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Quantitative Hedge Fund Strategies:
An Investor Perspective

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Outline of Talk

I.   Introduction to Quantitative Equity Strategies

II.   Overlaps of Hedge Fund Holdings

III.   Performance of Quant Equity During the Crisis

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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

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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

Strategy Groups	Strategies
Quant Equity	Equity Market Neutral
	Technical Equities
	Event-Driven
	Holdings-based HF Replication
Quant Futures and Forwards	Commodity Trading Advisors
	Short-Term Traders
	Systematic Macro
	Factor-based HF replication
Quant Options	Volatility Arbitrage
Quant Credit	Correlation, basis trading, long/short
Quant Hybrid Asset Strategies	Strategy-based HF replication

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

$$\text{e.g.,} \quad R_{i,t+1} = \beta \, \text{EPF}_{i,t} + \gamma \, \text{PMOM12}_{i,t} + \delta \, \text{D\_shrs}_{i,t}$$

- Slow turnover (months/quarters)
- Some funds ~$10bn; overall hundreds of billions
- Benchmarks: HFRI EMN Index

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

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II.   Overlaps of Hedge Fund Holdings

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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

Split by Market Capitalization				Split by GICS Sector			Split by Super Sectors		
Cap Group	Stocks	Min. Cap ($mm)	Weight	Sector Name	Stocks	Weight	Name	Stocks	Weight
Mega-Cap	50	42,000	39.0%	Consumer Discretionary	580	10.8%	Consumer	743	20.9%
				Consumer Staples	163	10.1%			
Large-Cap	200	10,800	29.0%	Energy	317	11.0%	Energy & Materials	518	15.3%
				Materials	201	4.3%			
Mid-Cap	750	1,800	22.7%	Financials	844	17.0%	Financials	844	17.0%
				Health Care	547	11.8%	Health Care	547	11.8%
Small-Cap	1500	254	8.0%	Industrials	535	10.9%	Industrials & Utilities	648	14.2%
				Utilities	113	3.3%			
Micro-Cap	1500	45	1.3%	Information Technology	648	18.2%	Tech and Telecom	700	20.6%
				Telecommunication Services	52	2.5%			

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

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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

Chart 1a: Histogram of Aggregate Market Values of Hedge Fund Holdings in the 4000 Stock Equity Universe (657 Funds)
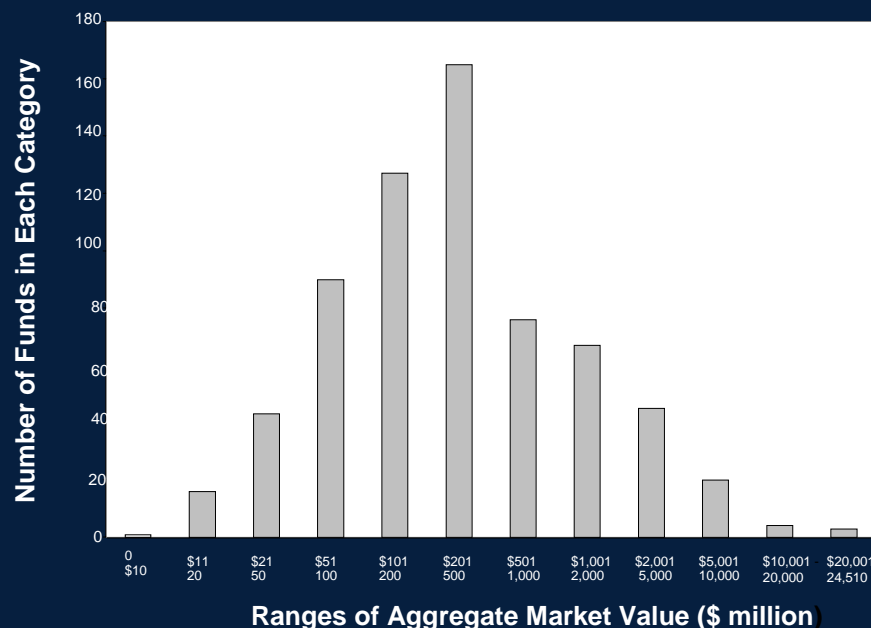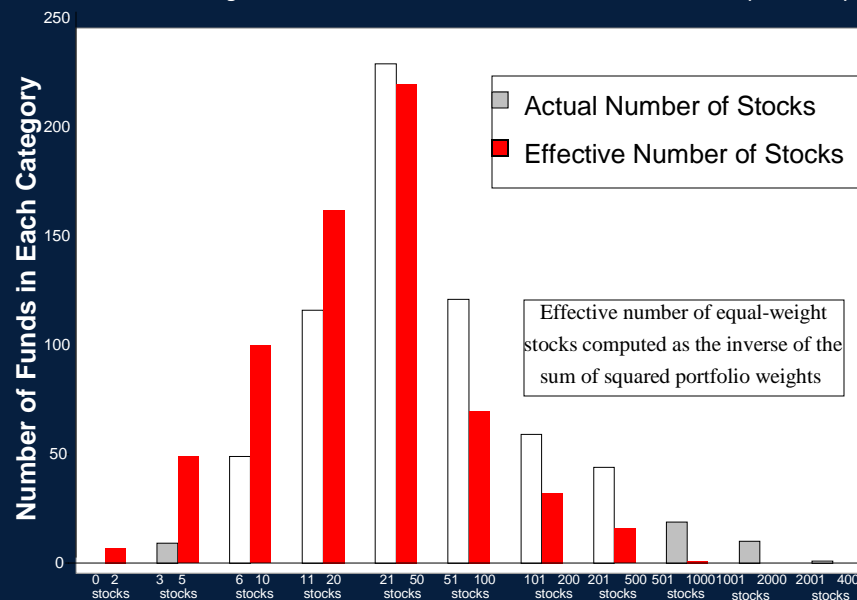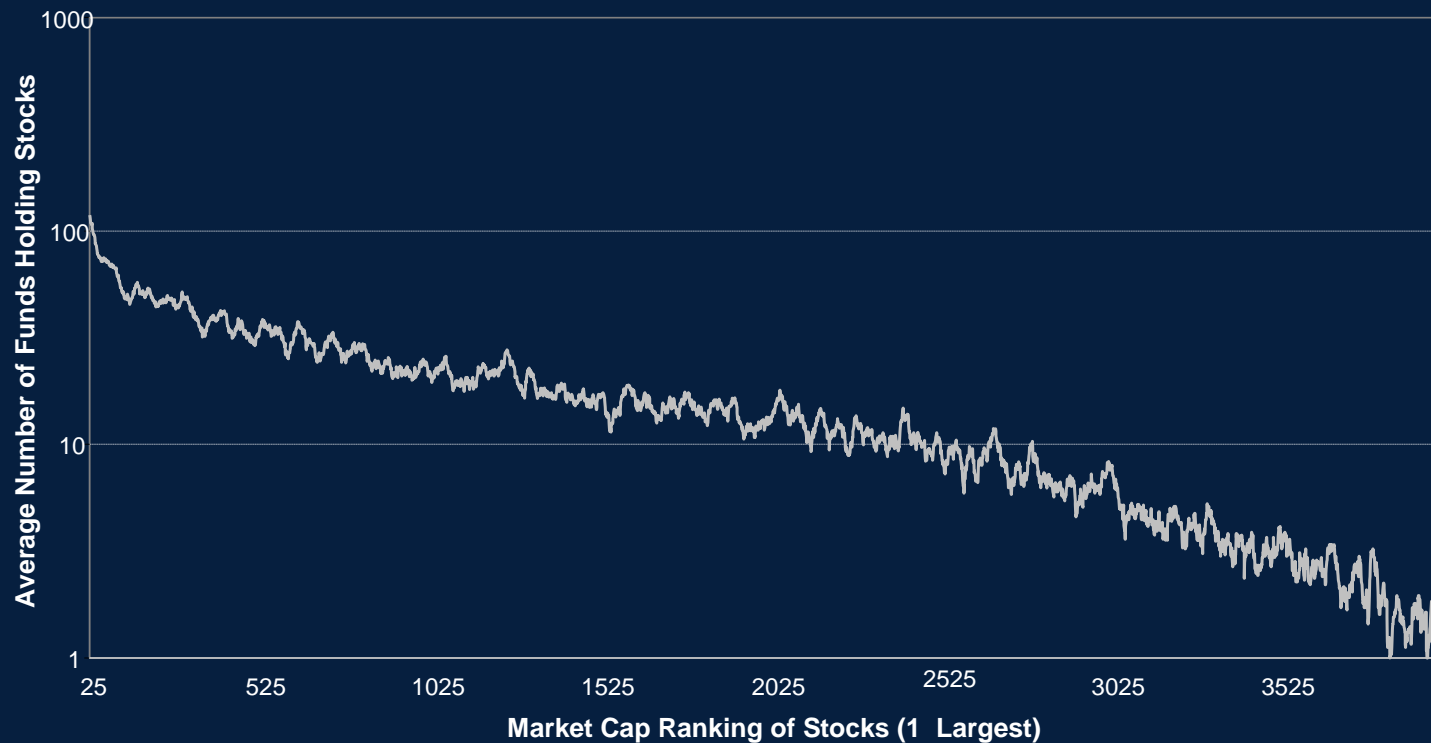

Chart 1b: Histogram of Actual and Effective Numbers of Stocks Per Fund (657 Funds)

Effective number of equal-weight stocks computed as the inverse of the sum of squared portfolio weights
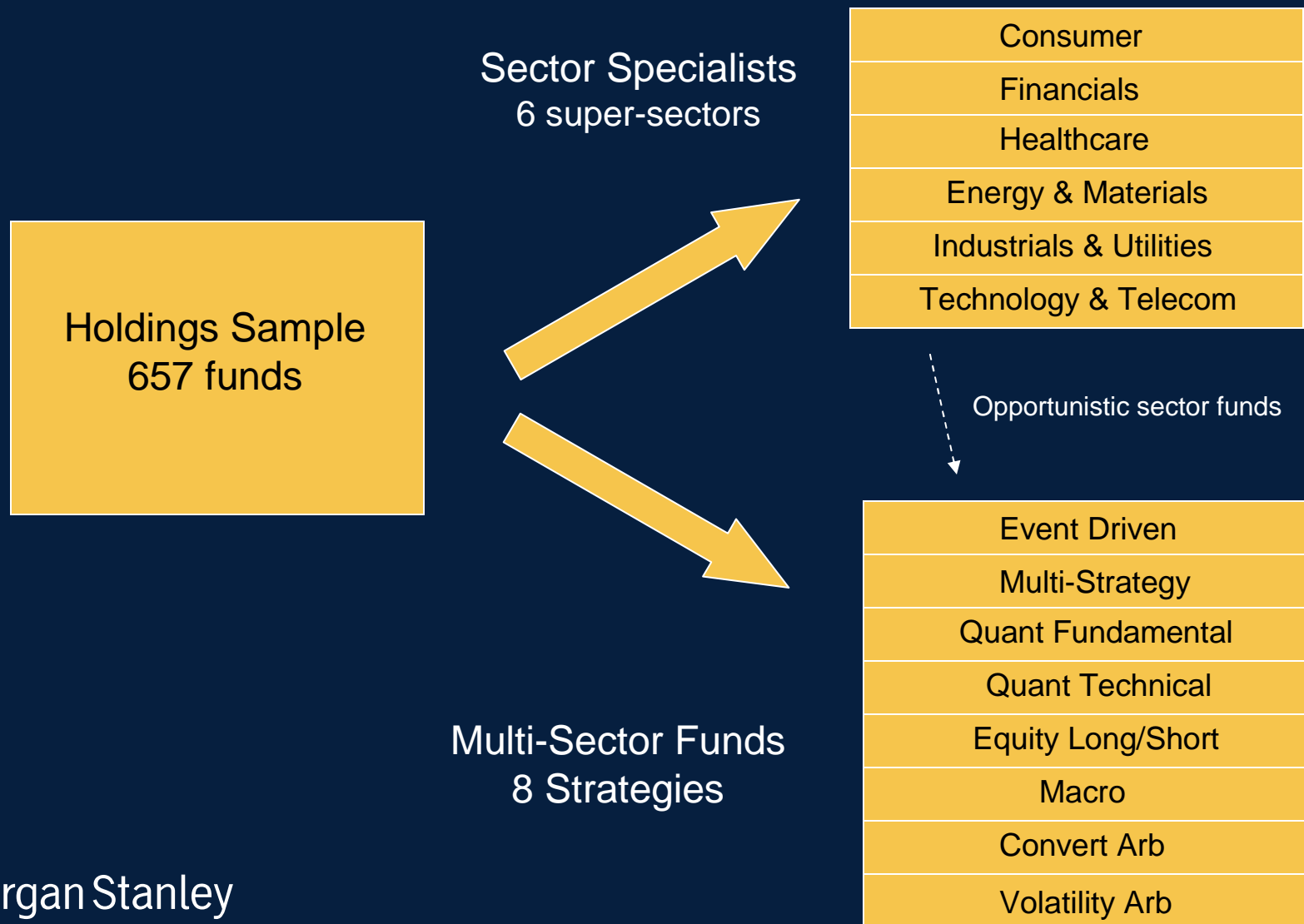
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Large-Cap Stocks More Popular Among Funds

- 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)

Y-axis: Average Number of Funds Holding Stocks (1000, 100, 10, 1)

X-axis: Market Cap Ranking of Stocks (1 Largest) — 25, 525, 1025, 1525, 2025, 2525, 3025, 3525

Strategy Classification Important in Overlap Analysis

Holdings Sample
657 funds

Sector Specialists
6 super-sectors

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

Opportunistic sector funds

Multi-Sector Funds
8 Strategies

| Event Driven |
| Multi-Strategy |
| Quant Fundamental |
| Quant Technical |
| Equity Long/Short |
| Macro |
| Convert Arb |
| Volatility Arb |

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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

Strategy Name	Number of Funds	Universe (Number of Stocks)	Median Market Value ($mm) *	Median Stocks in Portfolio *	Median Effective Stocks in Portfolio *	Number of Fund Overlaps	Bottom Quartile Overlap	Median Overlap	Top Quartile Overlap
Consumer Sector	8	743	527	17	7	28	0%	0%	4.0%
Energy & Materials Sector	23	518	222	20	13	253	0%	1.3%	11.1%
Financials Sector	29	844	127	26	16	406	0%	1.3%	7.5%
Healthcare Sector	20	547	278	30	15	190	2.1%	6.1%	12.0%
Industrials Sector	5	648	278	24	14	10	0%	22.4%	28.7%
Tech & Telecom Sector	20	700	319	37	18	190	2.9%	8.3%	17.8%
Long/Short Equity	366	4,000	257	39	23	66,795	0%	1.1%	4.2%
Event Driven	53	4,000	215	27	11	1,378	0%	1.6%	7.2%
Multi-strategy	62	4,000	402	94	26	1,891	0.9%	3.9%	8.6%
Convertible Bond Arbitrage	14	4,000	64	18	7	91	0%	0%	2.1%
Volatility Arbitrage	13	4,000	84	39	13	78	0.1%	0.8%	6.0%
Quant Fundamental	16	4,000	164	306	189	120	4.6%	8.2%	11.5%
Quant Technical	18	4,000	227	309	162	153	6.1%	12.1%	19.3%
Macro	10	4,000	129	51	17	45	0.6%	2.2%	4.7%

*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

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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

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

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

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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?

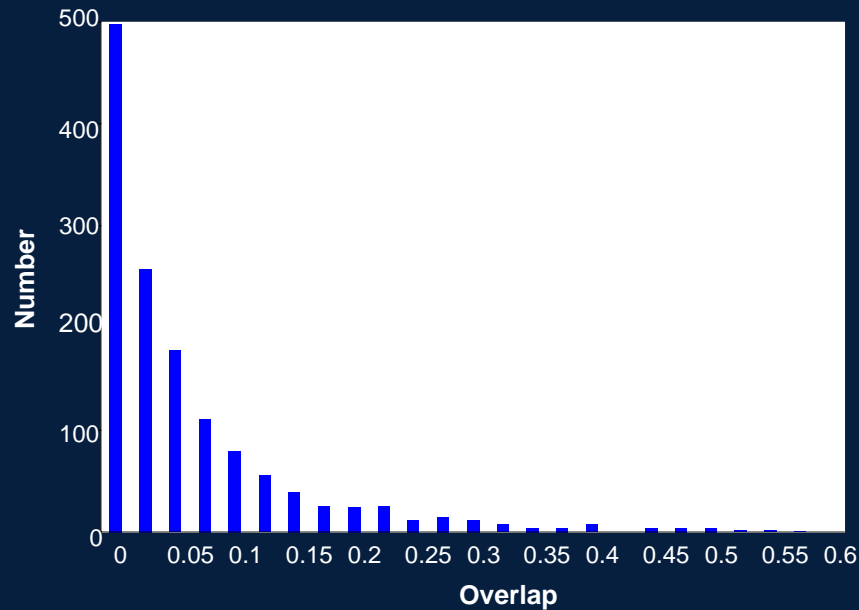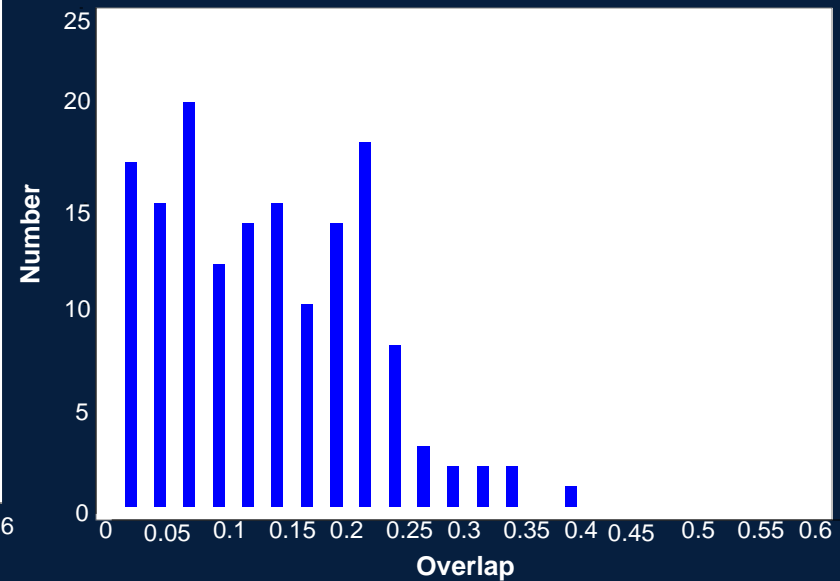**Chart 3a: Event Driven Funds' Distribution of Overlaps**

Chart 3b: Quant Technical Funds' Distribution of Overlaps

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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

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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:

$$E\left\{\text{Overlap}^{(1,2)}\right\} = \min(\tilde{n}^{(1)}, \tilde{n}^{(2)})/N$$

$$\text{Var}\left\{\text{Overlap}^{(1,2)}\right\} = \frac{\min(\tilde{n}^{(1)}, \tilde{n}^{(2)})\,(N-\tilde{n}^{(1)})(N-\tilde{n}^{(2)})}{\max(\tilde{n}^{(1)}, \tilde{n}^{(2)})\,N^2\,(N-1)}$$

- Aggregate quantities by bin in multi-bin models

- Hypergeometric distribution of common holdings, k (can be non-normal):

$$p(k;\tilde{n}^{(1)},\tilde{n}^{(2)},N) = \binom{\tilde{n}^{(1)}}{k}\binom{N-\tilde{n}^{(1)}}{\tilde{n}^{(2)}-k} \Big/ \binom{N}{\tilde{n}^{(2)}}$$

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

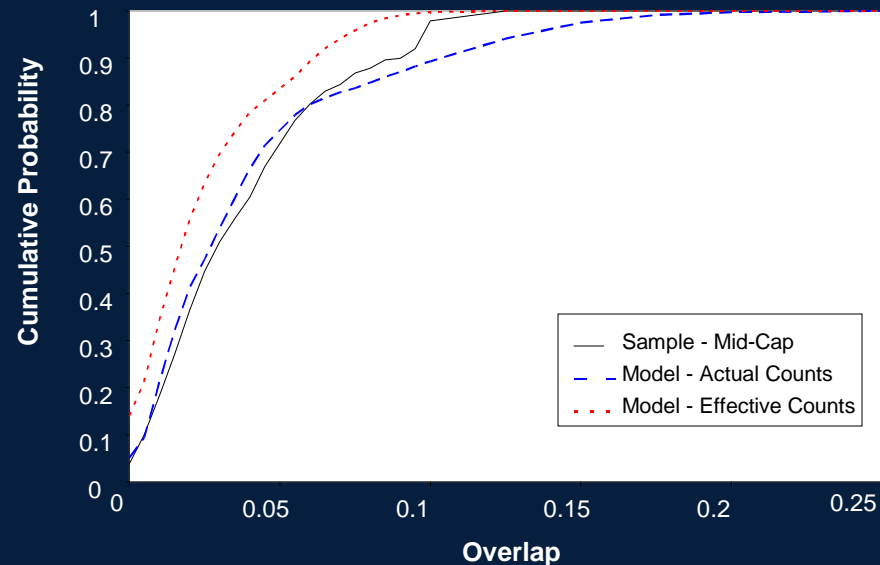- Compare sample and models using Kolmogorov-Smirnov test

Single-Bin Models Understate Overlaps

Chart 5a: Distributions of Overlaps Between Quant Fundamental and Quant Technical Funds: Overall Portfolios
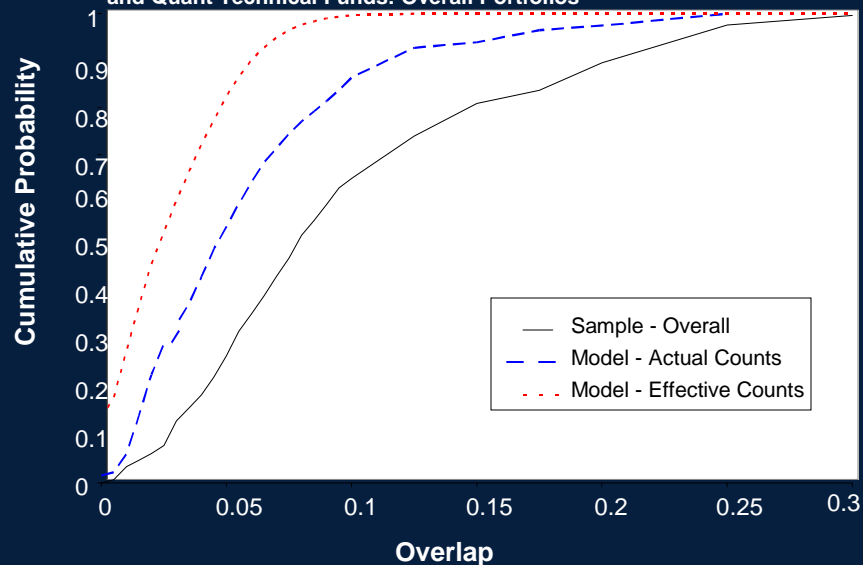
Multi-Bin Actual-Stocks Model Fits Well

Chart 5c: Distributions of Overlaps Between Quant Fundamental and Quant Technical Funds, Mid-Cap Sub-Portfolio
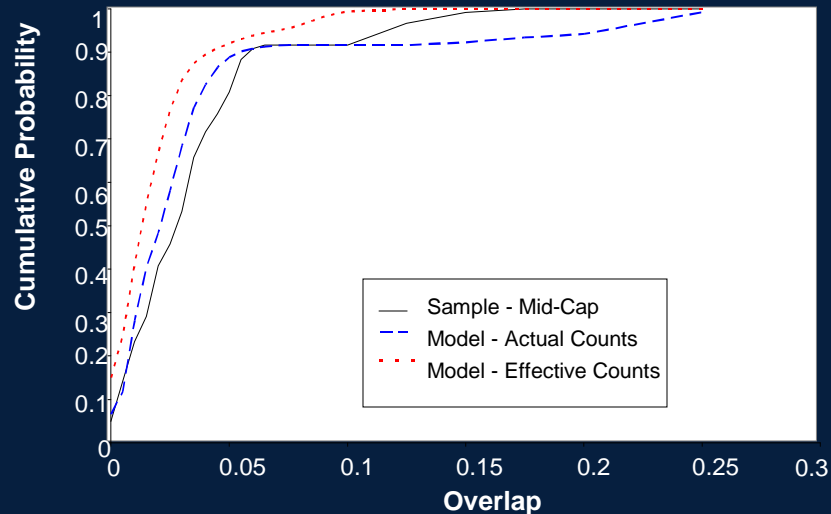
EMN & Quant Technical Overlaps Consistent with Multi-Bin Actual Stocks Model

- For both strategies, all 5 bins, cannot reject that sample and model from same distribution

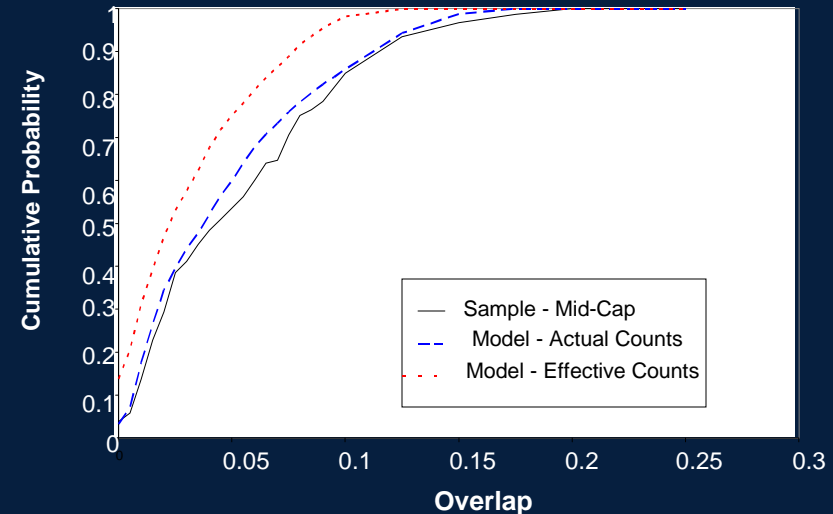- Overlaps consistent with independent stock selection

EMN Funds: Mid-Cap Bin

Quant Technical Funds: Mid-Cap Bin

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

Chart 6b: Quant Technical Distributions of Overlaps, Mid-Cap Sub-Portfolio
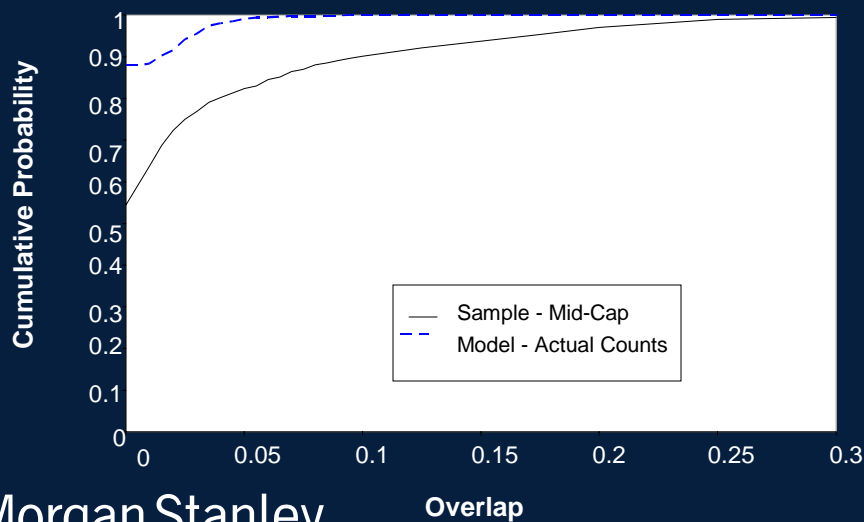
Event Driven & Multi-Strategy Overlaps Not Consistent with Any of Four Models

- Across all bins, both strategies, all four models are rejected

- Consistent with Event-Driven focus on subset of stocks
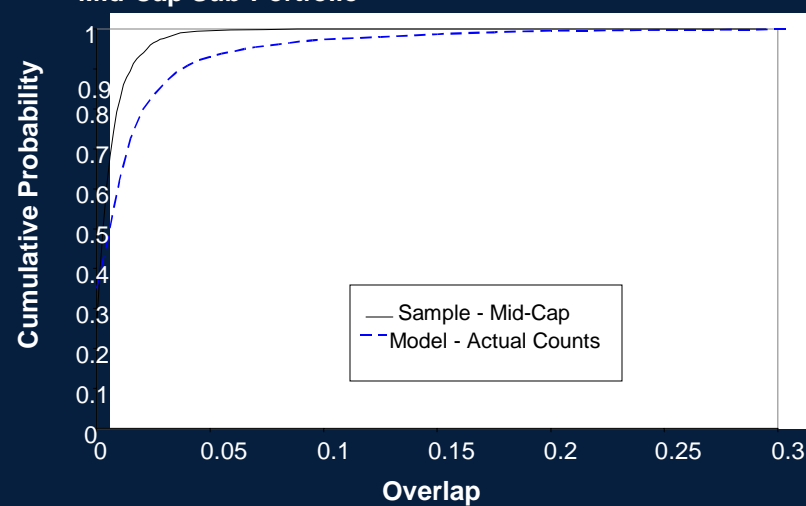
- Multi-Strategy funds often have Event Driven books

Event Driven Funds: Mid-Cap Bin

Multi-Strat Funds: Mid-Cap Bin

Chart 6c: Distributions of Overlaps among Event Driven Funds, Mid Cap Sub Portfolio

Chart 6d: Distributions of Overlaps among Multi Strategy Funds, Mid Cap Sub Portfolio

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

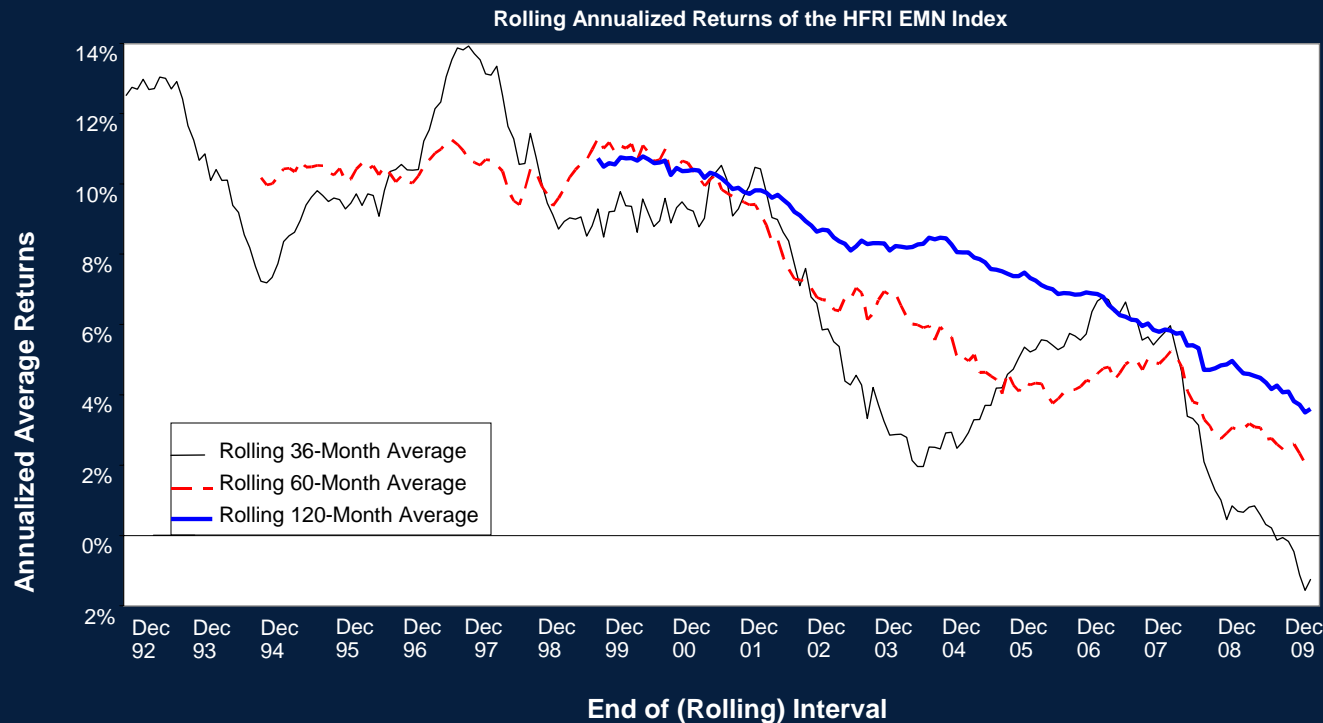- Small-cap skew to EMN overlap may have exacerbated fund drawdowns

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III.   Performance of Quant Equity During the Crisis

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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

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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

Rolling Annualized Returns of the HFRI EMN Index

Legend:
- Rolling 36-Month Average
- Rolling 60-Month Average
- Rolling 120-Month Average

Y-axis: **Annualized Average Returns**

X-axis: **End of (Rolling) Interval** — Dec 92, Dec 93, Dec 94, Dec 95, Dec 96, Dec 97, Dec 98, Dec 99, Dec 00, Dec 01, Dec 02, Dec 03, Dec 04, Dec 05, Dec 06, Dec 07, Dec 08, Dec 09

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Decline in Returns Not Due to Decrease in Risk

- Rolling 10 year HFRI EMN volatility is flat

- Suggests decreased efficiency of strategy

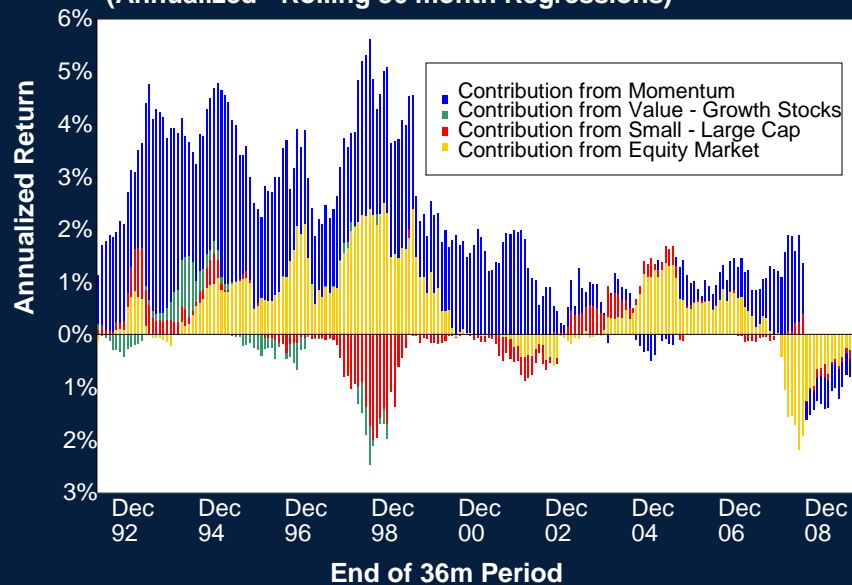- Reminiscent of Khandani and Lo (2007) findings for daily mean reversion strategy

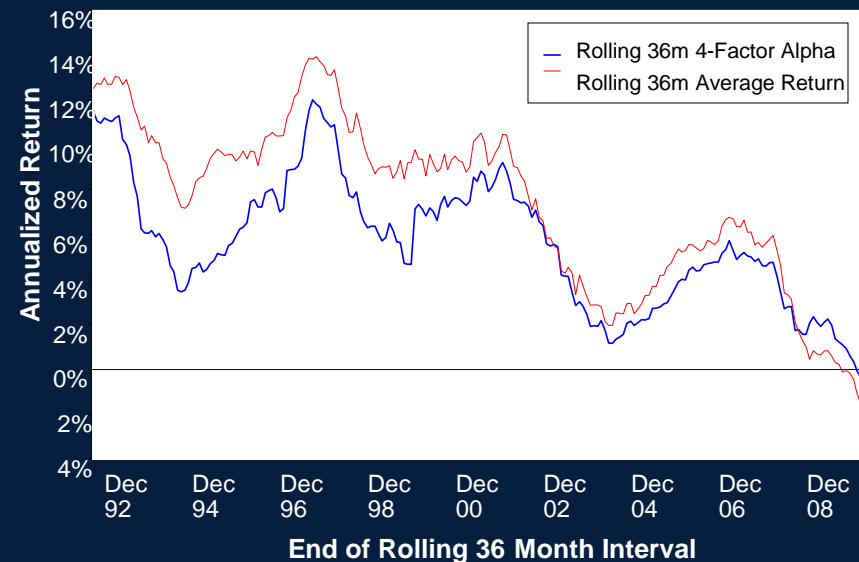**Rolling Annualized Volatility of the HFRI EMN Index**
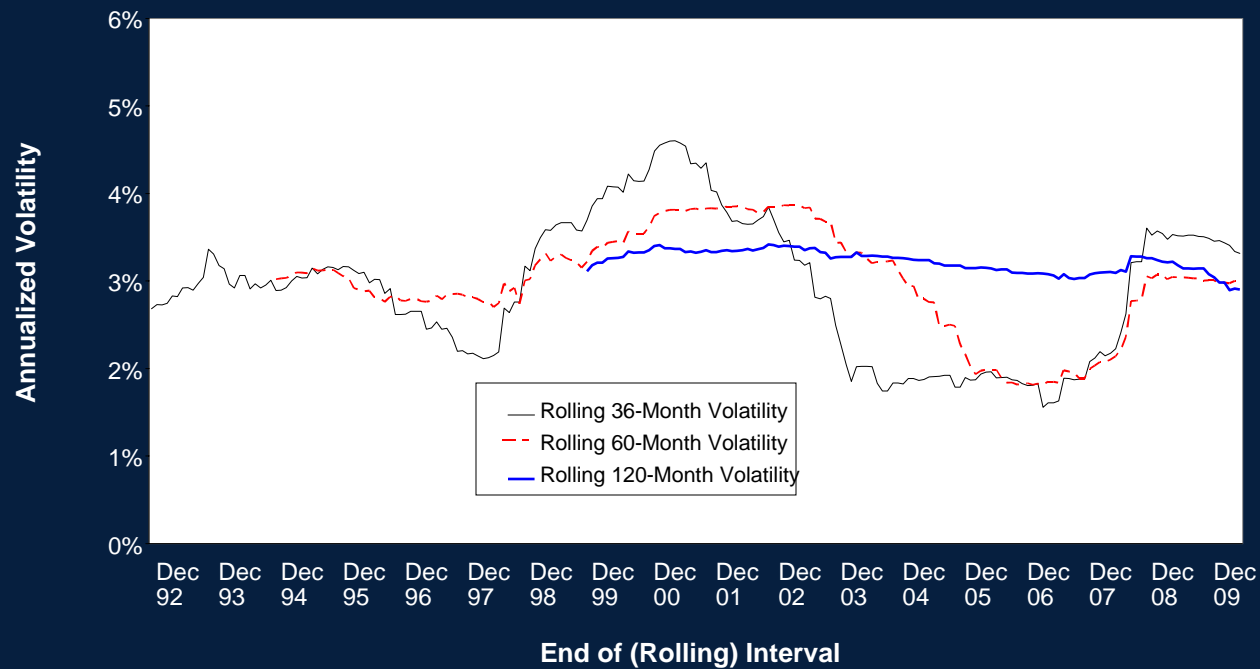
Factor Contributions Explain Part of Decline in EMN Returns

- 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)**

Legend:
- Contribution from Momentum
- Contribution from Value - Growth Stocks
- Contribution from Small - Large Cap
- Contribution from Equity Market

Y-axis: Annualized Return
X-axis: End of 36m Period

HFRI EMN Index: Average Return and Alpha from a Fama French Carhart 4 Factor Model

Legend:
- Rolling 36m 4-Factor Alpha
- Rolling 36m Average Return

Y-axis: Annualized Return
X-axis: End of Rolling 36 Month Interval

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
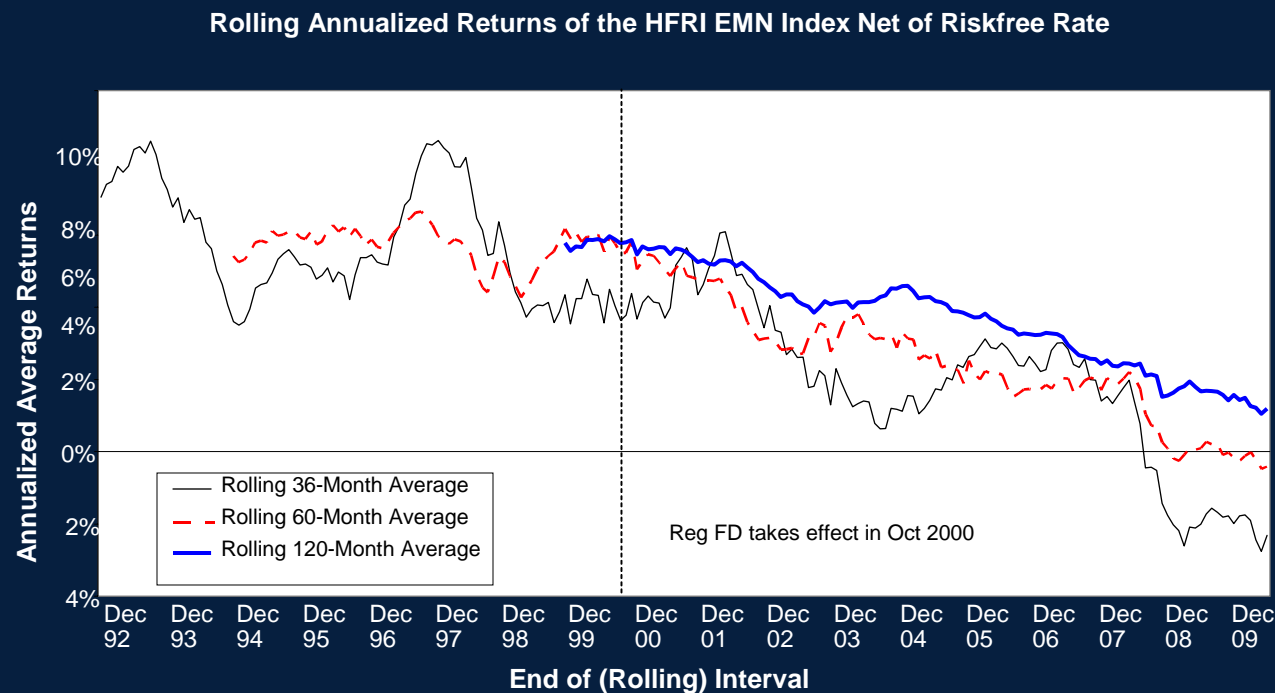
Timing of Decline Consistent with Impact from Regulation Fair Disclosure

- 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

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Regime-Switching Models with Break in Mean Capture Trend and Cycles of EMN Strategy

- 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

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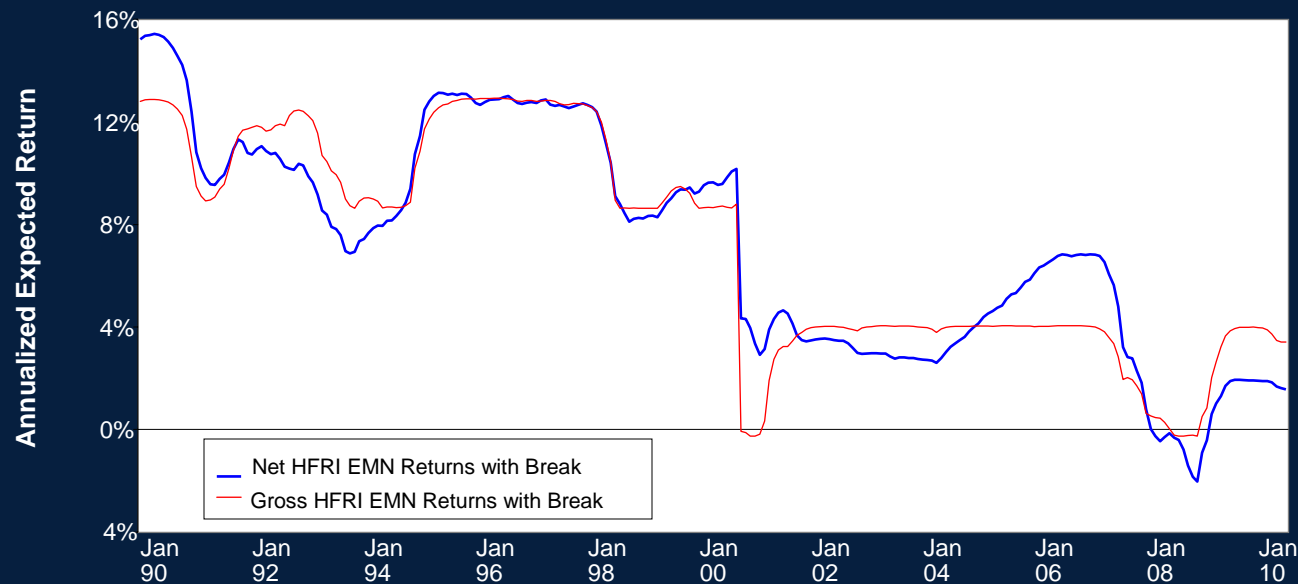# HFRI EMN Index Experienced 4 Cycles since 1990

- '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

Smoothed Probabilities for HFRI EMN Index to be in the "Good" State

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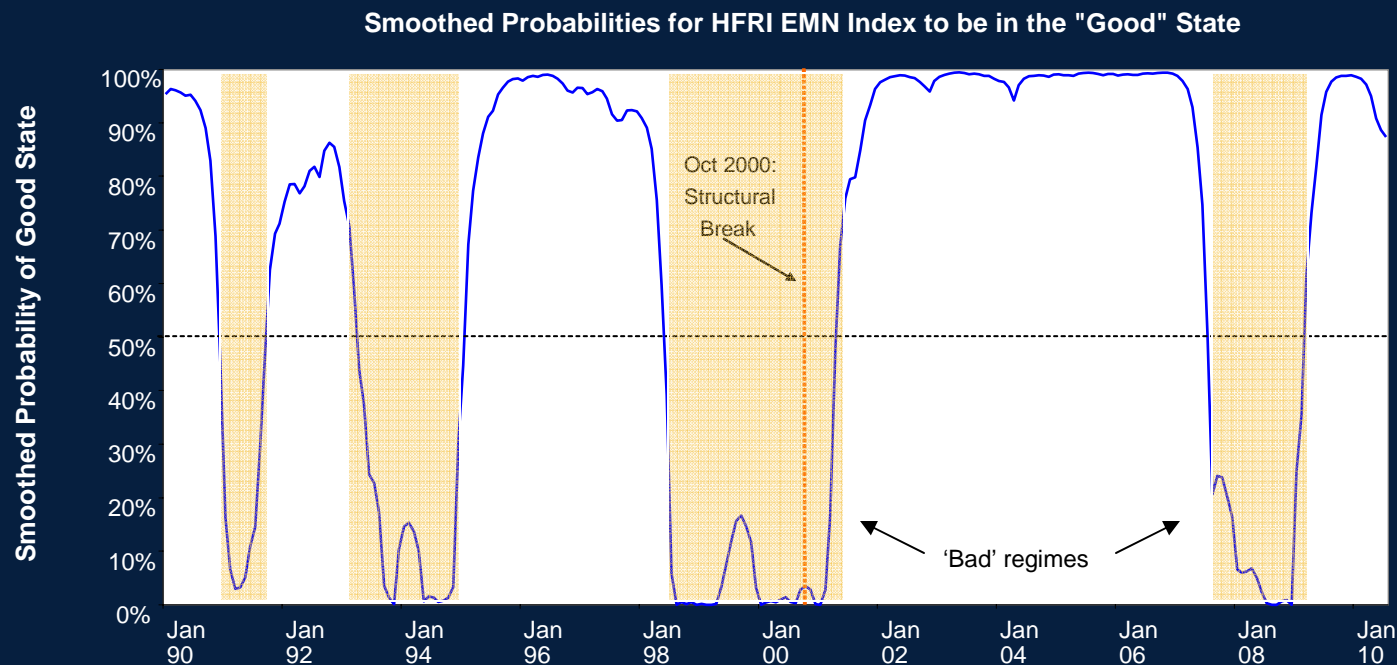
# Expected Returns of Model Track Decline in Index

- 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 Regine Switching Models

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

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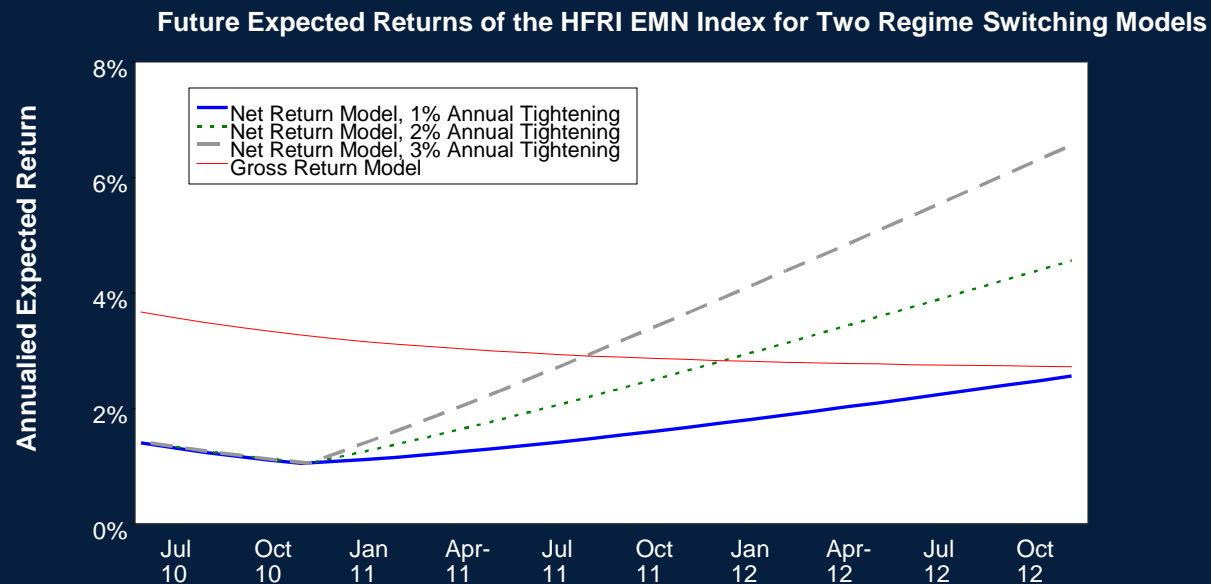
Conclusions

- 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

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