Quantitative Hedge Fund Strategies: An Investor Perspective

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Morgan Stanley

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I. Introduction to Quantitative Equity Strategies
II. Overlaps of Hedge Fund Holdings
III. Performance of Quant Equity During the Crisis
I. Introduction to Quantitative Equity Strategies
Quant Funds often Called “Black Box” Strategies

- Reflects discomfort of some investors with quant strategies
- Investors often more comfortable with fundamental managers
  - Stocks have ‘stories’; portfolios have ‘themes’
- From a statistical standpoint, quant strategies more thoroughly vetted
  - Many positions & high turnover vs. few positions & low turnover
  - Assumes markets stationary
Investors Must Decide Based on Limited Information

- Rarely have access to model signals
  - Investors often lack infrastructure to test signals
  - Research capability, rather than current model is often focus
- Discussion with manager (can be vague)
- Manager pedigree
- Staffing (e.g., # of PhDs)
- Technology – consistent with stated strategy?
- Service providers – well-known?
  - Track record
  - Holdings Snapshots

Quant tools helpful
Quant Funds Trade a Wide Array of Assets

- We focus on quant equity strategies
  - Specifically EMN and quant technical funds
- Excludes many quant funds
- CTAs, Systematic Macro also large aggregate assets under management

<table>
<thead>
<tr>
<th>Strategy Groups</th>
<th>Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quant Equity</td>
<td>Equity Market Neutral</td>
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<td>Technical Equities</td>
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<td>Event-Driven</td>
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<td>Holdings-based HF Replication</td>
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<td>Quant Futures and Forwards</td>
<td>Commodity Trading Advisors</td>
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<td>Short-Term Traders</td>
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<td>Systematic Macro</td>
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<td>Factor-based HF replication</td>
</tr>
<tr>
<td>Quant Options</td>
<td>Volatility Arbitrage</td>
</tr>
<tr>
<td>Quant Credit</td>
<td>Correlation, basis trading, long/short</td>
</tr>
<tr>
<td>Quant Hybrid Asset Strategies</td>
<td>Strategy-based HF replication</td>
</tr>
</tbody>
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Equity Market Neutral Funds Systematize Fundamental Data

- Portfolios of 100s of stocks long and short
  - Positions not concentrated
- Neutral to equity market
  - Some funds take sector and/or factor risks
  - Leverage of 1.5 – 4x
- Factor models provide signals
- Inputs: fundamental corporate data and long-term trends
  e.g., \( R_{i,t+1} = \beta \text{EPF}_{i,t} + \gamma \text{PMOM12}_{i,t} + \delta \text{D}_\text{shrs}_{i,t} \)
- Slow turnover (months/quarters)
- Some funds ~$10bn; overall hundreds of billions
- Benchmarks: HFRI EMN Index

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Quant Technical Funds Use Exclusively Price Data

- Three categories: statistical arbitrage, directional equities and high frequency
- Portfolios of 100s of stocks
- Stat arb funds generally market neutral
- Short holding periods (< 1 week)
- Signals from historical prices (volume sometimes used)
  - Stock deviates from basket of similar stocks: contrary bet
  - Price exceeds N-day high: go long
- Benchmarks lacking: investors must build peer groups
II. Overlaps of Hedge Fund Holdings
Holdings Snapshots Provide Information on Funds

- SEC requires quarterly 13-F disclosures
- Several limitations
  - Frequency, lag, only longs, commingled filings, US centric
- Universe split into 5 market-cap bins, 6 super-sectors

Table 1: Equity Universe Decomposition
As of March 31, 2010

<table>
<thead>
<tr>
<th>Split by Market Capitalization</th>
<th>Split by GICS Sector</th>
<th>Split by Super Sectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cap Group</td>
<td>Stocks</td>
<td>Min. Cap ($mm)</td>
</tr>
<tr>
<td>Mega-Cap</td>
<td>50</td>
<td>42,000</td>
</tr>
<tr>
<td>Large-Cap</td>
<td>200</td>
<td>10,800</td>
</tr>
<tr>
<td>Mid-Cap</td>
<td>750</td>
<td>1,800</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small-Cap</td>
<td>1500</td>
<td>254</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on the March 31, 2010 market values of 4000 US equities, whose aggregate market capitalization is $14.1 trillion
Excludes: Preferred stock, exchange traded funds (ETFs), American Depository Receipts (ADRs) and convertible bonds
Sources: FactSet
Hedge-Fund Holdings Sample is a Mix of Styles

- 657 funds, $632bn market value (4.5% of equity universe)
- Portfolio concentration: effective equal weight number of stocks (1/Herfindahl Index)
- Many funds concentrated, <20 effective stocks
Large-Cap Stocks More Popular Among Funds

- Sort stocks descending by market cap
- Rolling 25-stock average of number of funds holding each stock
- Possibly important for overlap models to take into account

Chart 2: Number of Holders of Stocks by Market Cap Rank (25-Stock moving average)
Strategy Classification Important in Overlap Analysis

Holdings Sample
657 funds

Sector Specialists
6 super-sectors

Multi-Sector Funds
8 Strategies

Opportunistic sector funds

Consumer
Financials
Healthcare
Energy & Materials
Industrials & Utilities
Technology & Telecom

Event Driven
Multi-Strategy
Quant Fundamental
Quant Technical
Equity Long/Short
Macro
Convert Arb
Volatility Arb
Overlap Measures Commonality of Holdings

- Computed on pairs of portfolios
- Sum over universe of minimum weight in each asset for the two portfolios

\[
\text{Overlap}^{(1,2)} = \sum_{i=1}^{N} \min(w_i^{(1)}, w_i^{(2)})
\]

- Independent of assets under management or leverage
- Between zero and one

For a given universe:
- Overlap rises with number of equal-weight holdings
- Overlap falls with increasing portfolio concentration
Overlaps Differ by Hedge Fund Strategy

- Most HF holdings overlaps are modest
  - Median <2% for L/S Equity and Event Driven

- Quantitative strategies have much higher overlaps
  - Medians 8% and 12% for EMN and Quant Technical, resp.

Table 3: Overlaps of Hedge Fund Equity Holdings Portfolios by Strategy
As of March 31, 2010

<table>
<thead>
<tr>
<th>Strategy Name</th>
<th>Number of Funds</th>
<th>Universe (Number of Stocks)</th>
<th>Median Market Value ($mm)</th>
<th>Median Stocks in Portfolio</th>
<th>Median Effective Stocks in Portfolio</th>
<th>Number of Fund Overlaps</th>
<th>Bottom Quartile Overlap</th>
<th>Median Overlap</th>
<th>Top Quartile Overlap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer Sector</td>
<td>8</td>
<td>743</td>
<td>527</td>
<td>17</td>
<td>7</td>
<td>28</td>
<td>0%</td>
<td>0%</td>
<td>4.0%</td>
</tr>
<tr>
<td>Energy &amp; Materials Sector</td>
<td>23</td>
<td>518</td>
<td>222</td>
<td>20</td>
<td>13</td>
<td>253</td>
<td>0%</td>
<td>1.3%</td>
<td>11.1%</td>
</tr>
<tr>
<td>Financials Sector</td>
<td>29</td>
<td>844</td>
<td>127</td>
<td>26</td>
<td>16</td>
<td>406</td>
<td>0%</td>
<td>1.3%</td>
<td>7.5%</td>
</tr>
<tr>
<td>Healthcare Sector</td>
<td>20</td>
<td>547</td>
<td>278</td>
<td>30</td>
<td>15</td>
<td>190</td>
<td>2.1%</td>
<td>6.1%</td>
<td>12.0%</td>
</tr>
<tr>
<td>Industrials Sector</td>
<td>5</td>
<td>648</td>
<td>278</td>
<td>24</td>
<td>14</td>
<td>10</td>
<td>0%</td>
<td>22.4%</td>
<td>28.7%</td>
</tr>
<tr>
<td>Tech &amp; Telecom Sector</td>
<td>20</td>
<td>700</td>
<td>319</td>
<td>37</td>
<td>18</td>
<td>190</td>
<td>2.9%</td>
<td>8.3%</td>
<td>17.8%</td>
</tr>
<tr>
<td>Long/Short Equity</td>
<td>366</td>
<td>4,000</td>
<td>257</td>
<td>39</td>
<td>23</td>
<td>66,795</td>
<td>0%</td>
<td>1.1%</td>
<td>4.2%</td>
</tr>
<tr>
<td>Event Driven</td>
<td>53</td>
<td>4,000</td>
<td>215</td>
<td>27</td>
<td>11</td>
<td>1,378</td>
<td>0%</td>
<td>1.6%</td>
<td>7.2%</td>
</tr>
<tr>
<td>Multi-strategy</td>
<td>62</td>
<td>4,000</td>
<td>402</td>
<td>94</td>
<td>26</td>
<td>1,891</td>
<td>0.9%</td>
<td>3.9%</td>
<td>8.6%</td>
</tr>
<tr>
<td>Convertible Bond Arbitrage</td>
<td>14</td>
<td>4,000</td>
<td>64</td>
<td>18</td>
<td>7</td>
<td>91</td>
<td>0%</td>
<td>0%</td>
<td>2.1%</td>
</tr>
<tr>
<td>Volatility Arbitrage</td>
<td>13</td>
<td>4,000</td>
<td>84</td>
<td>39</td>
<td>13</td>
<td>78</td>
<td>0.1%</td>
<td>0.8%</td>
<td>8.0%</td>
</tr>
<tr>
<td>Quant Fundamental</td>
<td>16</td>
<td>4,000</td>
<td>164</td>
<td>306</td>
<td>189</td>
<td>120</td>
<td>4.6%</td>
<td>8.2%</td>
<td>11.5%</td>
</tr>
<tr>
<td>Quant Technical</td>
<td>18</td>
<td>4,000</td>
<td>227</td>
<td>309</td>
<td>162</td>
<td>153</td>
<td>6.1%</td>
<td>12.1%</td>
<td>19.3%</td>
</tr>
<tr>
<td>Macro</td>
<td>10</td>
<td>4,000</td>
<td>129</td>
<td>51</td>
<td>17</td>
<td>45</td>
<td>9.6%</td>
<td>2.2%</td>
<td>4.7%</td>
</tr>
</tbody>
</table>

*For dedicated sector funds, market values, numbers of stocks and effective numbers of stocks are computed only for equities in the fund’s designated GICS sector (or sector pair)

The effective number of stocks is the reciprocal of the Herfindahl Index (sum of squared portfolio weights)

Source: FactSet
EMN Funds have Small-Cap Skew to Overlap

- Equity L/S and Multi-strategy have large-cap overlap skew
- Event Driven overlaps mainly mid-cap
- Quant Fundamental (EMN): largest fraction in small-cap overlap
  - Could exacerbate risks in liquidation

### Table 4: Average Intra-Strategy Equity Holdings Overlaps by Market-Cap Bin
As of March 31, 2010

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Funds</th>
<th>Mega-Cap</th>
<th>Large-Cap</th>
<th>Mid-Cap</th>
<th>Small-Cap</th>
<th>Micro-Cap</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equity Long/Short</td>
<td>366</td>
<td>1.4%</td>
<td>0.7%</td>
<td>0.5%</td>
<td>0.2%</td>
<td>0.0%</td>
<td>2.8%</td>
</tr>
<tr>
<td>Event Driven</td>
<td>53</td>
<td>0.9%</td>
<td>1.5%</td>
<td>2.8%</td>
<td>0.3%</td>
<td>0.0%</td>
<td>5.5%</td>
</tr>
<tr>
<td>Multi-Strategy</td>
<td>62</td>
<td>1.8%</td>
<td>2.1%</td>
<td>1.9%</td>
<td>0.3%</td>
<td>0.0%</td>
<td>6.2%</td>
</tr>
<tr>
<td>Convertible Bond Arbitrage</td>
<td>14</td>
<td>0.4%</td>
<td>0.5%</td>
<td>0.6%</td>
<td>0.4%</td>
<td>0.0%</td>
<td>1.8%</td>
</tr>
<tr>
<td>Volatility Arbitrage</td>
<td>13</td>
<td>2.2%</td>
<td>1.5%</td>
<td>0.6%</td>
<td>0.7%</td>
<td>0.3%</td>
<td>5.4%</td>
</tr>
<tr>
<td>Quant Fundamental</td>
<td>16</td>
<td>1.3%</td>
<td>1.4%</td>
<td>3.4%</td>
<td>3.1%</td>
<td>0.2%</td>
<td>9.4%</td>
</tr>
<tr>
<td>Quant Technical</td>
<td>18</td>
<td>2.2%</td>
<td>4.2%</td>
<td>5.4%</td>
<td>1.0%</td>
<td>0.0%</td>
<td>12.9%</td>
</tr>
<tr>
<td>Macro</td>
<td>10</td>
<td>1.2%</td>
<td>1.0%</td>
<td>0.4%</td>
<td>0.2%</td>
<td>0.0%</td>
<td>2.8%</td>
</tr>
</tbody>
</table>

The 50 largest stocks in our universe are mega-caps; the next 200 are large-caps; the next 750 are mid-caps; the next 1500 are small-caps; and the smallest 1500 are micro-caps

Average overlap is the average over all pairwise overlaps among funds in the sector
Average overlaps within bins are computed including funds without any allocation to those bins, if applicable

Source: Factset
Overlaps Alone Not Informative Regarding Independence of Stock-Selection

- Event Driven overlaps smaller than those of Quant Technical
- Event Driven portfolios also much more concentrated
- Which strategy’s overlaps are consistent with independent stock selection?

Chart 3a: Event Driven Funds' Distribution of Overlaps

Chart 3b: Quant Technical Funds' Distribution of Overlaps
Overlap Models Intended to be Tractable Yet Describe Features of Holdings

- 4 related models
- Portfolios are equal-weight
  - 2 use actual number of stocks
  - 2 use effective number
- Stocks are equally-likely to appear
  - 2 assume equally-likely over universe
  - 2 assume equally-likely over each of 5 market-cap bins
  - Bins chosen *a priori* and not fit to sample
- Funds select stocks independently
  - Baseline hypothesis to test using model
Models Yield Simple Formulas for Expected Overlap and Variance

- Inputs: Stocks in universe, \(N\), and funds, \(\tilde{n}^{(1)}\) and \(\tilde{n}^{(2)}\)
- Multi-bin models also require bin weights and counts
- For single-bin models:
  \[
  \text{E}\{\text{Overlap}^{(1,2)}\} = \min(\tilde{n}^{(1)}, \tilde{n}^{(2)}) / N
  \]
  \[
  \text{Var}\{\text{Overlap}^{(1,2)}\} = \frac{\min(\tilde{n}^{(1)}, \tilde{n}^{(2)}) (N - \tilde{n}^{(1)}) (N - \tilde{n}^{(2)})}{\max(\tilde{n}^{(1)}, \tilde{n}^{(2)}) N^2 (N - 1)}
  \]
- Aggregate quantities by bin in multi-bin models
- Hypergeometric distribution of common holdings, \(k\) (can be non-normal):
  \[
  p(k; \tilde{n}^{(1)}, \tilde{n}^{(2)}, N) = \binom{\tilde{n}^{(1)}}{k} \binom{N - \tilde{n}^{(1)}}{\tilde{n}^{(2)} - k} / \binom{N}{\tilde{n}^{(2)}}
  \]

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Strategies with Distinct Stock-Selection Criteria Used to Test Models

- EMN and Quant Technical funds use different criteria to select stocks
- Cumulative overlap distribution pairs one fund from each strategy
- Compare sample and models using Kolmogorov-Smirnov test

Single-Bin Models Understate Overlaps

Multi-Bin Actual-Stocks Model Fits Well

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EMN & Quant Technical Overlaps Consistent with Multi-Bin Actual Stocks Model

- For both strategies, all 5 bins, cannot reject that sample and model from same distribution
- Overlaps consistent with independent stock selection

**Chart 6a:** Quant Fundamental Distributions of Overlaps, Mid-Cap Sub-Portfolio

**Chart 6b:** Quant Technical Distributions of Overlaps, Mid-Cap Sub-Portfolio

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Event Driven & Multi-Strategy Overlaps Not Consistent with Any of Four Models

- Across all bins, both strategies, all four models are rejected
- Consistent with Event-Driven focus on subset of stocks
- Multi-Strategy funds often have Event Driven books
Conclusions

- HF holdings portfolio overlaps vary by strategy, but are generally modest
- Highest overlaps in quantitative equity strategies
- We present four models to give context to overlaps
- Quant equity holdings overlaps consistent with independent stock selection
- Suggests herding into stocks did not cause Aug ‘07 crisis
- Small-cap skew to EMN overlap may have exacerbated fund drawdowns
III. Performance of Quant Equity During the Crisis
Quant Equity Funds Have Struggled Since Onset of Financial Crisis

- HFRI EMN Index down 3% since Nov ’07
- Investable HFR EMN Index down 6% over same period
- Anecdotally difficult period for many EMN funds
- Recent period different from backtest periods:
  - Short rates pegged at zero
  - Quantitative easing (2x)
  - Short-sale bans
  - Major regulatory changes in Financials and Healthcare
- Quant funds struggled at previous inflection points
  - Spring/summer 2003 ‘junk’ rally
Recent EMN Performance Continues Longer Downward Trend

- 10-year rolling average of HFRI EMN Index has downward trend
- Cyclicality of performance visible in shorter-term averages
Decline in Returns Not Due to Decrease in Risk

- Rolling 10 year HFRI EMN volatility is flat
- Suggests decreased efficiency of strategy
- Reminiscent of Khandani and Lo (2007) findings for daily mean reversion strategy

**Rolling Annualized Volatility of the HFRI EMN Index**

- Rolling 36-Month Volatility
- Rolling 60-Month Volatility
- Rolling 120-Month Volatility

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Factor Contributions Explain Part of Decline in EMN Returns

- 4-Factor model
  - Market, small-large cap, value-growth, momentum
- Main contribution is from momentum
  - Falls sharply in early 2000s
- Rolling alphas still exhibit decline

Contributions to HFRI EMN Index Returns from Four Factors (Annualized - Rolling 36 month Regressions)

HFRI EMN Index: Average Return and Alpha from a Fama-French-Carhart 4-Factor Model
Secular Decline in Short-Term Rates Explains Part of Drop-Off in Returns

- EMN funds take $1 and lever to $K long and $K short
- Results in net positive exposure to short-term rates
- Subtracting short-term rates removes significant serial correlation

Rolling Annualized Returns of the HFRI EMN Index Net of Riskfree Rate

Reg FD takes effect in Oct 2000
Timing of Decline Consistent with Impact from Regulation Fair Disclosure

- Decline in average net returns begins post-implementation of Reg FD in Oct 2000
- Studies of Reg FD show negative impact on analyst revisions
  - May also be related to decline in momentum factor returns
- Tests indicate a structural break in mean returns
  - Chow test significant for Oct 2000
  - Quandt test also significant, indicating break in 2000 or 2001
We test four regime-switching models:
- 2 use gross returns and 2 use net-of-riskfree returns
- 2 include break in mean returns at Oct 200 (2 have no break)

- Momentum exposure integral to strategy - not broken out
- Estimate models using Hamilton scheme
- Best fit with net-return model incorporating break in mean returns
HFRI EMN Index Experienced 4 Cycles since 1990

- ‘Bad’ regimes have smoothed probabilities <50%
- Extended ‘good’ period following Reg FD may have cushioned impact of break in mean returns
- HFRI EMN Index in ‘good’ state since spring 2009
Expected Returns of Model Track Decline in Index

- Probability-weighted expected returns
- Net-return model has 2 parts – add back short-term rates
- Net-return model has less-extreme jump down in 2000
  - Still requires 5.9% downward jump

![Expected Returns of the HFRI EMN Index for Two Regime-Switching Models](image-url)
Future Expected Index Returns Modest for Several Scenarios

- For net-return model, scenarios on short-term rates can be used to characterize expected returns
- Near-term, expected returns decline as good-state probability equilibrates
- Further out, expected returns modest under 3 interest-rate scenarios

![Future Expected Returns of the HFRI EMN Index for Two Regime-Switching Models](chart.png)
Conclusions

- EMN funds and HFRI EMN Index fared poorly in crisis
- Continues longer-term downward trend
- Shorter-term cycles also visible
- Regime switching model with structural break admits key features of HFRI EMN returns
- Despite lackluster recent returns, Index appears to be in a ‘Good’ regime
- Expected return outlook muted under a range of interest rate trajectories