Investing in Systematic Strategies

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OVERVIEW

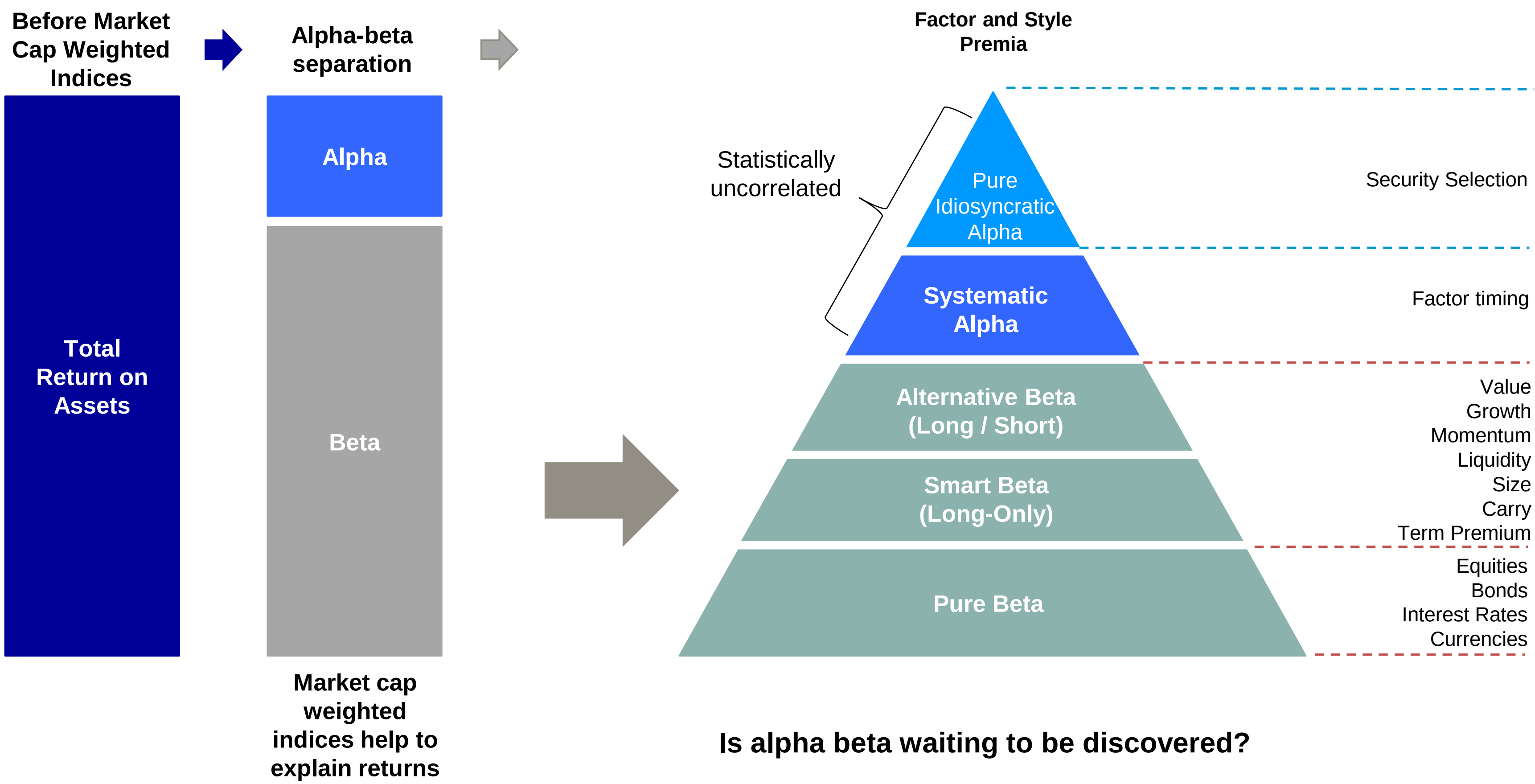
- What are hedge funds?
  - Classification of quantitative strategies
- Hedge fund manager selection
  - Can skill be identified ex-ante?
- Qualitative Manager Due Diligence
- Quantitative Manager Due Diligence
  - Learning from historical data
- Manager monitoring
  - Hedge fund risk reporting
- Summary

What are hedge funds?

SOURCES OF HEDGE FUND RETURNS

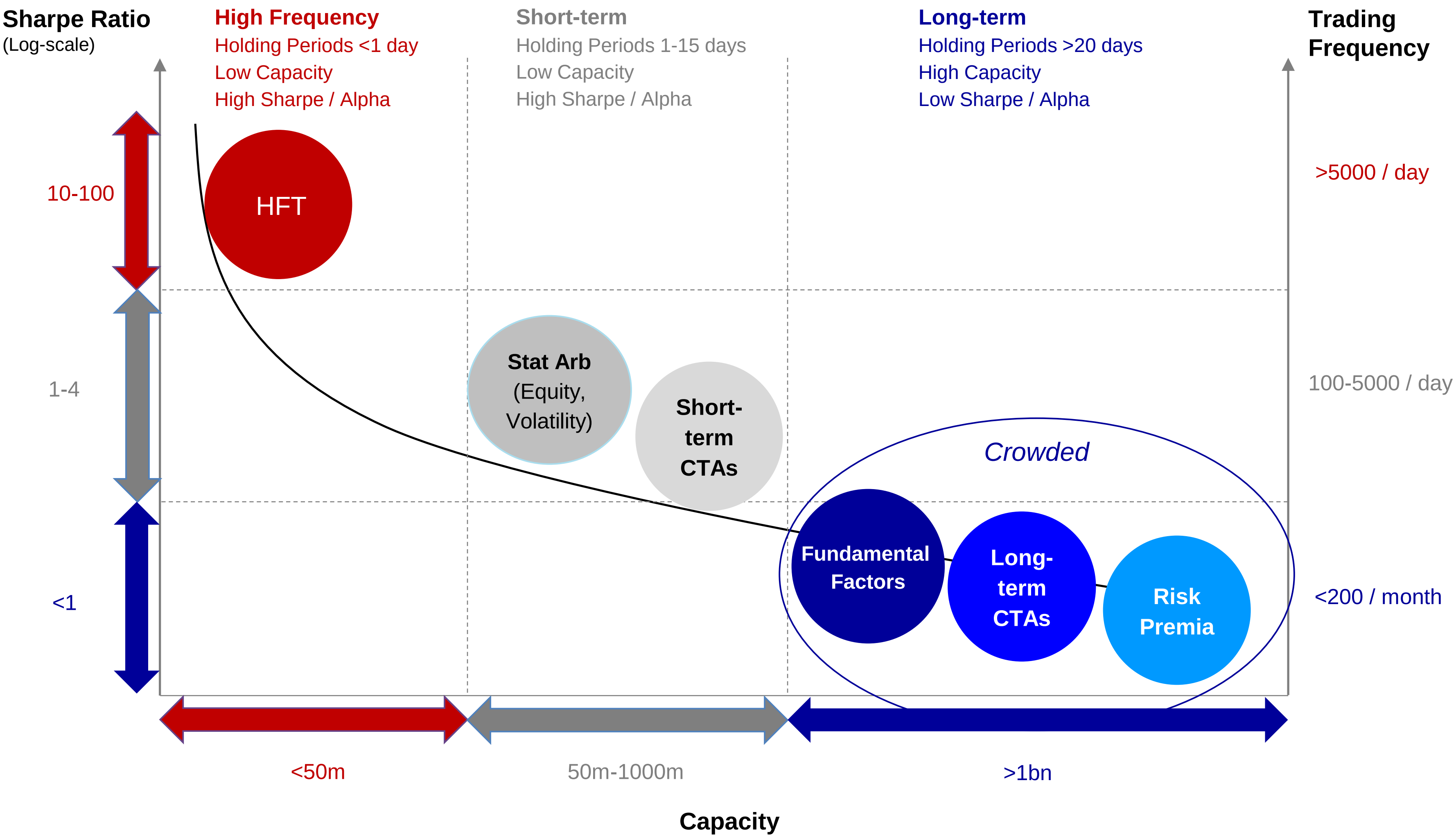
- Hedge fund returns are a mixture of **systematic risk premiums** and **alpha** that are enhanced by **leverage**
- Systematic risk premiums
  - Equity, Credit, High Yield, Emerging Markets, Bond Risk Premiums
  - Mortgages (complexity), Conversion Premium, Volatility
- Alpha
  - **Inefficiencies**: Regulatory, supply/demand imbalances, limits to arbitrage
  - **Forecasting skill** (rare)
- **Liquidity risk premiums** constitute a significant source of hedge fund returns

ALTERNATIVE BETA: FROM ASSET CLASS TO STYLE PREMIA



Is alpha beta waiting to be discovered?

CLASSIFICATION of Quantitative Strategies



Hedge fund manager selection

THE ART AND SCIENCE OF MANAGER PICKING

- Past performance is a poor indicator of future returns
  - Can skill be identified ex-ante?
- In a multifactor model, skill, luck and alpha **are not the same**
  - Alpha relative to what? – Benchmark
  - Alpha estimates are strongly dependent on the multi-factor model used
  - Factor models specific to each manager
- Manager **skill goes beyond statistics**
  - Manager personality traits

SUCCESSFUL MANAGER PERSONALITY TRAITS

- Humility
  - Admit being wrong
- Confidence
  - Ability to take risk and recover from drawdowns
- Growth Mindset
  - Incremental improvement and learning from mistakes
- Long-term goal orientation
  - Tradeoff short-term costs for long-term benefits
- Perseverance
  - Tenacity to overcome challenges

Qualitative Manager Due Diligence

OVERVIEW

- Objectives
- Data
- Research Process
- Alpha Model – Signal generation
- Portfolio Construction
- Execution – Transaction Cost Model
- Risk Management
- Performance Analysis

REALISTIC INVESTMENT OBJECTIVES

- Managers over-promise and (most of the time) under-deliver:
  - AuM: 600M USD
  - Expected Net Return: 35%
  - Expected **Net** Sharpe: 4-6
  - Leverage (Overnight): 6x
  - Fees: 3% management & 30% performance
  - Strategies: Diversified group of **medium frequency** strategies
- How many managers do you know that can run **3.5 billion GMV** with a **Sharpe of 5** and a return on **GMV of 10%** ?

Source: Hedge fund manager factsheet, 2017 (name is kept confidential)

DATA

- Data sourcing
  - Types of data used
- Data storage and updating
- Data processing
  - Data cleaning
  - Data transofrmations and information loss
- Role of **alternative data** in the investment process

RESEARCH PROCESS

- Beliefs that underpin the research process
  - What constitutes a good model?
- Backtesting methodology
- Strategy evolution

ALPHA MODEL – SIGNAL GENERATION

- Alpha model description
  - Robustness
  - Combining models
  - Model updating
- Model forecasts
  - What does the model forecast?
  - Inputs to model
  - Model output

ALPHA MODEL – SIGNAL GENERATION (continue)

- Classification of underlying forecasts
  - Price driven
    - Momentum
    - Mean reversion
    - Sentiment
  - Fundamentally driven
    - Yield (carry)
    - Value / Growth
    - Quality
  - Machine Learning – Data mining
    - **Bias vs. Variance – Accuracy vs. Conviction of forecasts**
- Signal properties

PORTFOLIO CONSTRUCTION

- Portfolio Optimization
  - Objective function
  - Covariance matrix
- Position sizing
  - Risk constratints
  - Transaction costs
  - Capacity estimation
- Scaling in or out of positions

TRANSACTION COST MODEL & EXECUTION

- Slippage and Market impact
  - Impact estimation at the security level
  - Impact of market microstricture
  - How the transaction cost model interact with the alpha model and portfolio construction
- Execution process
  - **Who** trades? Automated or managed by humans?
  - **When** do you trade and why? Does execution speed matter for the strategy?
  - Order types – **How** do you trade?
  - Execution venues – **Where** do you trade?
- Trading volume
- Transaction costs & commissions
- Estimation of **own impact** on asset prices

RISK MANAGEMENT

- Risk management philosophy
- Investment risks
  - Strategy risk
  - Liquidity risk
  - Leverage
- **Business risks** – are quants good business managers?
  - Counterparty risk
  - Client redemption risk
- Risk constraints and monitoring

PERFORMANCE ANALYSIS

- Factors affecting performance
- Understanding periods of flat performance
- Understanding drawdowns
  - ‘Drawdown is within statistical expectations’…
  - Has something changed prior to the drawdown? Increase in GMV? Execution?
  - Is drawdown concentrated in countries/sectors/subsectors?
  - Are long positions performing very different than short positions?
  - Do daily returns exhibit any serial correlation?
- Strategy metrics
  - Hit rate
  - Win/loss ratio

“KISS OF DEATH” ISSUES

- Lack of robustness
- Basis risk
- Complexity
- Unwanted exposures
- Business risks
  - Diseconomies of scale

Quantitative Manager Due Diligence

Can you learn from limited historical data?

HOW IS ALPHA MEASURED

- Under the assumptions:
  - Portfolio returns are stationary and ergodic
  - The return of each asset i, $R_i(t)$ satisfies a linear K -factor model:

$$R_i(t) = \alpha_i(t) + \beta_{i1}(t)F_1(t) + \cdots + \beta_{iK}(t)F_K(t) + \varepsilon_i(t)\ ,\ \ E[(\varepsilon_i(t)|F_K(t))] = 0$$

  - The factors $F_k(t)$ are stationary and ergodic

Beta to k-th factor return

k-th factor return

$$E\big[R_p(t)\big] = \underbrace{\alpha_P(t)}_{\substack{\textbf{Pure Idiosyncratic Alpha} \\ \textbf{(Security selection)}}} + \underbrace{\sum_{k=1}^{K} Cov\big[\beta_{pk}(t), F_k(t)\big]}_{\substack{\textbf{Systematic Alpha} \\ \textbf{(Factor timing)}}} + \underbrace{\sum_{k=1}^{K} E\big[\beta_{pk}(t)\big]E\big[F_k(t)\big]}_{\substack{\textbf{Structural Positions} \\ \textbf{(Risk Premia)}}}$$

Source: Lo, “Where do Alphas Come From?: A New Measure of the Value of Active Investment Management”, Journal of Investment Management, 2008

UNDERSTANDING ALPHA ESTIMATES

- Two types of factors:
  - Factors that are explained by investors **aversion to risk**
  - Factors explained as **institutional constraints** or persistent **behavioral anomalies.**
- Alpha and skill deciphered based on the **t-statistic** on the constant term of the factor model regression
  - Expected factor returns are very hard to estimate
  - Errors in the Sharpe ratio of the factor portfolio will cause **opposite sign errors** in the t-statistic proportional to $\sqrt{\frac{R^2}{1-R^2}}$
  - Sharpe ratios are sensitive to small changes in factor specification.
  - Imposes greater estimation errors on the estimated alpha of funds with high R^2

UNDERSTANDING SHARPE RATIOS

- The Sharpe ratio (under normality) is related to the **t-statistic** of the hypothesis H_0: $\hat{\mu} \leq r_0$:

$$t_{stat} = \frac{\hat{\mu} - r_0}{\hat{\sigma}/\sqrt{n}} = \sqrt{n}\,\widehat{SR}$$

- Sharpe ratio maximization is **not consistent with stochastic dominance**
  - In the case $\mu < 0$ Sharpe ratio maximization “prefers” higher σ^2
- A large Sharpe ratio approximately bounds the probability of a large drawdown, as measured in units of volatility
- Sharpe ratio has better sample variance and more power than alternative objective measures

UNDERSTANDING SHARPE RATIOS (continue)

- The Sharpe ratio is a **biased estimator.** The bias is a function only of sample size and approaches 1 quickly so the estimator is asymptotically unbiased.
- Under the assumption that returns are **stationary** and **ergodic**, the Sharpe ratio is normally distributed!

$$\widehat{SR} \sim \mathcal{N}\left[SR, \frac{1}{n}\left(1 - \mu_3\, SR + \frac{2+\mu_4}{4} SR^2\right)\right]$$

where n is the number of observations, μ_3 is the skew, and μ_4 is the excess kurtosis of the return distribution

- Modest **heteroskedasticity** causes a mild bias in the Sharpe ratio and has little effect on the standard error
- A small **autocorrelation** ϱ in returns, inflates the standard error of the Sharpe ratio by about $200\varrho\%$

Source: Lo, "The Statistics of Sharpe Ratios", Financial Analysts Journal, 2002, Opdyke, "Comparing Sharpe ratios: So where are the p-values?", 2007,

HYPOTHESIS TESTING REQUIRES A LOT OF DATA

- **How long** should a **track record** be in order to have statistical confidence that its Sharpe ratio is above a given threshold?
- Example: Assume an observed Sharpe ratio of 2. What is the minimum track record length (in years) to say with 95% confidence that the true Sharpe is greater than 1 or 1.5?

	Sharpe > 1	Sharpe > 1.5
○ Daily i.i.d returns	2.73	10.91
○ Weekly i.i.d returns	2.83	11.26
○ Monthly i.i.d returns	3.24	12.71
○ Monthly non-i.i.d (skew=-0.72, kurtosis=5.78)	4.99	19.72

Source: Bailey and Lopez de Prado, “The Sharpe Ratio Efficient Frontier”, The Journal of Risk, 2013

EVALUATING BACKTESTS

- Statistical tests applied **multiple times on the same data**
- Hedge funds interviewing hundereds of portfolio managers before hiring
- Asset allocators interview thousands of hedge funds before selecting candidates on the basis of statistical criteria
- Probability of false positives **increases** with the number of trials

EVALUATING BACKTESTS (continue)

- Assume a manager has performed K (independent) trials. Given a sample of i.i.d Gaussian Sharpe ratios:

$$\left\{\widehat{SR}_k\right\} \sim \mathcal{N}\left[0, V\left[\left\{\widehat{SR}_k\right\}\right]\right], k = 1, \ldots, K$$

$$E\left[\frac{\max_k\left\{\widehat{SR}_k\right\}}{\sqrt{V\left[\left\{\widehat{SR}_k\right\}\right]}}\right] \sim (1-\gamma)Z^{-1}\left[1-\frac{1}{K}\right] + \gamma Z^{-1}\left[1-\frac{1}{Ke}\right]$$

- Unless $\max_k\left\{\widehat{SR}_k\right\} \gg E\left[\max_k\left\{\widehat{SR}_k\right\}\right]$,the discovered strategy is likely to be a false positive

Source: Lopez de Prado and Lewis, “Confidence and power of the Sharpe ratio under multiple testing”, Working Paper, January 2019

TYPE I and TYPE II ERRORS

- Consider the test of the hypothesis H_0: $SR = 0$ against the alternative H_1: $SR > 0$
- Define the probability of **falsely rejecting the null hypothesis** (Type I error) as α
- After a "family" of K independent tests, the **Familywise Error Rate (FWER)** is:

$$FWER\colon \alpha_K = 1 - (1 - \alpha)^K$$

- **Bonferroni approximation:** $\alpha_K \approx \alpha\, K$

Source: Lopez de Prado and Lewis, "Confidence and power of the Sharpe ratio under multiple testing", Working Paper, January 2019

TYPE I and TYPE II ERRORS (continue)

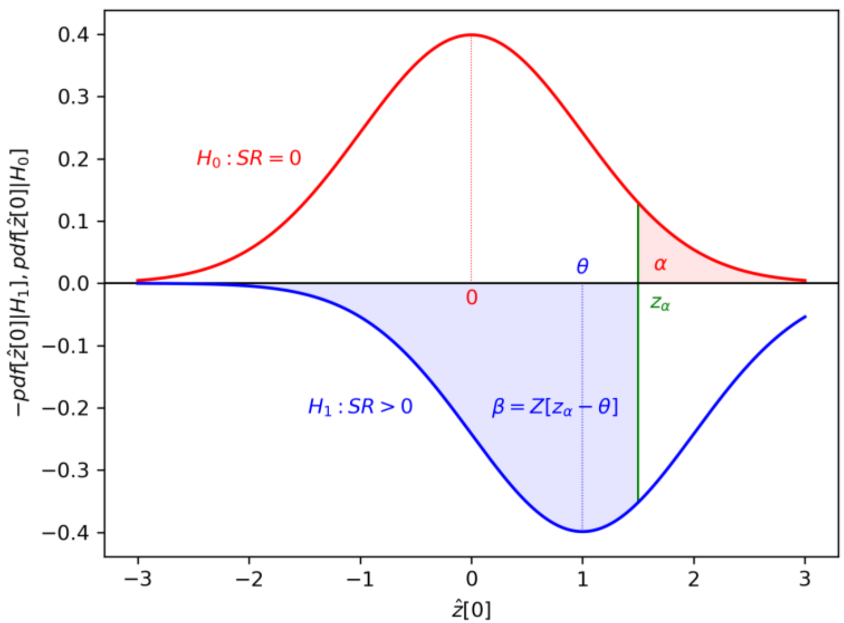
- Consider the test alternative hypothesis H_1: $SR > 0$ for the best strategy is true and $SR = SR^*$
- The Type II error probability β of a single event, or **power** of the test associated with a FWER α_K is the probability that the test **fails to reject a false null** hypothesis H_0 when the alternative hypothesis H_1 is true
- The **familywise false negative (miss) probability** is the probability that all individual positives are missed: $\beta_K = \beta^K$

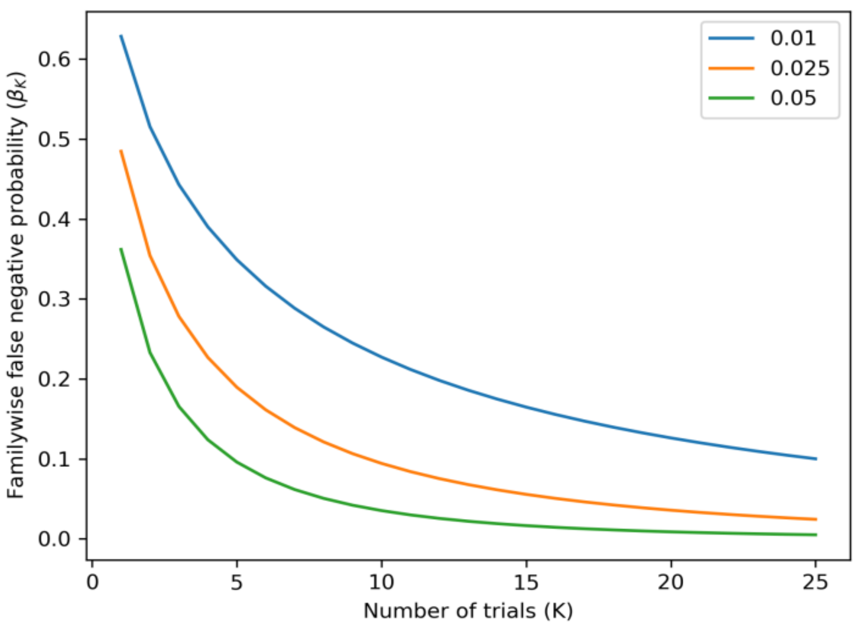
TYPE I and TYPE II ERRORS (continue)

- Type I and type II error probabilities are related:

$$\beta_K = \left(Z\left[Z^{-1}\left[(1-\alpha_K)^{1/K}\right]-\theta\right]\right)^K$$

$\alpha_K \in \{0.01, 0.025, 0.05\}$





Source: Lopez de Prado and Lewis, "Confidence and power of the Sharpe ratio under multiple testing", Working Paper, January 2019

CORRECTING FOR TYPE I and TYPE II ERRORS – AN EXAMPLE

- Daily data, 3-years: n=750
- Observed Sharpe: $SR = 1.5$
- Effective number of independent tests: K=10
- True Sharpe $SR^* = 1.0$

- Normally distributed data:

$$\alpha = 0.005 \qquad \alpha_K = 0.047$$

$$\beta = 0.806 \qquad \beta_K = 0.116$$

- Fat tailed data ($skew = -3,\ excess\ kurtosis = 7$):

$$\alpha = 0.012 \qquad \alpha_K = 0.109$$

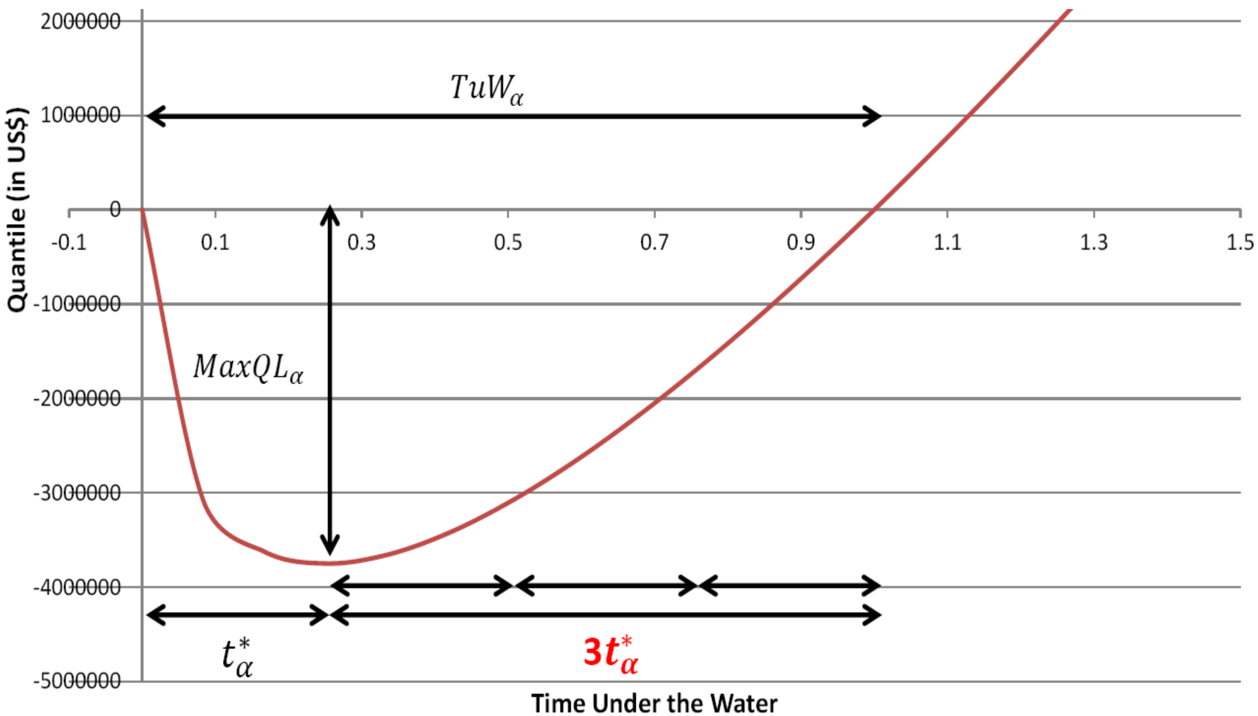
$$\beta = 0.776 \qquad \beta_K = 0.079$$

UNDERSTANDING DRAWDOWNS

- Then the maximum drawdown M_n is a function of the standard deviation σ and the Sharpe ratio
  - An asset with higher volatility will have larger drawdowns
  - A higher Sharpe ratio leads to a lower probability of a drawdown of a fixed size
- Performing a hypothesis test solely on the sample maximum drawdown, one would reject the null if either the Sharpe ratio was high, or the volatility was low
- It is unclear that the variance of the sample maximum drawdown statistic decreases with sample size
- Drawdowns matter because they are the **main driver of client redemptions**
  - Not only drawdowns but **time to recovery** from a drawdown are important

TRIPLE PENANCE RULE

- Assuming returns are normally distributed, it takes **three times longer** to recover from the maximum quantile-loss ($TuW\alpha$) than the time it took to produce it regardless of the strategy's Sharpe ratio!



Source: Bailey and Lopez de Prado, "Stop-outs under serial correlation and the triple penance rule", The Journal of Risk, November 2015

Manager monitoring

HEDGE FUND RISK REPORTING

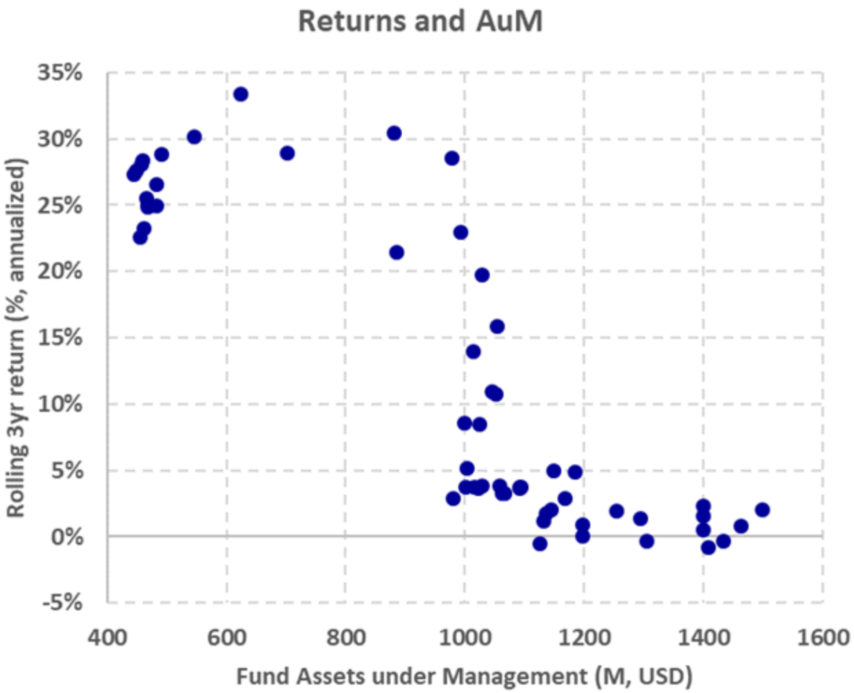
- Performance metrics
  - Daily and monthly returns (gross and net of fees)
  - Drawdown as a measure of risk
- Exposure metrics
  - Gross and net exposure. How do they vary over time?
  - Return on invested capital for both long and short portfolios
  - Factor attribution: Long and short alpha from security selection and market timing
- Position metrics
  - Portfolio concentration
  - Portfolio liquidity
  - Batting Average and Win/Loss Ratio
  - Changes in assets under management

BUSINESS RISKS

- Contractual obligations with counterparties and investors
- "Funding" option: reduce leverage during crises
  - Mismatch between fund assets and liabilities (investment horizon vs. funding terms)
  - Depends on fund's performance and volatility
- "Redemption" option: provide liquidity to investors when assets are needed the most
  - Mismatch between investment horizon and investor liquidity

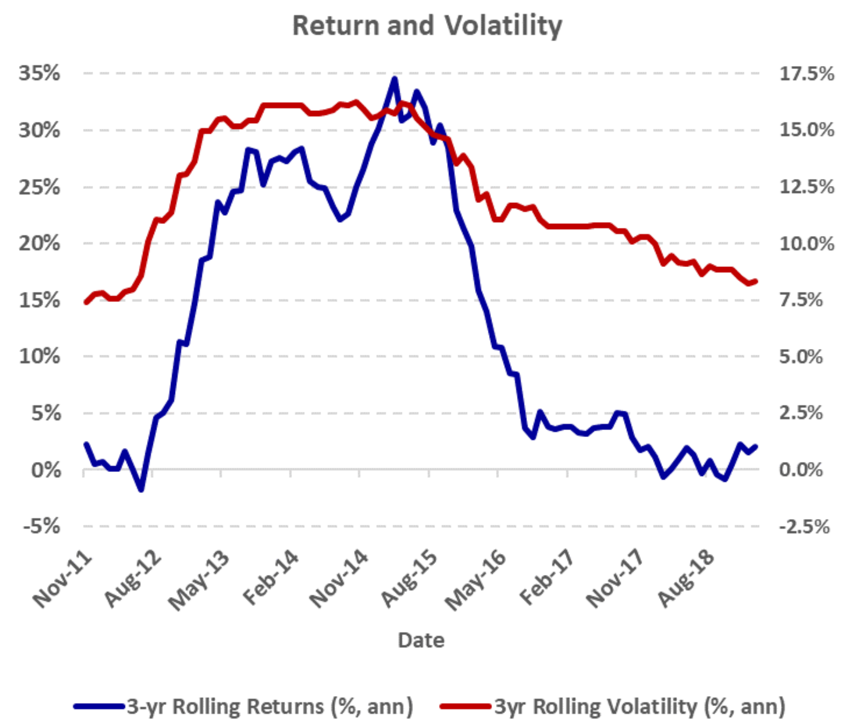
DIS-ECONOMIES OF SCALE

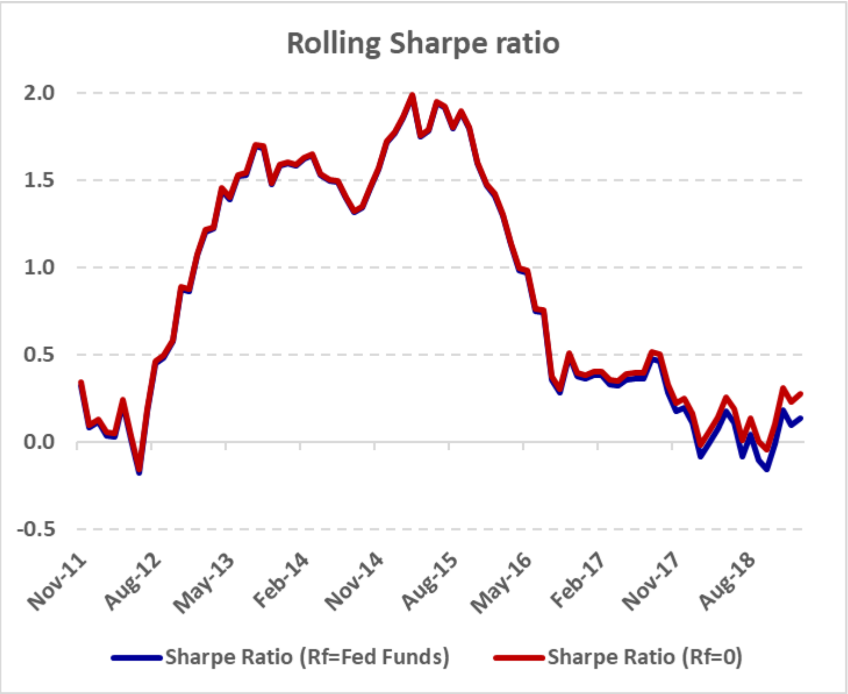
- Alpha is finite and not scalable
- Alpha is a zero sum game
- Dollar P&L matters more than returns
- Increases in assets under management lead to:
  - Longer holding periods
  - Concentration in crowded names
  - Higher exposure to systematic risks



Source: Well known multi-billion systematic hedge fund

DIS-ECONOMIES OF SCALE (continue)





Source: Well known multi-billion systematic hedge fund

Summary

HOW TO IMPROVE QUANTITATIVE HEDGE FUND INVESTING

- Form your **own views** - Adopt a **skeptic** attitude questioning the conventional wisdom
- Conduct your own due diligence
- Understand that **chance** significantly impacts manager selection process
- Understand the **limitations of statistics**
- Beware of **capacity constraints**
- Focus on process and understand rewards (**skin in the game**)

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