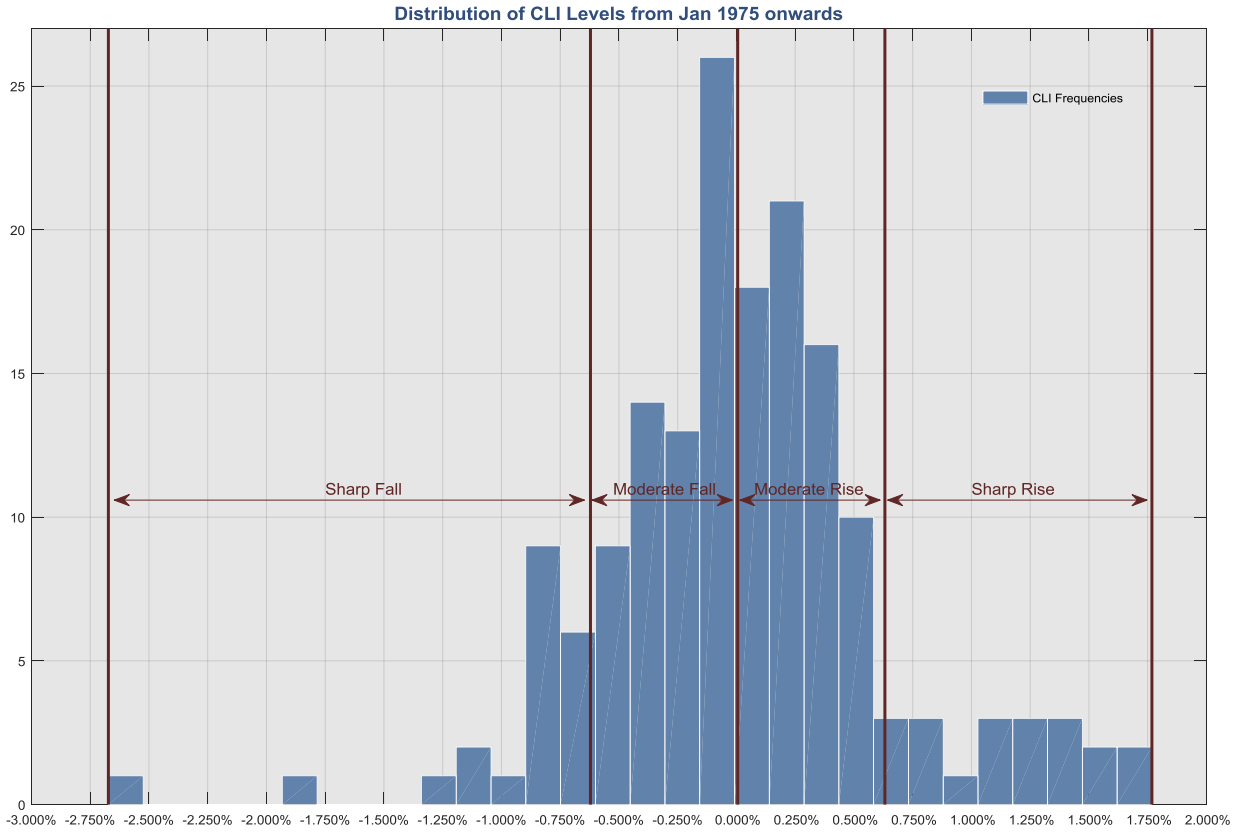
Moderate Fall

$$\mu_{CLI} - \sigma_{CLI} \leq CLI_{change} < \mu_{CLI}$$

Sharp Fall

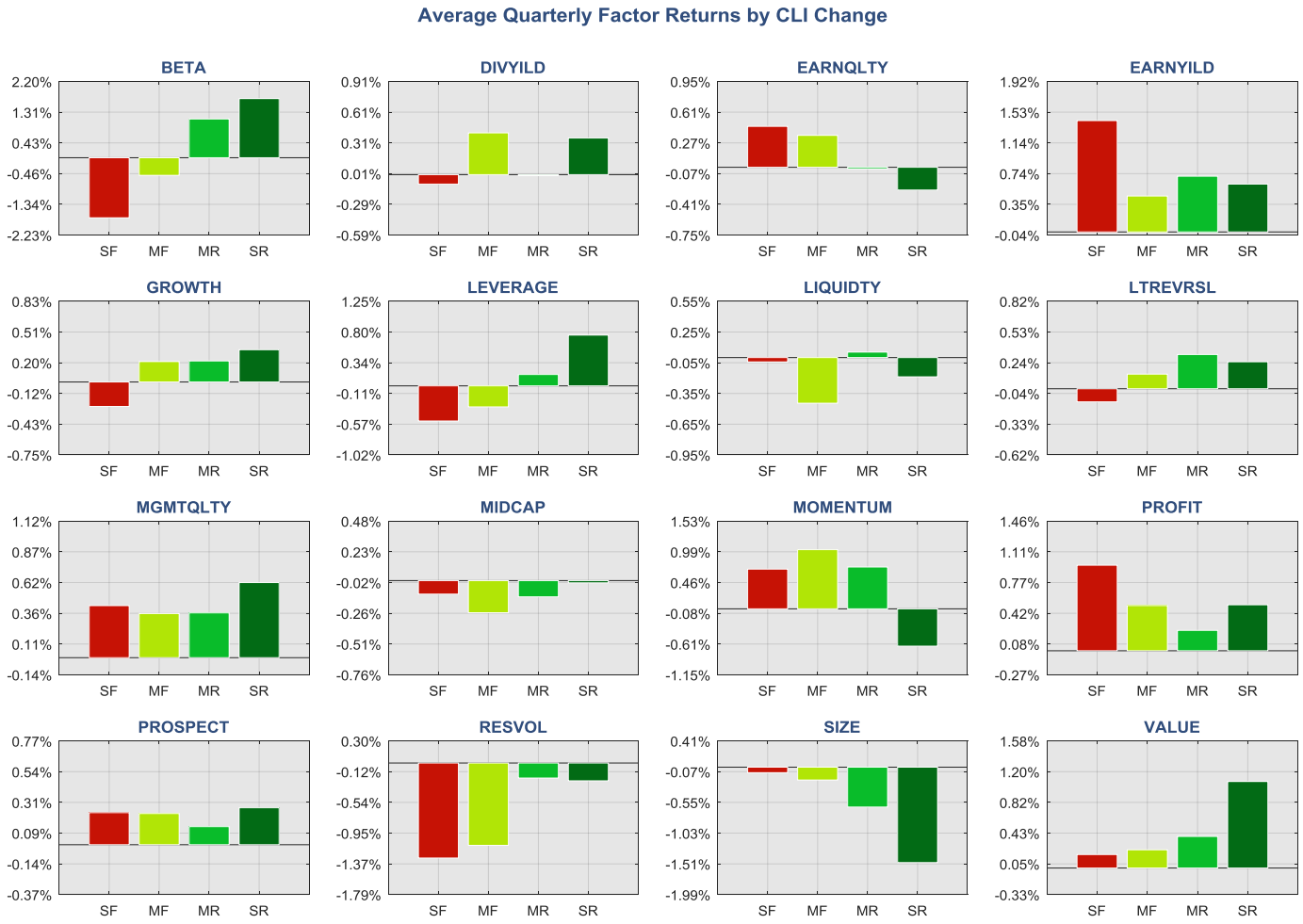
$$CLI_{change} < \mu_{CLI} - \sigma_{CLI}$$

*μ_{CLI} stands for the median



CAN WE UNDERSTAND WHAT FACTORS PERFORMED IN WHAT REGIME?

Classification and Average Style Factor Returns

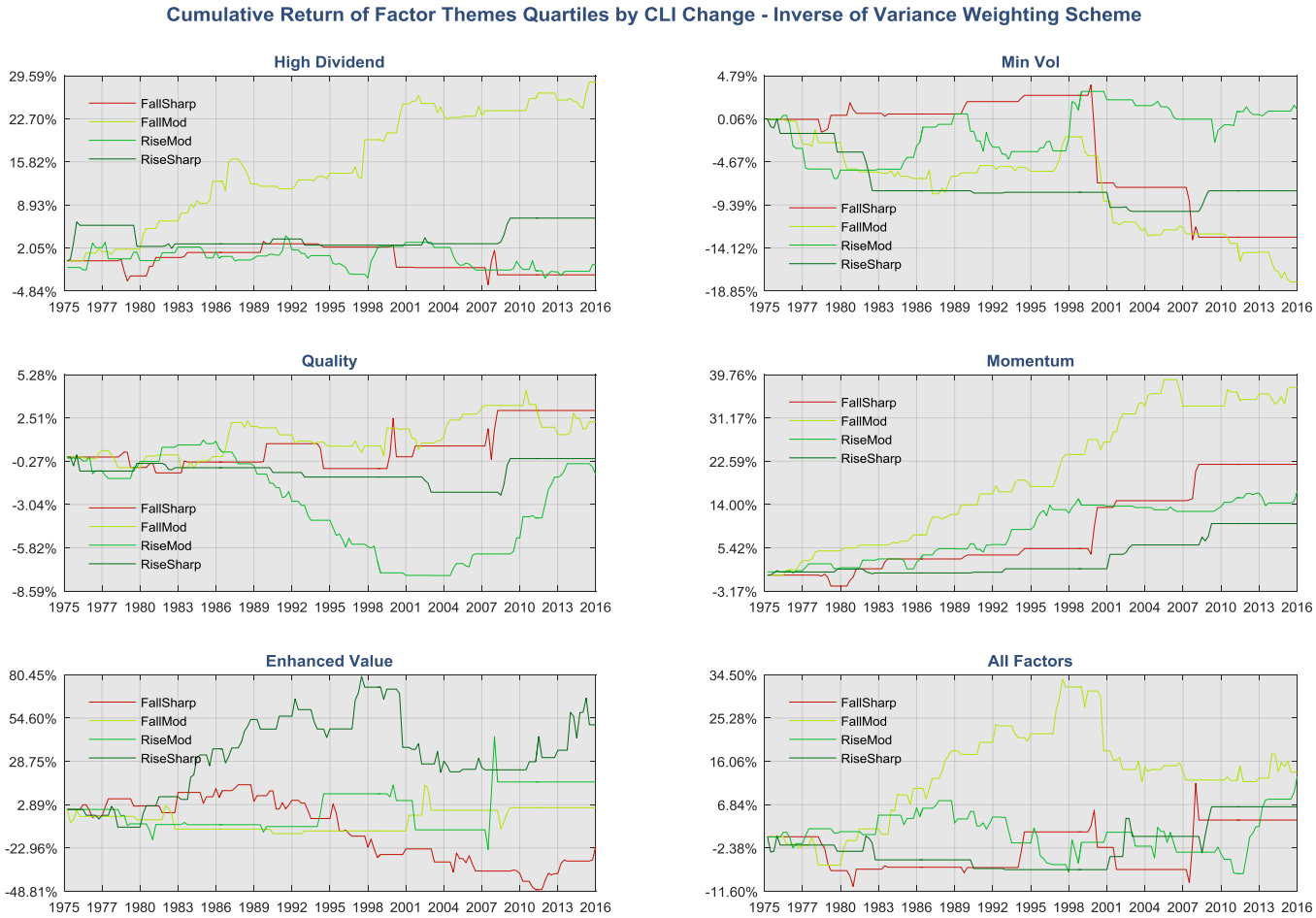


CAN WE UNDERSTAND WHAT FACTOR THEMES PERFORMED IN WHAT REGIME?

Group the Factor Returns into investment themes– Inverse of Variance Weighting

IS THE EVOLUTION OF THE BUCKETS CONSISTENT WITH OUR EXPECTATIONS?

Style Themes Cumulative Returns by Quartiles

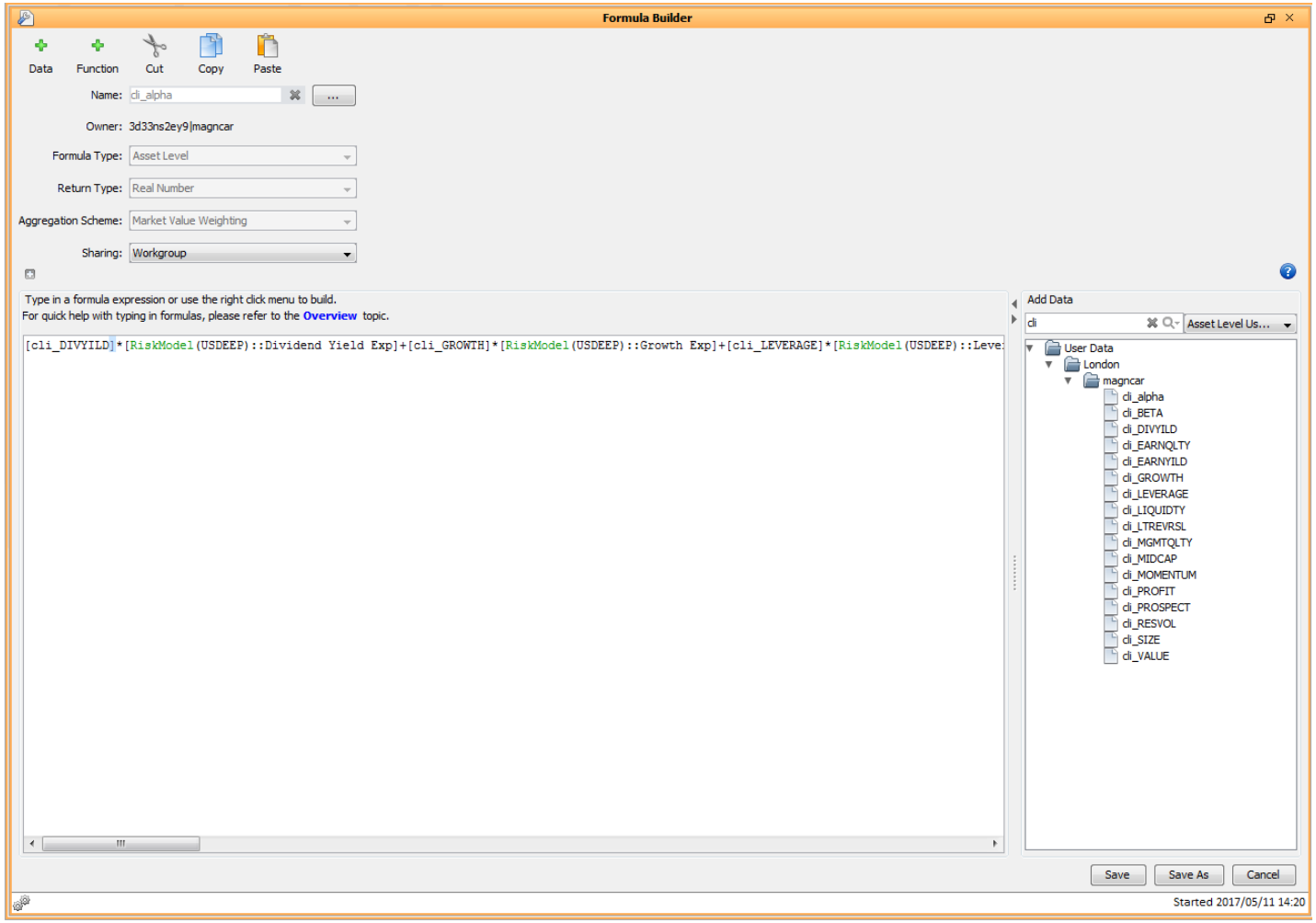


5. SIGNAL IMPLEMENTATION (CLI)

CREATING THE SIGNAL

Using FORMULA BUILDER in BPM we create the expected return vector based on:

- Loaded Factor Weights
- Risk Model Factor Exposures



OPTIMIZATION CASE – LONG ONLY CLI

General Ops Settings

- Period: Mar-2006 - Mar-2017, Quarterly Rebalance
- Benchmark: MSCI USA
- Objective: Max Utility, i.e. Expected Return - Risk
- Risk Model: USDEEPL

Specific Constraints

- Fully invested optimal portfolios
- 20% Max Turnover
- Benchmark+-2% Active weights

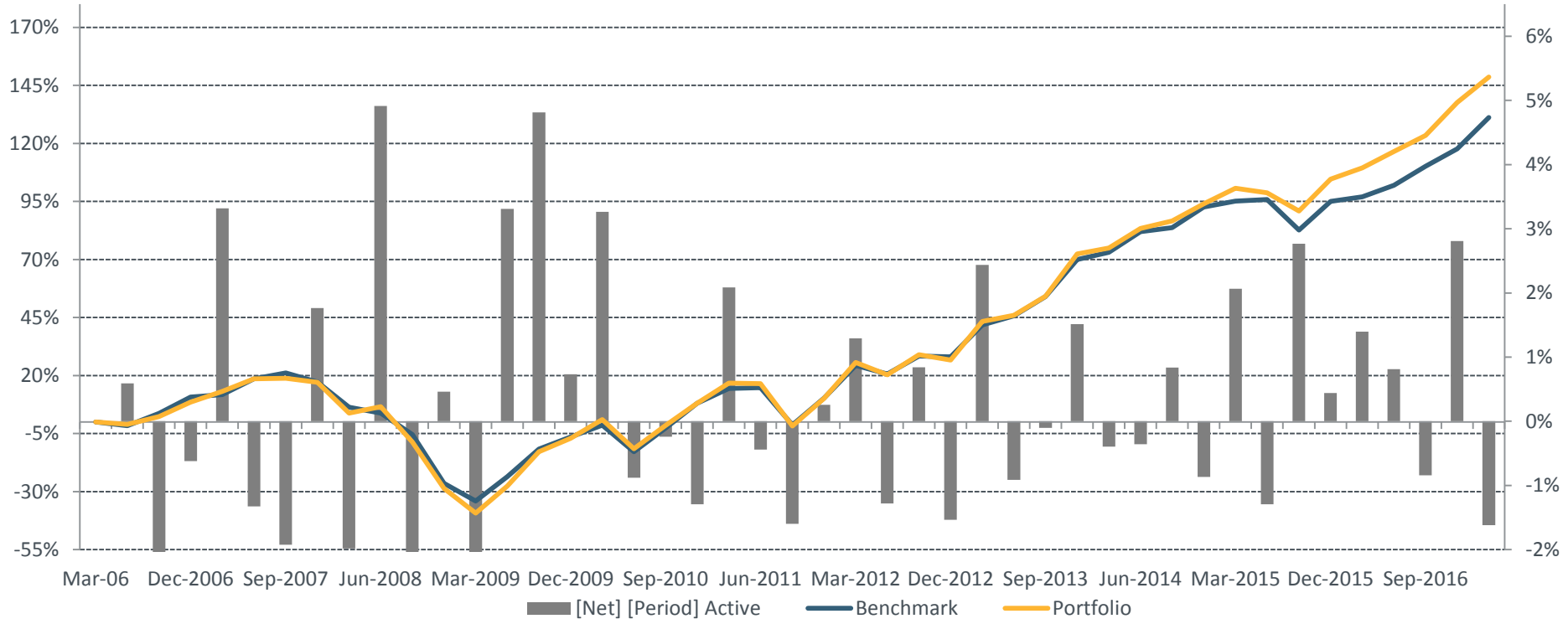
Active Exposures

- Styles in rotation
- b+-0.5 standard deviations

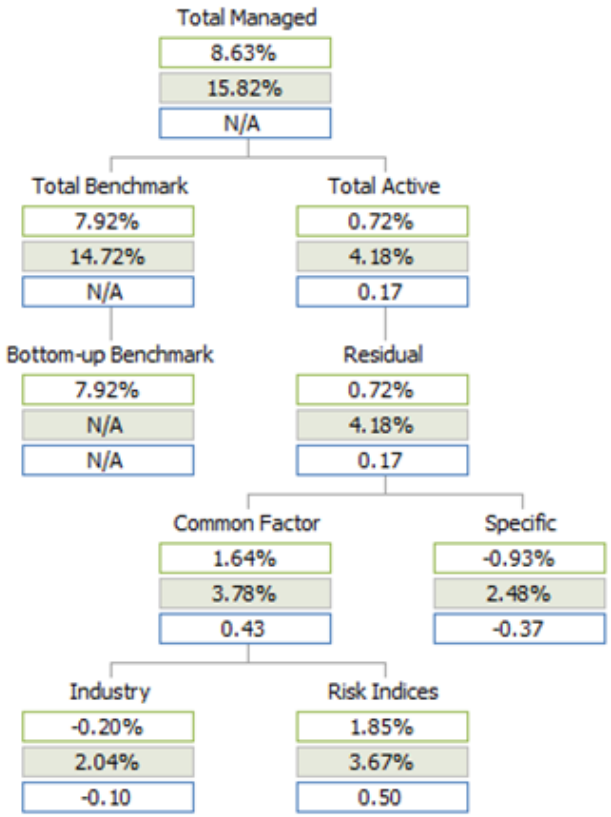
Tracking error limit (soft)

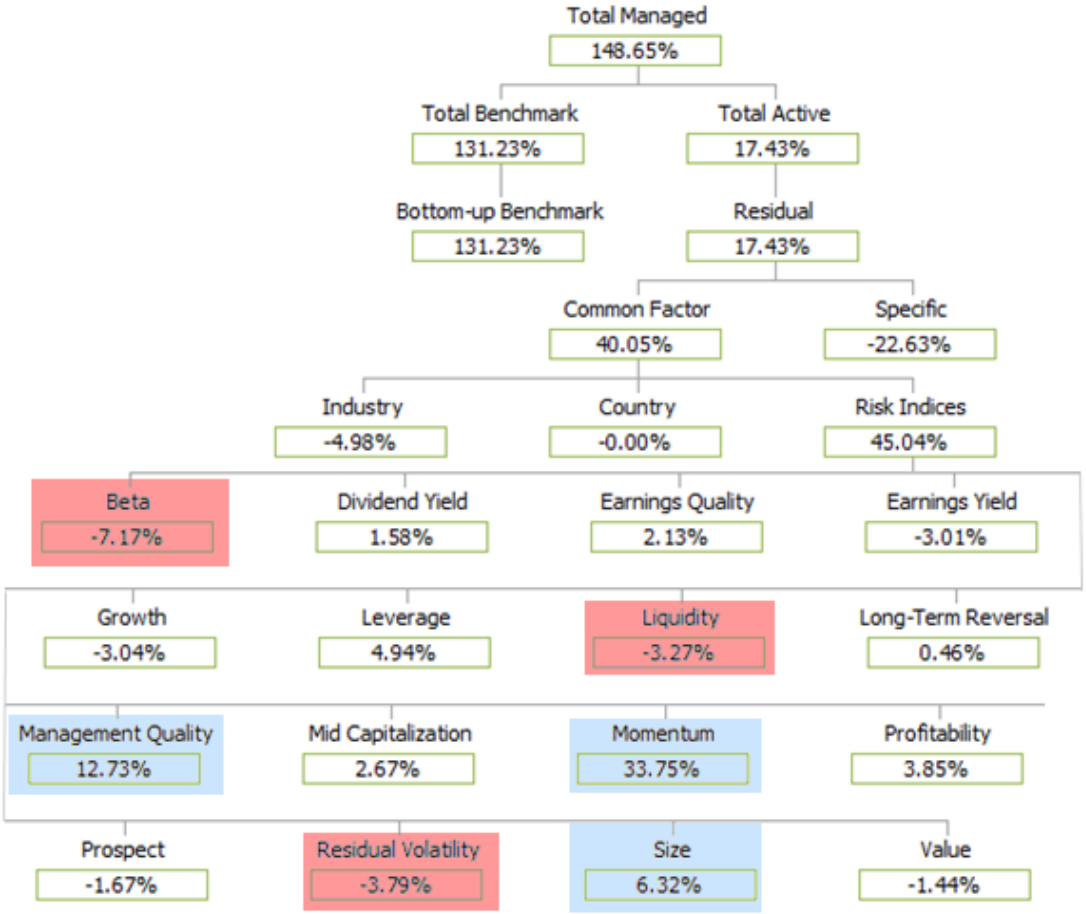
Max 10%

BACKTEST - CLI



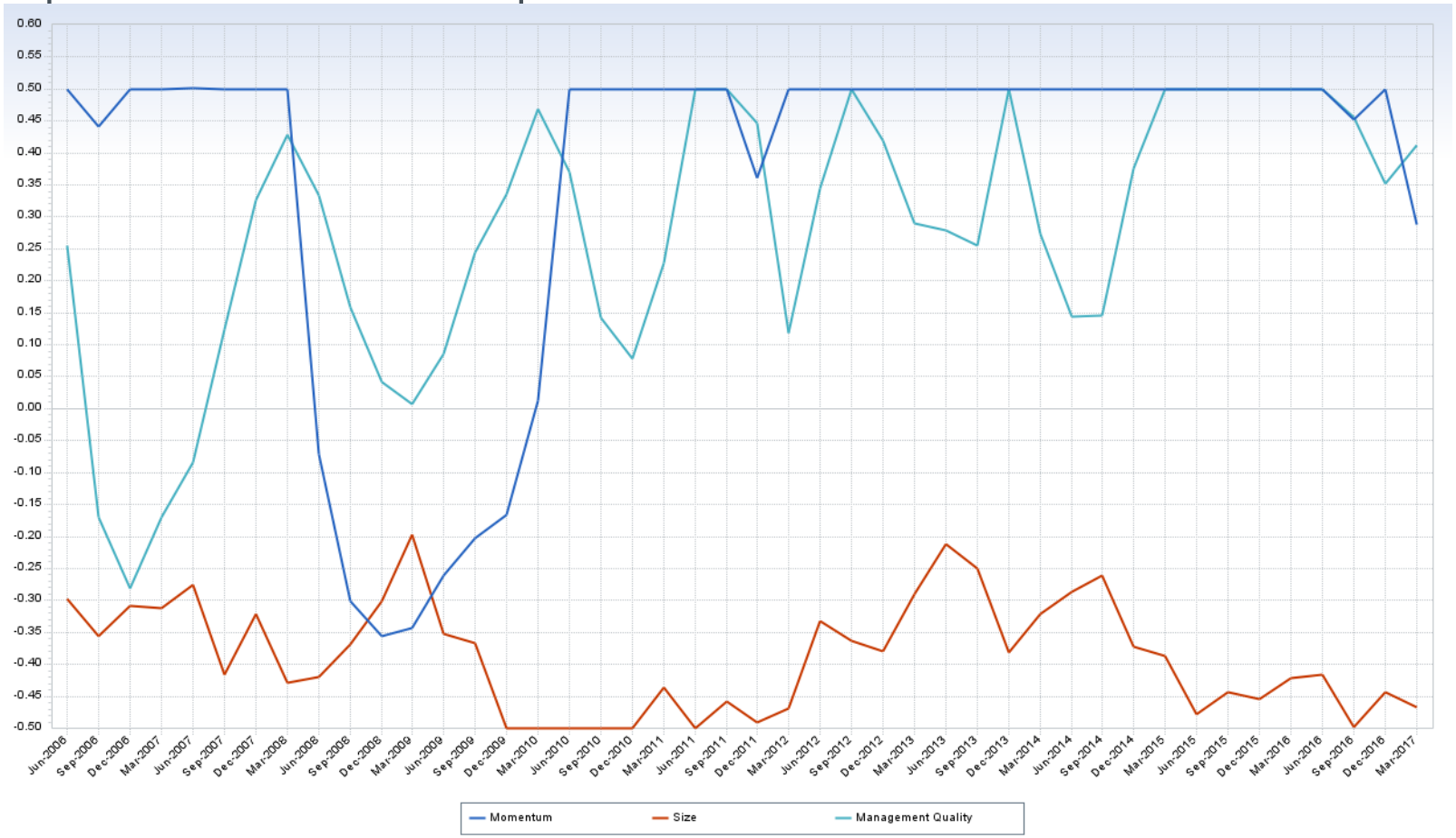
PERFORMANCE - CLI





EXPOSURES – CLI

Top Contributors Active Exposures



FINAL REMARKS

- Performance and risk of Style factors changes across time, therefore, it's important to time their contemporaneous characteristics
- Combining multiple SES signals together increases portfolio stability
- Rotation is a technique that can be used to invest in the right factors at the right moment
- Rotation can be based on single indicators or combination of indicators between macro, valuation, risk/correlations
- Capturing risk-premia is always a challenge but not impossible!

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