## RCM-X

**FINANCIAL TECHNOLOGY FIRM PROVIDING:**

- Benchmark & Custom Execution Algorithms for Futures & Equities
- Strategy Studio - RCM's proprietary trading platform which is licensed to high volume/low latency systematic traders across asset classes
- Risk Management Consulting for Hedge Funds, Mutual Funds, and 3rd Party Asset Managers

## RCM ALTERNATIVES

RCM is a boutique investment firm bridging the gap between Fintech and High Touch, merging new technology with industry veterans to help trading firms reach their full potential in terms of alpha generation, capital raising, and operational efficiency.

# Market Neutral Equity Investing:
## Objectives and Challenges

# Types of Quantitative Equity Strategies

- High Frequency
  - Sell side execution algos
  - Automated market making
  - Intraday opportunistic trading
- Stat Arb
  - Typical forecasting horizon of 1-4 trading days
- **Market Neutral Equity**
  - Forecasting horizon usually 1 week to 3 months
  - Usually based on returns factor modeling plus asset allocation and portfolio optimization theory, seeking to profit from longer term regularities of the market

# Basic Objective

- Estimate asset returns distribution, model an investment objective, maximize, trade, repeat. An example objective is '*maximize risk adjusted returns net of fees*':

$$w_t = \underset{\substack{e' w_t = 0 \\ w_t \in C}}{\operatorname{argmax}} \; w_t' \hat{\mu} - \lambda w_t' \widehat{Cov} \, w_t - Costs(w_t, w_{t-1})$$

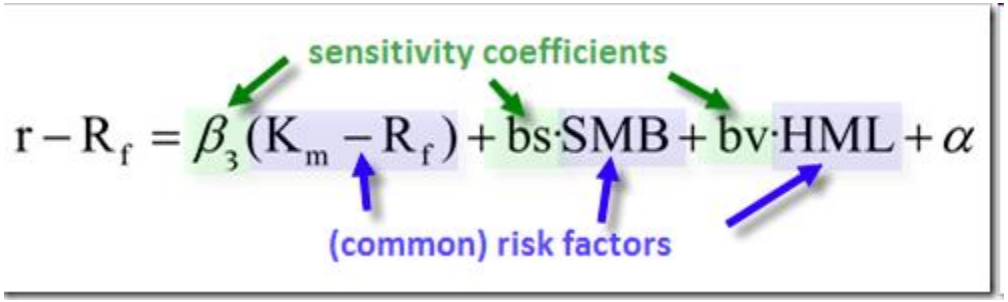
- Many variations on this theme are used in practice, each with pitfalls, all only approximately grounded in terms of maximizing investors' expected utility of wealth at their investment horizon

# Core Challenges

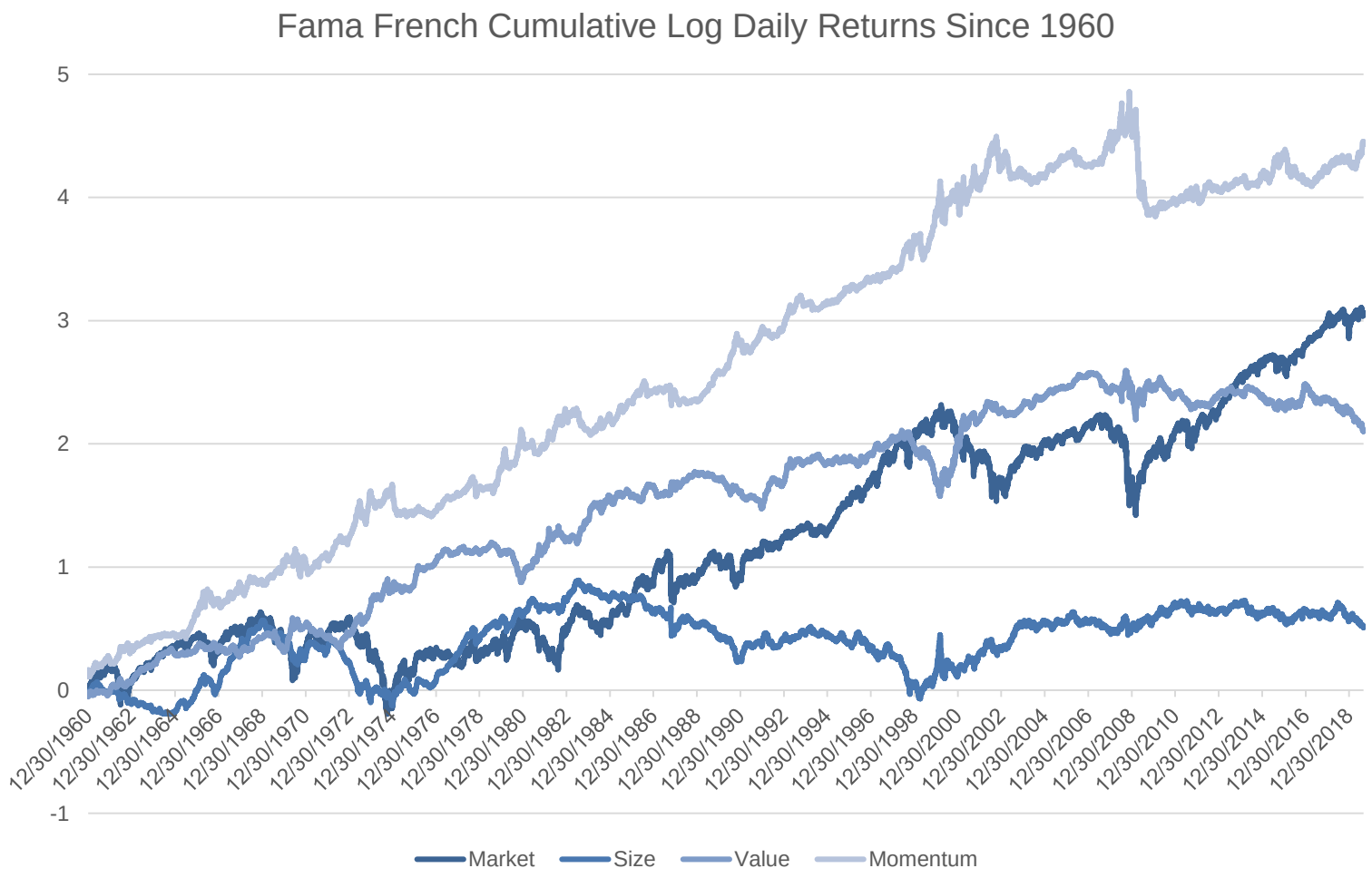
- Use robust, consistent estimation of out-of-sample expected returns and variance
- Navigate data quality shortcomings
- Understand the limits of optimization software
- Balance returns objective with costs and risks of leverage and execution

# Factor Model Review

- Factor models are essentially multidimensional extensions of CAPM, more broadly they represent a decomposition of asset returns distribution
- The basic example is the Fama-French 3-factor model:

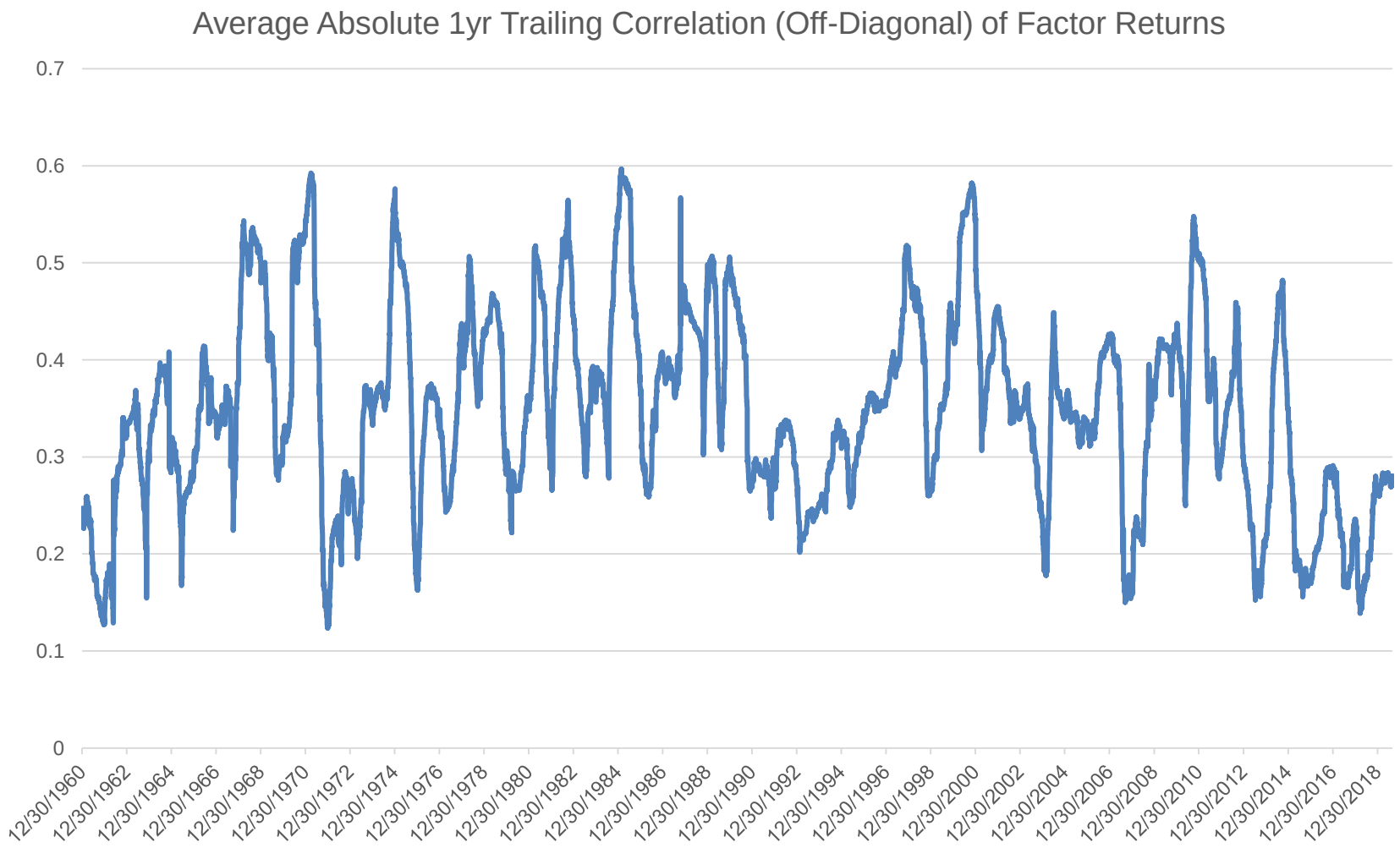



- SMB = 1/3 (Small Value + Small Neutral + Small Growth)
  - 1/3 (Big Value + Big Neutral + Big Growth).
- HML = 1/2 (Small Value + Big Value)
  - 1/2 (Small Growth + Big Growth)
- Each component portfolio is value weighted based on sorts of firm characteristics




But these are costless, high turnover, not well orthogonalized. Market beta of Value series is -.11 with large t-stat (-26.85). Factors returns are 2:1 levered, without funding costs or realistic investable universe constraints.

# Correlation Instability



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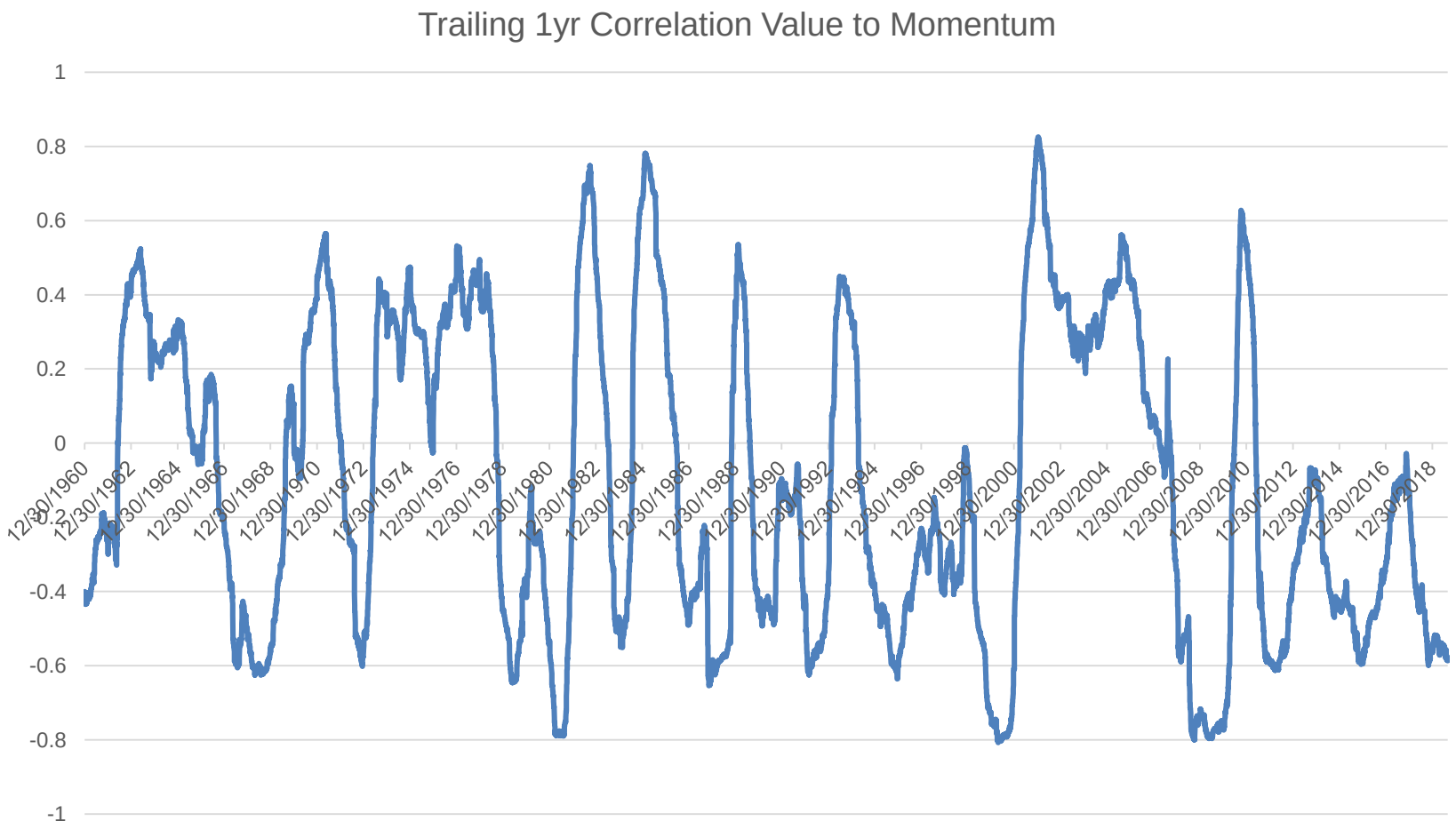
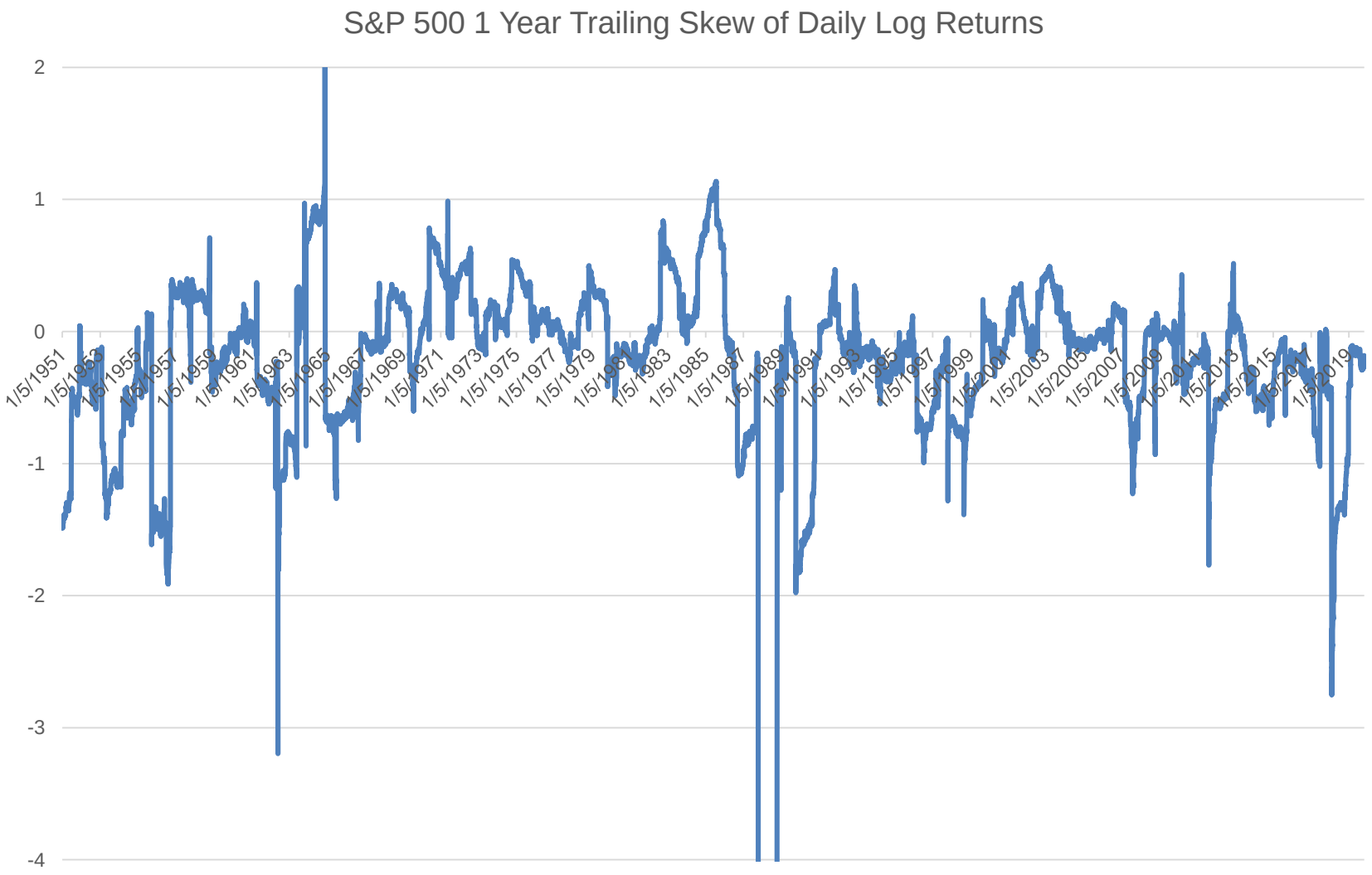



Full period sample correlation: -.26

# Higher Order Moments…



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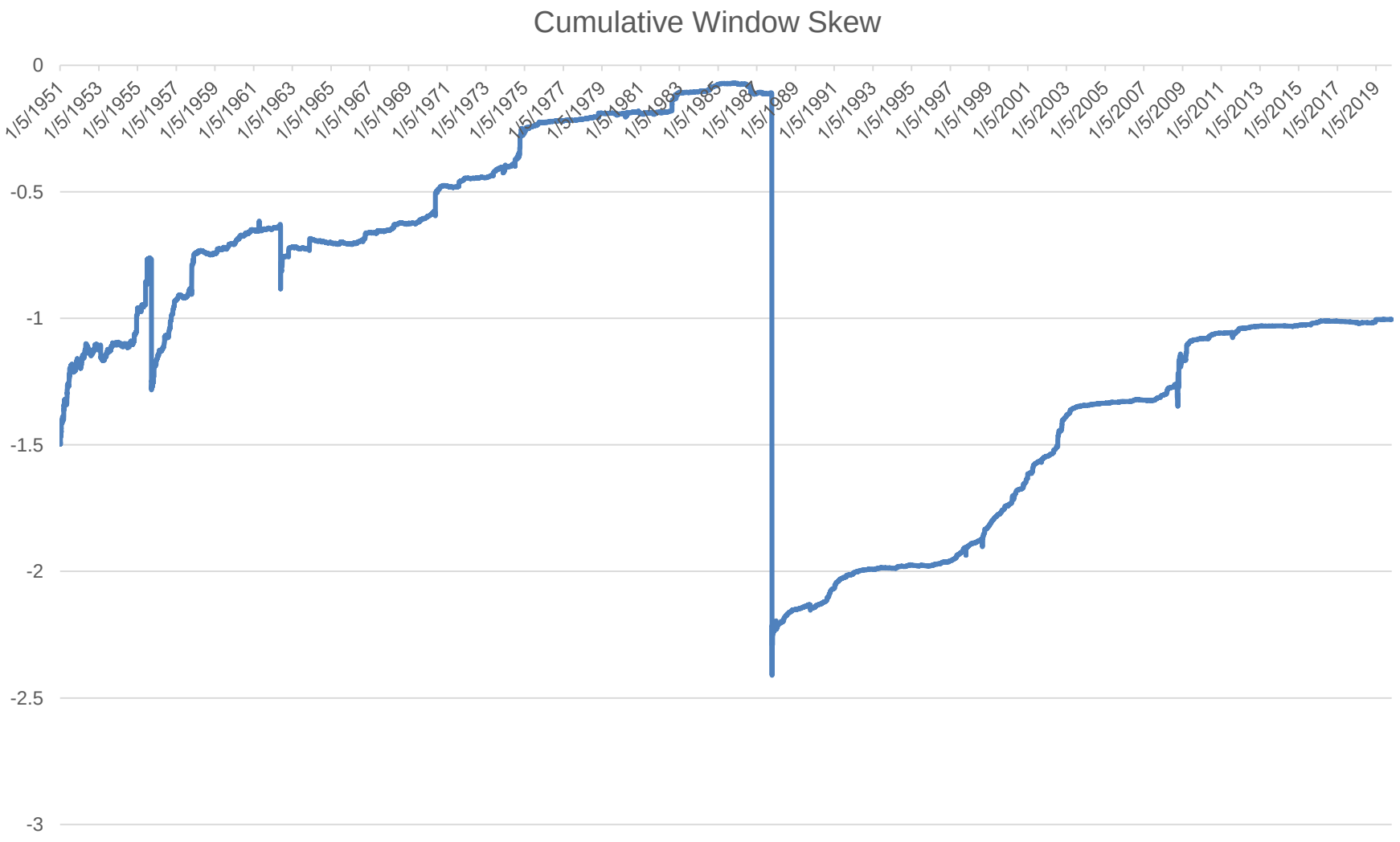

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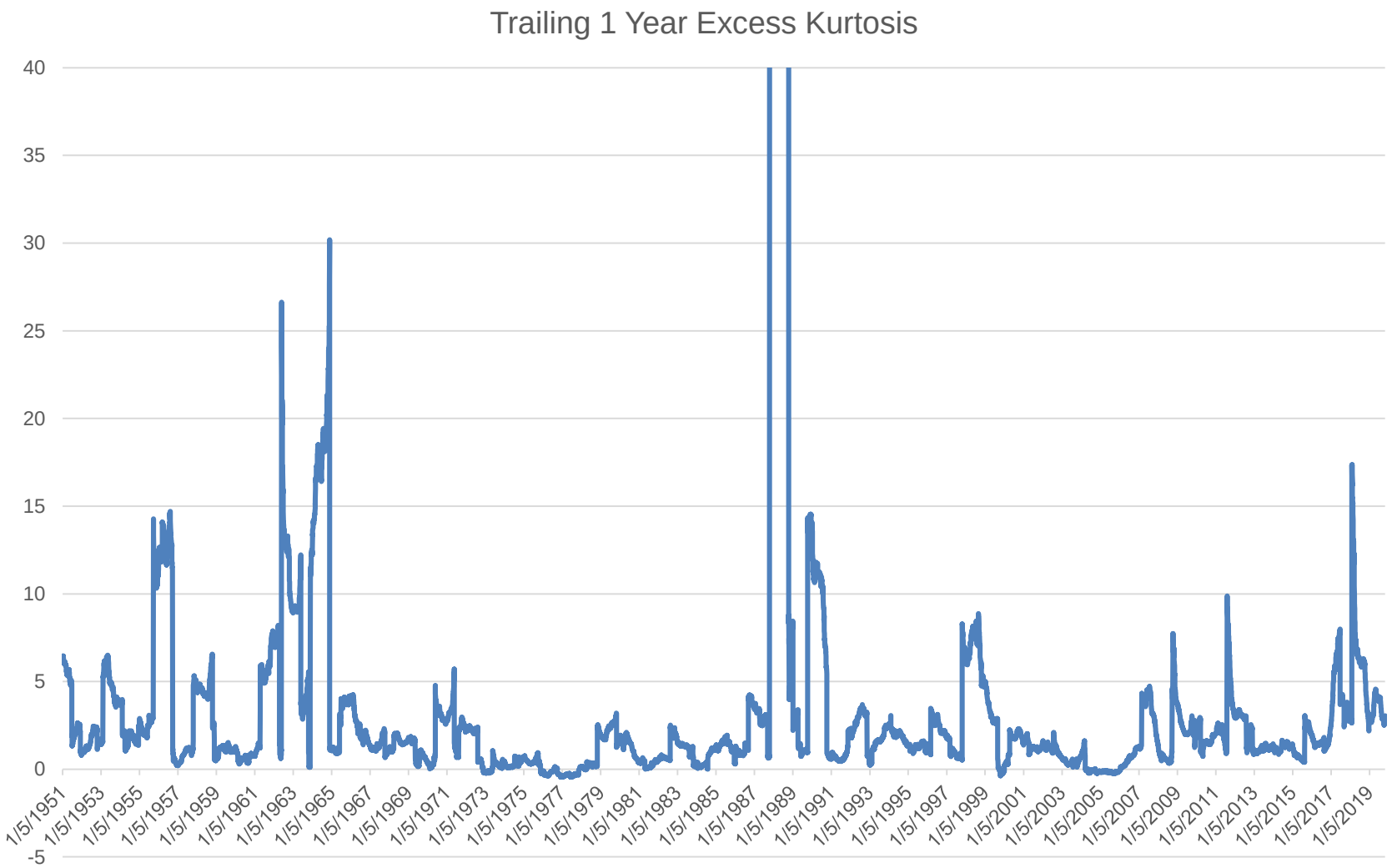

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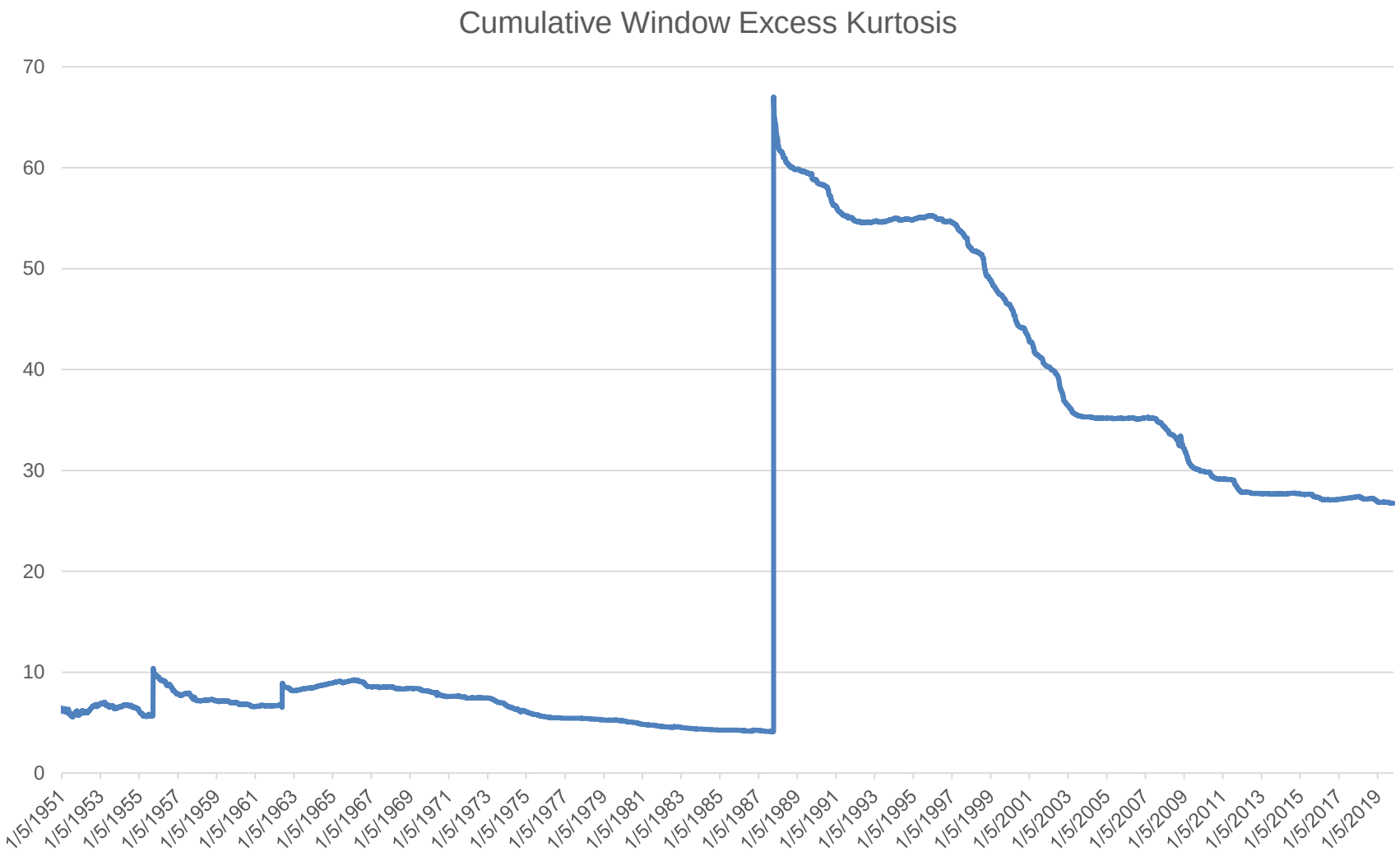


# Risk Factors or Market Anomalies?

- Empirically, some factors are more powerful for explaining variance, while others look more useful for forecasting the next period's returns, but every factor exposure carries risk.
- Goal is to discern which factors offer attractive returns, and to have a strong hypothesis regarding why this should persist. Explanations include:
  - Exposure to systematic risk that covaries with investors' discount policy (tied to wealth/consumption/endowment utility). Examples: financial distress risk, liquidity risk.
  - Time varying risk premia & investor preferences.
  - Information costs & asymmetries
  - Transaction/funding costs & asymmetries

# Know Your Data

- Vendor data is guilty until proven innocent; data errors and subtle biases are the rule, not the exception.
- Example 1: IBES analyst earnings per share data was traditionally delivered split adjusted, rounded to the penny, reducing granularity of EPS for stocks that had undergone several splits, and driving them to zero in the limit, inducing biases surveyed by *The Implications of Using Stock-Split Adjusted I/B/E/S Data in Empirical Research, Payne & Thomas 2003.*
- Example 2: Vendor risk model version releases can introduce quality control issues and look-ahead bias in the research process.

# Know Your Optimizer

- Support for large universes, diverse portfolio constraints, adjustments for estimation uncertainty, and flexible cost function specification takes optimizers out of the realm of easy-to-implement quadratic programming, requiring broader convex optimization algorithms (mixed integer, second-order cone programming).
- Not all constraints have feasible solutions, and commercial optimizers can vary in how gracefully they handle a given optimization problem.

# Optimization: Output Quality Example

- Base Scenario: Maximize returns subject to
  - Universe: S&P 900
  - MinLong: 50%
  - MinShort: 50%
  - MaxLeverage: 6.6x
  - MaxHolding: 12%
  - NetIndustry: 16%
  - NetSector: 20%
  - MaxAbsFactorBeta: 0.1
  - MaxAnnualizedVolatility: 6%

# Optimization: …Results

| Optimizer | Max Num Security Constraint | Objective Score, Scaled to Best Case | Number Of Holdings | Leverage |
|---|---|---|---|---|
| Opt_A | None | 1.0000 | 801 | 6.6 |
| Opt_B | None | 0.9410 | 749 | 6.286 |
| Opt_B_15Min | None | 0.9541 | 777 | 6.379 |
| Opt_A | 330 | 0.9484 | 330 | 5.781 |
| Opt_B | 330 | 0.6597 | 266 | 3.887 |
| Opt_B_15Min | 330 | 0.6937 | 295 | 4.079 |
| Opt_A | 300 | 0.9350 | 300 | 5.596 |
| Opt_B | 300 | 0.6327 | 255 | 3.656 |
| Opt_B_15Min | 300 | 0.7272 | 231 | 4.069 |

# Know Your Costs: Financing

- Costs of financed leverage: example 6x levered dollar neutral portfolio (3x capital base in long positions, 3x in short positions). Stylized funding agreement:
  - Borrow 2x of capital to fund excess long exposure, paying T-Bill plus FundingSpread
  - Short 3x capital, cash proceeds from easy-to-borrow names ('General Collateral') earn interest at T-Bill minus FundingSpread
  - If all short names are returning GC, net funding returns:
    Receive T-Bill – 5 * FundingSpread.
  - *If FundingSpread = 50bps, that's a 2.5% drag on annual returns.*
  - Cash proceeds from hard-to-borrow names pay less attractive, often negative, 'Special Rate'
  - Stock loan is a notoriously opaque business, but improving. Attractive short candidates likely to be correlated to hard-to-borrow list, so it's important to include Special Rates in back tests.

# Know Your Costs: Slippage

- Slippage or implementation shortfall is the average difference between decision time prices and execution prices, driven by several components.
- Back-of-envelope impact on annual returns for levered weekly to monthly frequency quant portfolio:
  - Average slippage: 6bps of dollar value traded. *This is 1.5 pennies per share when the average stock price is $25*
  - Average weekly turnover: 25% of absolute dollar market exposure.
  - Leverage: 6x
  - Approximate impact on annual returns: .25 * 6 * 52 * .0006 = 4.68%
- Slippage typically modeled as a function of trade size vs median daily volume, turnover, volatility, market cap, etc. For example *Direct Estimation of Equity Market Impact, Almgren et al 2005*.
- Large volume traders can model and calibrate slippage estimate with their own execution data, compare to unconditional industry estimates.

# Know Your Costs: Fees

- Institutional basket execution management desks can charge on the magnitude of a penny a share per execution. Per prior slide, this is material in terms of annual returns.
- DMA brokerage can be an order of magnitude cheaper. Furthermore DMA brokerage often passes through exchange fees, where exchanges typically pay traders to provide liquidity, charging a slightly larger amount to take liquidity (‘Maker-Taker’ business model).
- But there’s a tradeoff for the lower marginal transaction cost: the fixed cost overhead of market access infrastructure and execution expertise.

# Optimal Basket Execution

- Basic objective: minimize slippage while constraining the variance of the trading outcomes.
- Intuition: Pay a liquidity premium for immediate execution, vs spread out the trade (if alpha decay is slow) to try avoiding market impact
- Many commonalities with portfolio optimization theory (minimizing slippage ⇔ maximizing revenue), but literature places greater emphasis on dynamically reacting to stochastic order fill events.
- See for instance *Optimal Execution of Portfolio Strategies. Almgren and Chriss, 2000.*
- Practical market microstructure considerations abound.

# Fragmented Markets

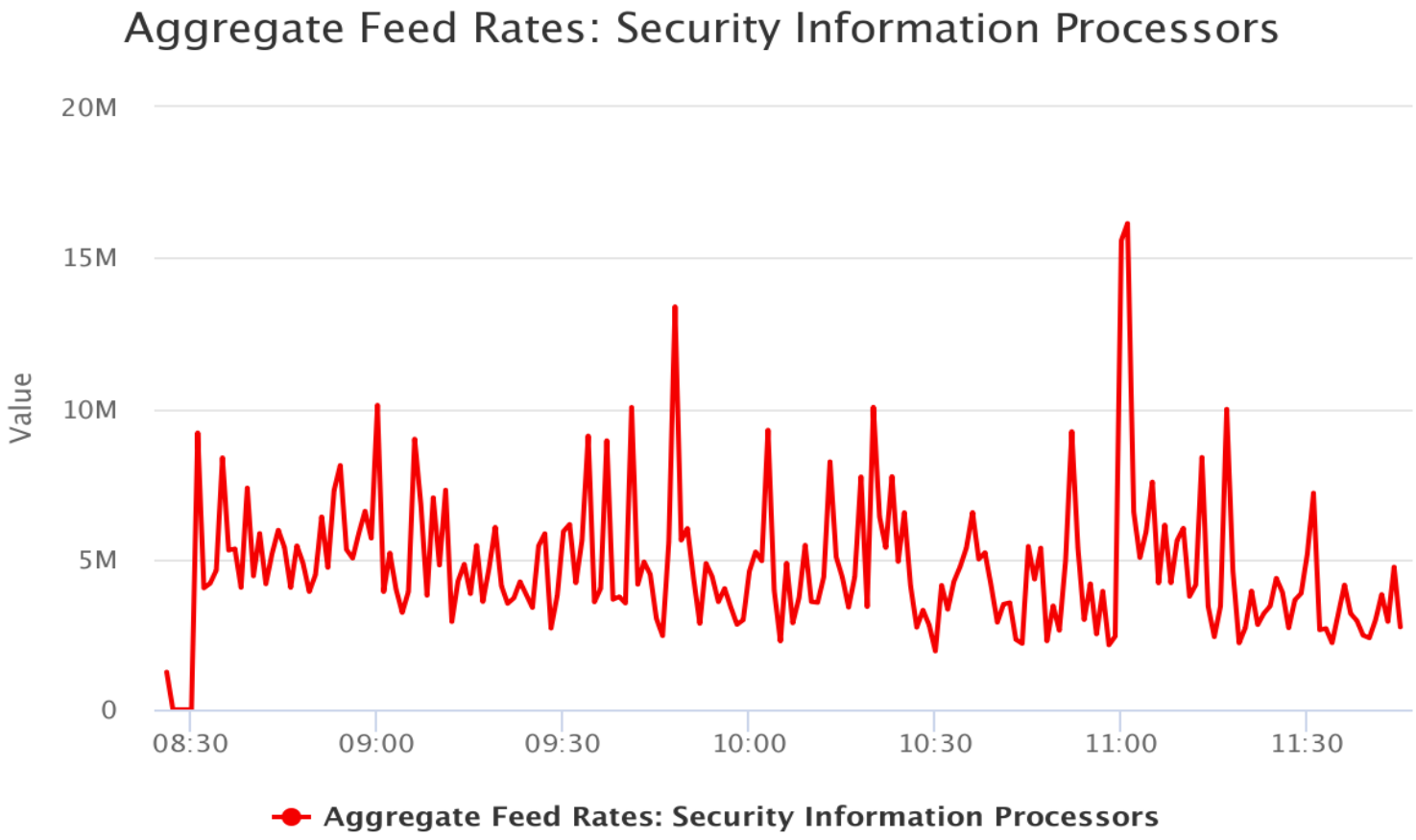
- 13 US ‘Lit’ Equity exchanges, competing on fee structure, order types (post RegNMS proliferation), technology, liquidity, and data.
- Off-market trading activity accounts for roughly 1/3 of total trading volume. Most of this trading occurs amongst the roughly three dozen Alternative Trading System (ATS) market centers commonly referred to as ‘Dark Pools’.
- Each market center typically offers several technology paths for market access, and several data feed products.
- Market centers are not all physically located in the same data center, and have different latency profiles.


MAHWAH
NY4 (SECAUCUS)
NJ2 (WEEHAWKEN)
CARTARET
West Milford
Hardyston Township
Spring Valley
Nanuet
Armonk
Tarrytown
Ramsey
White Plains
Greenwic
Sparta
Jefferson
Oakland
Port Chester
Ridgewood
Harrison
Paramus
Yonkers
Paterson
New Rochelle
Dover
Denville
Hackensack
Parsippany-Troy Hills
Clifton
Randolph
BRONX
Montclair
Morristown
Livingston
Mineola
Newark
QUEENS
Garden City
Summit
New York
Union
Hempste
BROOKLYN
Elizabeth
Valley Stream
Warren
Plainfield
Linden
Bridgewater
Somerville
STATEN ISLAND
Long Beach
Woodbridge

# Consolidated Feeds vs Direct Feeds

- In the Year 2000: The standard feeds were the consolidated tape (SIAC/UTP), which combine each exchange's BestBid/BestOffer + Trades, and Nasdaq Level 2 (top level liquidity for each Nasdaq participant).
- Now: Direct feeds from the exchanges are broadly available and widely used, including full updates on every limit order in the exchange's book.
- Consolidated feeds lag by ~1ms, roughly the time it takes for a high frequency trader to execute a round trip transaction.
- However, depth feeds carry high licensing costs, and contain large data volumes. Conflation is not an option for depth-by-order feeds – they require fast market data processing technology.

# Large, Bursty Data Volumes




*Source: marketdatapeaks.com*

# Summary

- From the simple idea “maximize risk adjusted returns, avoid exposure to common risk factors” we nest into a diverse array of implementation challenges.
- The field offers endless research opportunities for individuals who constantly strive to tweak and refine methodologies, in search of an optimal outcome.