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

Before Market Cap Weighted Indices

Alpha-beta separation

Total Return on Assets

Market cap weighted indices help to explain returns

Pure Beta

Systematic Alpha

Alternative Beta (Long / Short)

Smart Beta (Long-Only)

Pure Idiosyncratic Alpha

Factor and Style Premia

Statistically uncorrelated

Security Selection

Factor timing

Value Growth
Momentum Liquidity
Size Carry
Term Premium
Equities Bonds
Interest Rates Currencies

Is alpha beta waiting to be discovered?
CLASSIFICATION of Quantitative Strategies

Sharpe Ratio (Log-scale)

High Frequency
Holding Periods <1 day
Low Capacity
High Sharpe / Alpha

Short-term
Holding Periods 1-15 days
Low Capacity
High Sharpe / Alpha

Long-term
Holding Periods >20 days
High Capacity
Low Sharpe / Alpha

HFT

Stat Arb (Equity, Volatility)

Short-term CTAs

Fundamental Factors

Long-term CTAs

Risk Premia

Trading Frequency

>5000 / day

100-5000 / day

<200 / month

Capacity

<50m

50m-1000m

>1bn

Crowded
Hedge fund manager selection
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
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 transformations 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
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 constraints
  - Transaction costs
  - Capacity estimation
- Scaling in or out of positions
Slippage and Market impact
- Impact estimation at the security level
- Impact of market microstructure
- 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.

\[
E[R_p(t)] = \alpha_P(t) + \sum_{k=1}^{K} Cov[\beta_{pk}(t), F_k(t)] + \sum_{k=1}^{K} E[\beta_{pk}(t)]E[F_k(t)]
\]

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 $R^2$
The Sharpe ratio (under normality) is related to the t-statistic of the hypothesis $H_0: \hat{\mu} \leq r_0$:

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

Sharpe ratio maximization is not consistent with stochastic dominance.

- In the case $\mu < 0$, Sharpe ratio maximization “prefers” higher $\sigma^2$.

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.
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!

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

where \( n \) is the number of observations, \( \mu_3 \) is the skew, and \( \mu_4 \) 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** \( \rho \) in returns, inflates the standard error of the Sharpe ratio by about \( 200\rho \% \)

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?

<table>
<thead>
<tr>
<th></th>
<th>Sharpe &gt; 1</th>
<th>Sharpe &gt; 1.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily i.i.d returns</td>
<td>2.73</td>
<td>10.91</td>
</tr>
<tr>
<td>Weekly i.i.d returns</td>
<td>2.83</td>
<td>11.26</td>
</tr>
<tr>
<td>Monthly i.i.d returns</td>
<td>3.24</td>
<td>12.71</td>
</tr>
<tr>
<td>Monthly non-i.i.d</td>
<td>4.99</td>
<td>19.72</td>
</tr>
</tbody>
</table>

(skew=-0.72, kurtosis=5.78)

EVALUATING BACKTESTS

- Statistical tests applied **multiple times on the same data**
- Hedge funds interviewing hundreds 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
Assume a manager has performed $K$ (independent) trials. Given a sample of i.i.d Gaussian Sharpe ratios:

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

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

Unless $\max_k \{\hat{SR}_k\} \gg E \left[ \max_k \{\hat{SR}_k\} \right]$, 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
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 \( \alpha \)

After a “family” of \( K \) independent tests, the **Familywise Error Rate (FWER)** is:

\[
FWER: \alpha_K = 1 - (1 - \alpha)^K
\]

**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
Consider the test alternative hypothesis \( H_1: SR > 0 \) for the best strategy is true and \( SR = SR^* \)

The Type II error probability \( \beta \) of a single event, or power of the test associated with a FWER \( \alpha_K \) 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 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:
  \[
  \alpha = 0.005 \quad \alpha_K = 0.047 \\
  \beta = 0.806 \quad \beta_K = 0.116
  \]

- Fat tailed data (\( skew = -3 \), excess kurtosis = 7):
  \[
  \alpha = 0.012 \quad \alpha_K = 0.109 \\
  \beta = 0.776 \quad \beta_K = 0.079
  \]
Then the maximum drawdown $M_n$ is a function of the standard deviation $\sigma$ 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.
Assuming returns are normally distributed, it takes **three times longer** to recover from the maximum quantile-loss ($T_u W_\alpha$) than the time it took to produce it regardless of the strategy’s Sharpe ratio!

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
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)

**Return and Volatility**

- **3-yr Rolling Returns (% ann)**
- **3yr Rolling Volatility (% ann)**

**Rolling Sharpe ratio**

- **Sharpe Ratio (Rf=Fed Funds)**
- **Sharpe Ratio (Rf=0)**

*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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