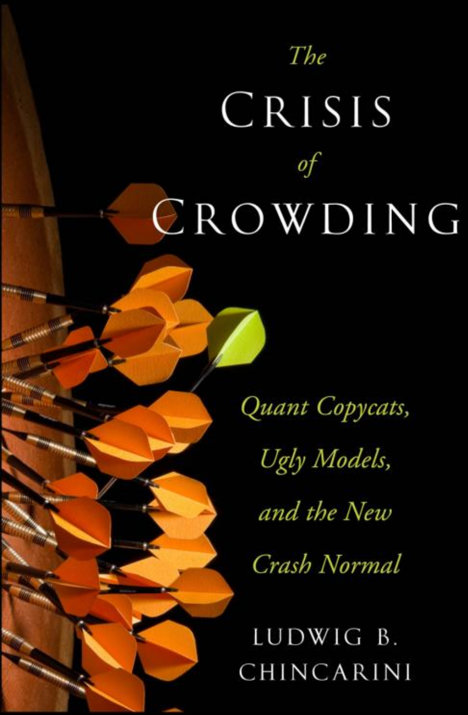
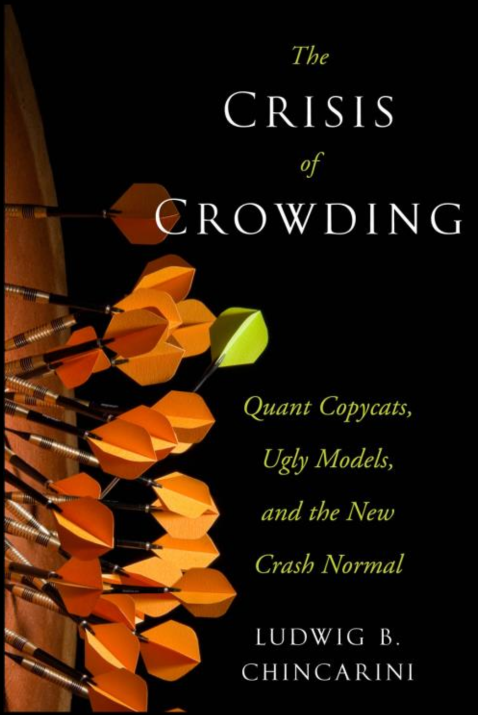


Crowded Spaces and Copycat Risk Management

More Evidence of the Crisis of Crowding

September 15, 2015



Ludwig B. Chincarini, Ph.D., CFA
University of San Francisco
United States Commodity Funds

CFA Society of San Francisco
September 15, 2015

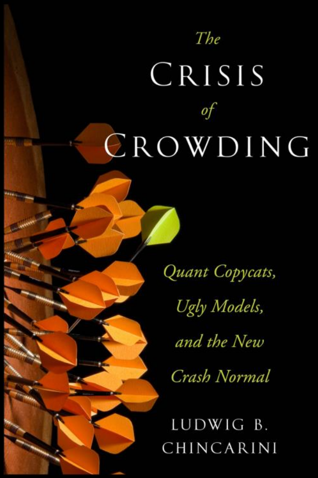
- Thank you for coming. Thanks to the CFA Society.

Outline

1. *The Crisis of Crowding* (2012)
2. Intro to Crowding
3. Crowded Spaces and Copycat Risk Management
    a. Risk Management might create crowding
    b. A Simple Demonstration
    c. A Reasonable Solution
    d. Empirical Investigation of the Problem
4. Conclusions/Discussion

Bottom Line: Crowding can be caused from concentration in risk mode usage, even when portfolio manager selection models are completely independent.

New Idea of Crowding



- *The Crisis of Crowding* by Ludwig Chincarini.
- The book tells the real stories of the financial crisis of 2008 and beyond how they are all connected by elements of crowding.
- The book is easy to read and informative with lots of interviews with insiders, including Goldman Sachs executives, Jimmy Cayne, Myron Scholes, John Meriwether, Vice Chairman of Citibank, government regulators, and others.

2. Intro to Crowding

Crowding takes place when multiple market participants begin to follow the same trade altering the risk and return dynamics of the trade.

- Not always east to detect – holders matter

- Risk will be incorrectly measured if not accounted for, both market and liquidity risk.

- Can lead to levered firms failing rapidly.

2. Intro to Crowding

How does crowding differ from herding?

They are similar. However, herding represents many similar investors following the same strategy.

Crowding represents similar and/or different investors following the same or different, but correlated strategies to an extent that the opportunity or trading space is crowded/saturated. When the saturation is severe, the return and risk of the space is no longer determined by fundamentals, but determined by the behavior of the participants in the space. This makes all historical return and risk calculations useless.

2. Intro to Crowding

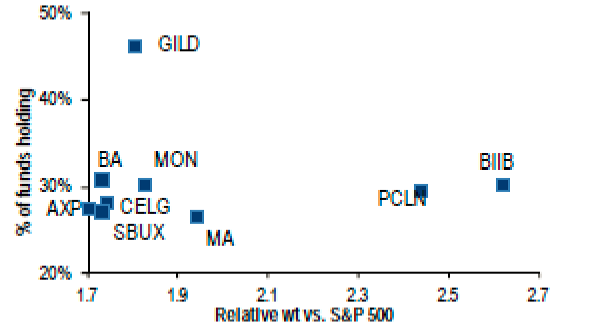
How Crowding Typically Happens

1. Attractive Trading Opportunity Develops
2. Copycats rush to follow the leader (even if it's not their core business)
3. Herding occurs, but sometimes very hidden (not obvious)
4. The trading space becomes crowded
5. Not all crowded spaces are similar.
    a. 1 type of holder (all traders similar)
    b. N types of holders (different motivations and behaviors to risk)
    c. Holders can have exactly same position or slightly different positions, still leading to crowded behavior.
    d. Inadvertent Crowding (see Bruno, Chincarini & Davis (2015)).

2. Intro to Crowding

A. Examples bank reports from Goldman Sachs, Bank of America, Bernstein, JP Morgan Chase, and many others.

Chart 15: Overowned - most overweighted stocks, broadest ownership



Source: BofA Merrill Lynch US Equity & US Quant Strategy, Lionshares

Exhibit 9: The 20 most concentrated stocks in the S&P 500 <Bloomberg: GSTHHFHI>
Holdings as of September 30, 2012; Pricing as of November 15, 2012

S&P 500: Twenty MOST CONCENTRATED Hedge Fund Holdings (Bloomberg Ticker: GSTHHFHI)

Company	Ticker	Sector	Sub-sector	Equity Cap ($ bil)	Total Return During 3Q	Total Return 2012 YTD	% of equity cap owned by Hedge Funds 30-Sep-12
TripAdvisor	TRIP	Consumer Discretionary	Internet Retail	5	(26)	45	50%
AutoNation	AN	Consumer Discretionary	Automotive Retail	5	24	9	45
LyondellBasell Industries N.V.	LYB	Materials	Specialty Chemicals	26	29	53	34
E*TRADE Financial	ETFC	Financials	Investment Banking & Brokerage	2	9	(1)	32
J.C. Penney	JCP	Consumer Discretionary	Department Stores	4	4	(53)	29
Tenet Healthcare	THC	Health Care	Health Care Facilities	3	20	23	23
Yahoo! Inc.	YHOO	Information Technology	Internet Software & Services	21	1	11	23
VeriSign Inc.	VRSN	Information Technology	Internet Software & Services	7	12	16	23
Beam Inc	BEAM	Consumer Staples	Distillers & Vintners	8	(8)	6	21
MetroPCS Communications	PCS	Telecommunication Servic	Wireless Telecommunication Services	4	94	20	20
Ralph Lauren Corp.	RL	Consumer Discretionary	Apparel Accessories & Luxury Goods	14	8	9	20
Life Technologies	LIFE	Health Care	Life Sciences Tools & Services	8	9	20	19
American Intl Group	AIG	Financials	Multi-line Insurance	46	2	35	19
CBRE Group Inc	CBG	Financials	Real Estate Services	6	13	14	19
WPX Energy	WPX	Energy	Oil & Gas Exploration & Production	3	3	(17)	19
Family Dollar Stores	FDO	Consumer Discretionary	General Merchandise Stores	8	0	15	18
priceline.com	PCLN	Consumer Discretionary	Internet Retail	31	(7)	32	18
Coca-Cola Enterprises	CCE	Consumer Staples	Soft Drinks	9	12	17	18
BMC Software	BMC	Information Technology	Systems Software	6	(3)	19	18
Motorola Solutions	MSI	Information Technology	Communications Equipment	15	6	16	17

Top 50 Holdings: Top 50 Hedge Funds

Market value is in millions of dollars and represents the market value held by the top 50 hedge funds at the end of the quarter. The market value change measures the total position change of each security multiplied by its quarter-end price. "% Port" indicates the weight of the stock in an aggregated equity portfolio of the top 50 hedge funds. "% Shares Out" indicates the proportion of the shares outstanding of the stock owned by the aggregated portfolio of the top 50 hedge funds and the "Total" and "50 Highest" lines show the average for this item*. "# of companies" indicates the number of funds (out of the top 50) holding the stock.

High/Low - %Portfolio	GICS Sector	Qtr End Market Value	Mkt Val Chg - 3 mo ($millions)	Mkt Val Chg 3mnth	% Port	%Shrs Out*	# Of Co's
Total							
55 Highest							
LyondellBasell Industries N.V. Cl A							
Google Inc. Cl A							
Realogy Holdings Corp.							

Highlights

In this report we extend the definition of crowding to include breadth of high conviction overweights by active managers, as well as persistence of accumulation by active managers. We also demonstrate that crowding is an important risk factor at the stock level (with neutral performance profile), but tends to be a useful contrarian performance indicator at the aggregate sector, region level.

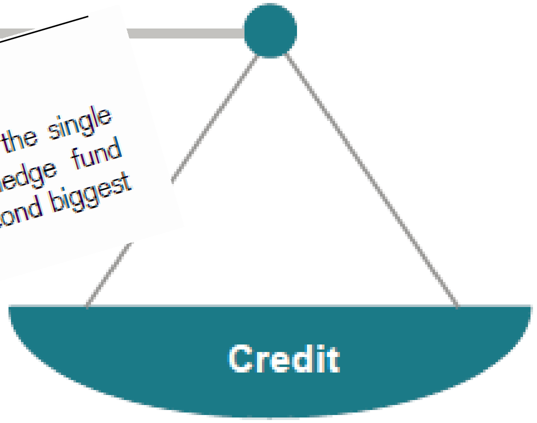
2. Intro to Crowding

A. Examples bank reports from Goldman Sachs, Bank of America, Bernstein, Credit Suisse, JP Morgan Chase, and many others.

1. Sources of Risk to the Hedge Fund Industry in 2014

As with the last three surveys, investors have continued to express crowded trades and herd mentality as the single biggest threat to the industry in 2014, given the increasing challenge they pose in differentiating hedge fund performance. Given the low market volatility over the past year, risk complacency was highlighted as the second biggest threat.

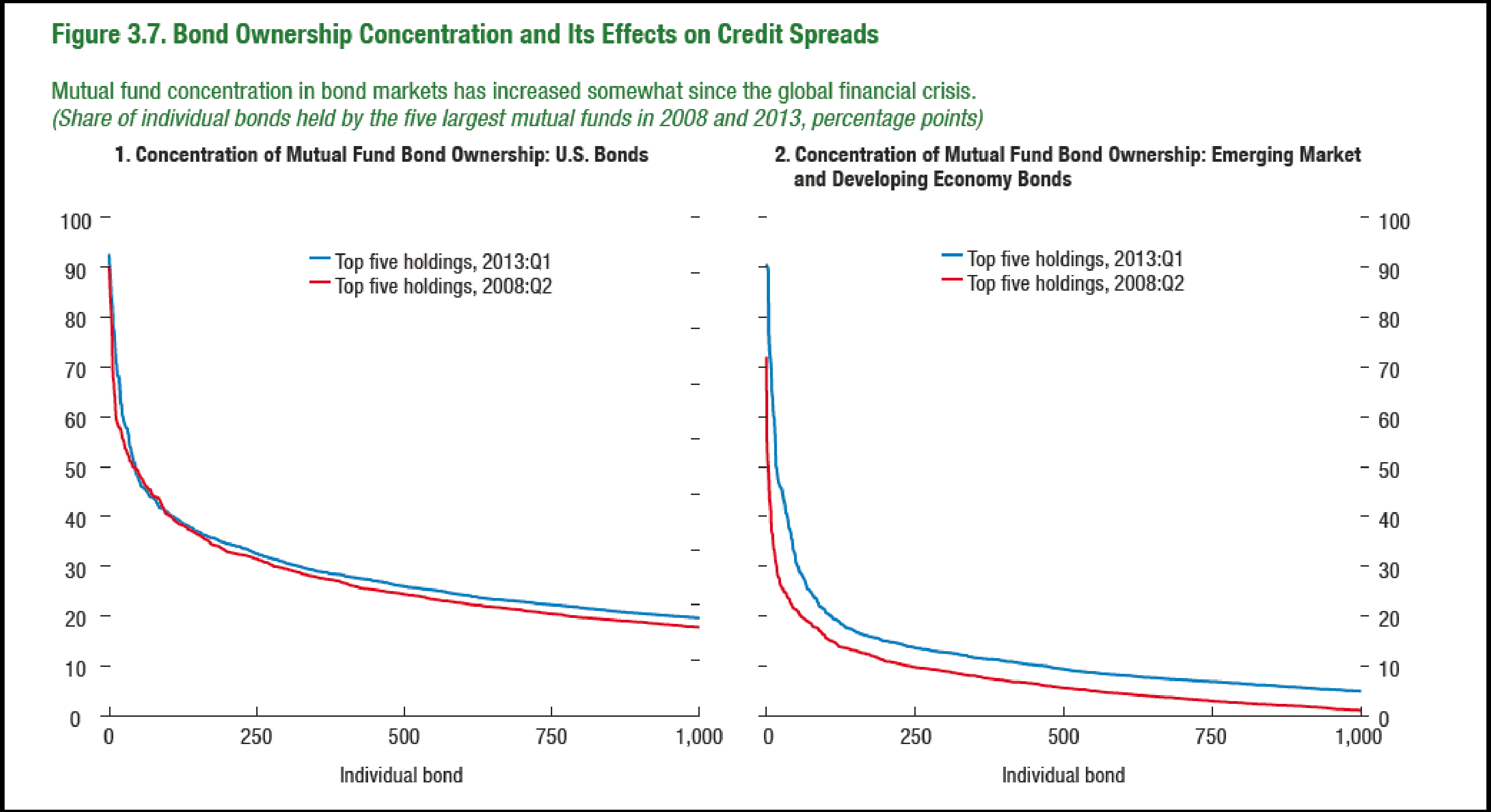
Crowded Trades: The Bank Loan Story



- Avoid crowded trades
  - Loans
  - CCC-rated bonds
- Alternative strategies: understand your exposure
- Consider municipal credit

2. Intro to Crowding

A. Examples IMF Report "The Asset Management Industry and Financial Stability" April 2015.



2. Intro to Crowding

A. Bloomberg Story on June 23, 2015.

BloombergBusiness

How to Spot Crowded Trades That the Shoeshine Boy Missed

by Michael P Regan
June 23, 2015 — 8:56 AM PDT

The way that the famous yarn is usually told, Joe Kennedy got out of the market before the 1929 crash because a shoe-shine boy was offering him stock tips, and that just didn't seem right.

Almost nine decades later, markets seem to be no less vulnerable to the proverbial "crowded trade" that lures investors like lemmings over the edge of a cliff. Exhibit A could be the crowds that bid the yield on German 10-year bunds down to almost zero a few months ago, only to later flee like a flock of scared birds.

3. Crowded Spaces and Copycat Risk Management

A. Risk Management and Crowding

- If portfolio managers use similar risk models, these risk models might cause positions to become crowded.

- Could occur if models are similar or even slightly different.

3. Crowded Spaces and Copycat Risk Management

B. A Simple Demonstration

- Mean-variance optimization with no constraints
- Expected returns are random

- What happens when we compare the pairwise correlations of the random expected returns with the actual portfolio weightings?

- We get higher correlations.

3. Crowded Spaces and Copycat Risk Management

B. A Simple Demonstration (Pairwise Correlations)

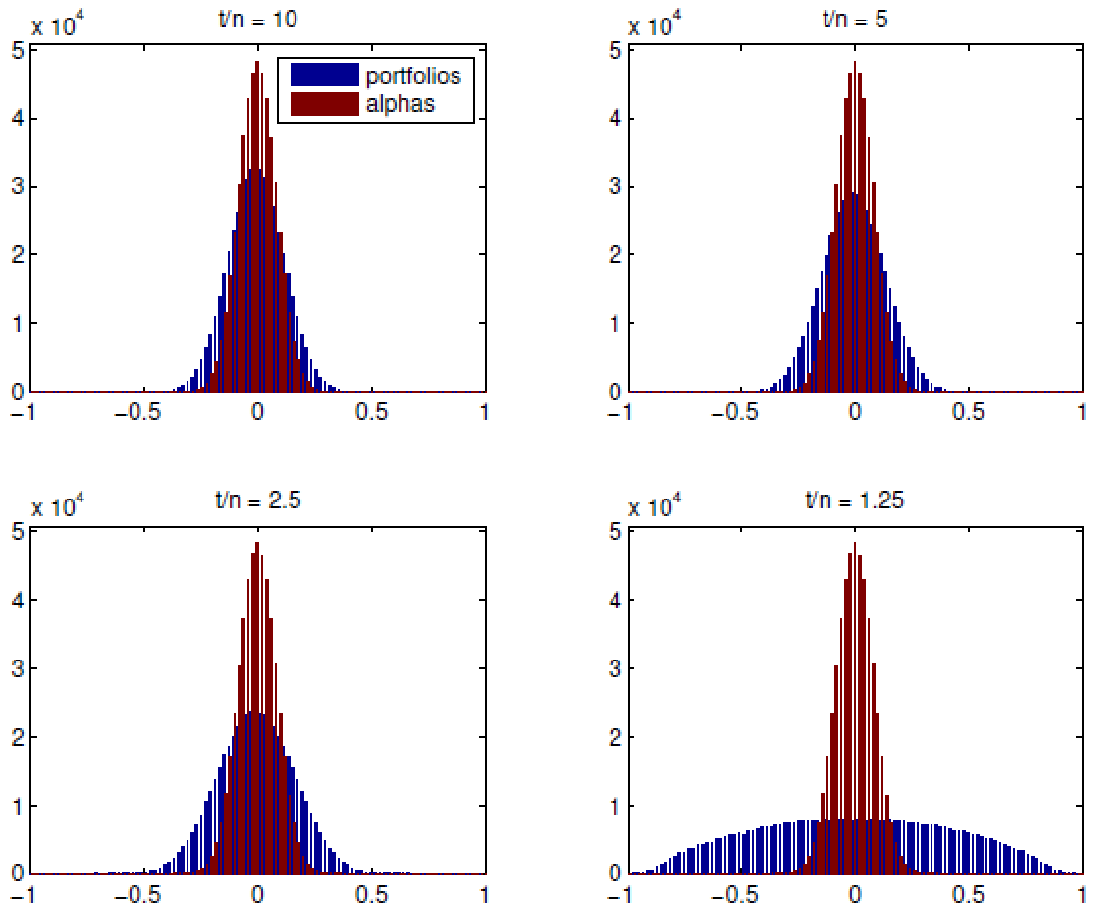


Figure F1: Distribution of Alpha Correlations and Portfolio Correlations for Various Look-back Values ($\delta = 1$). $\Omega = 1.4564, 1.6342, 2.0144$, and 5.4597 for upper left, upper right, lower left, and lower right respectively.

3. Crowded Spaces and Copycat Risk Management

B. A Simple Demonstration (Pairwise Correlations)

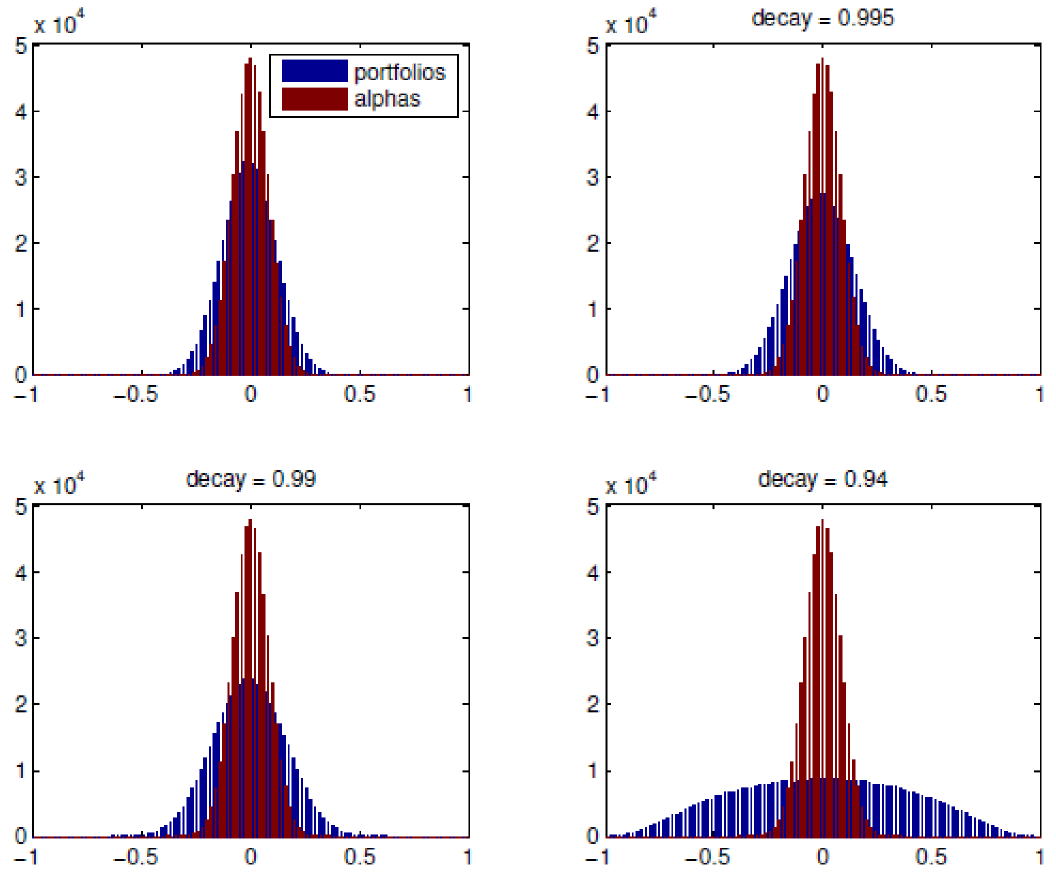


Figure F2: Distribution of Alpha Correlations and Portfolio Correlations for Various Decay Values ($t/n = 5$). $\Omega = 1.6273, 1.7184, 1.9701$, and 4.9166 for upper left, upper right, lower left, and lower right respectively.

3. Crowded Spaces and Copycat Risk Management

B. A Simple Demonstration

- Thus, crowding could occur from the *risk management process*.

- Why is crowding occurring?

  - Using Principal Component Decomposition, we find that optimal portfolios are projected along the eigenvector with the smallest eigenvalue.

  - In fact, we can look at the correlation between all of the portfolios with this eigenvector.

3. Crowded Spaces and Copycat Risk Management

B. A Simple Demonstration

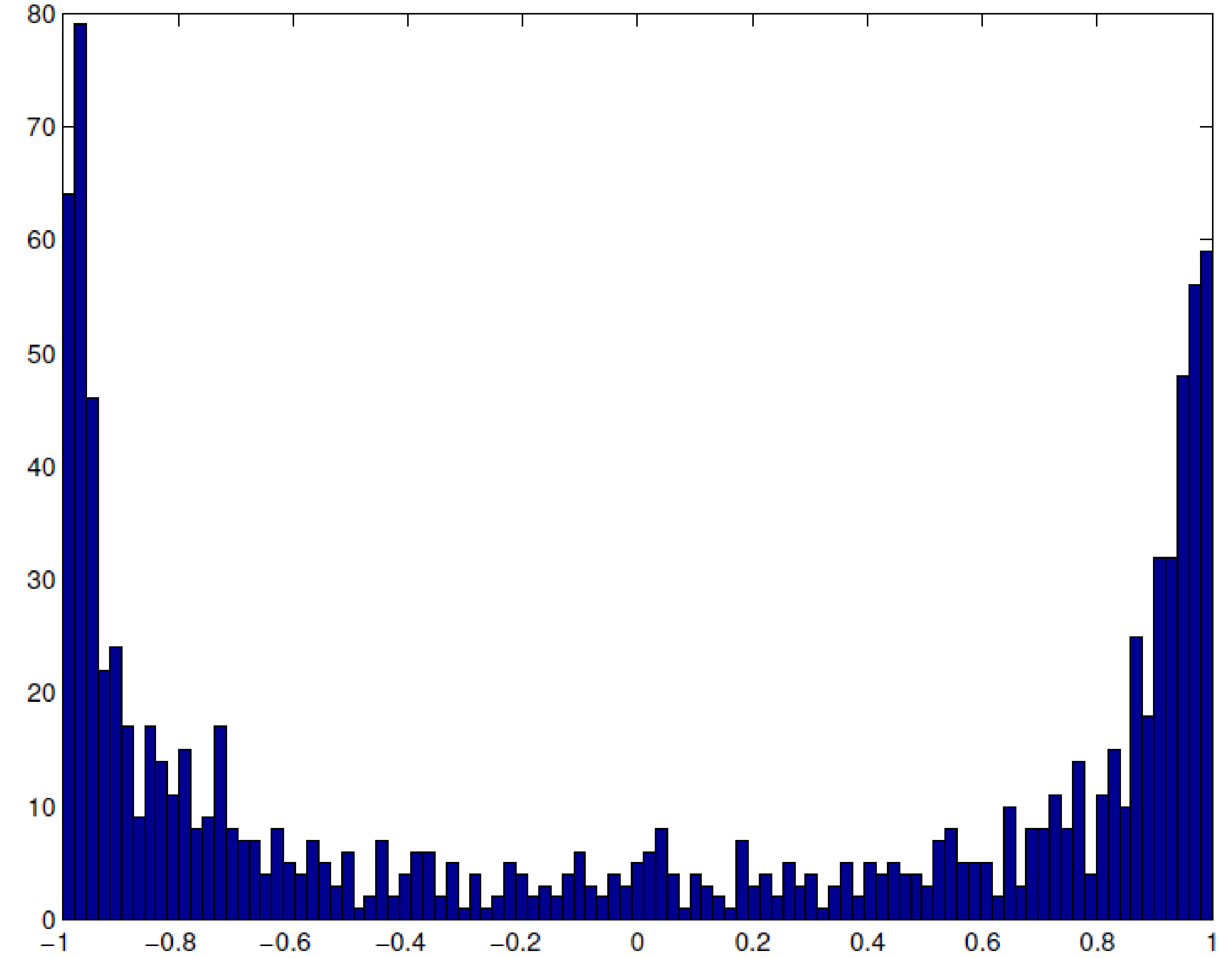


Figure F4: Correlations of the Portfolios to the Smallest Eigenvector. $t/n = 1.05$ and $\delta = 0.94$.

3. Crowded Spaces and Copycat Risk Management

B. A Simple Demonstration

- In the limit, optimal portfolios converge to eigenvector of smallest eigenvalue.

- How does this particular portfolio behave?

3. Crowded Spaces and Copycat Risk Management

B. A Simple Demonstration – Most eigenvalues are random noise…

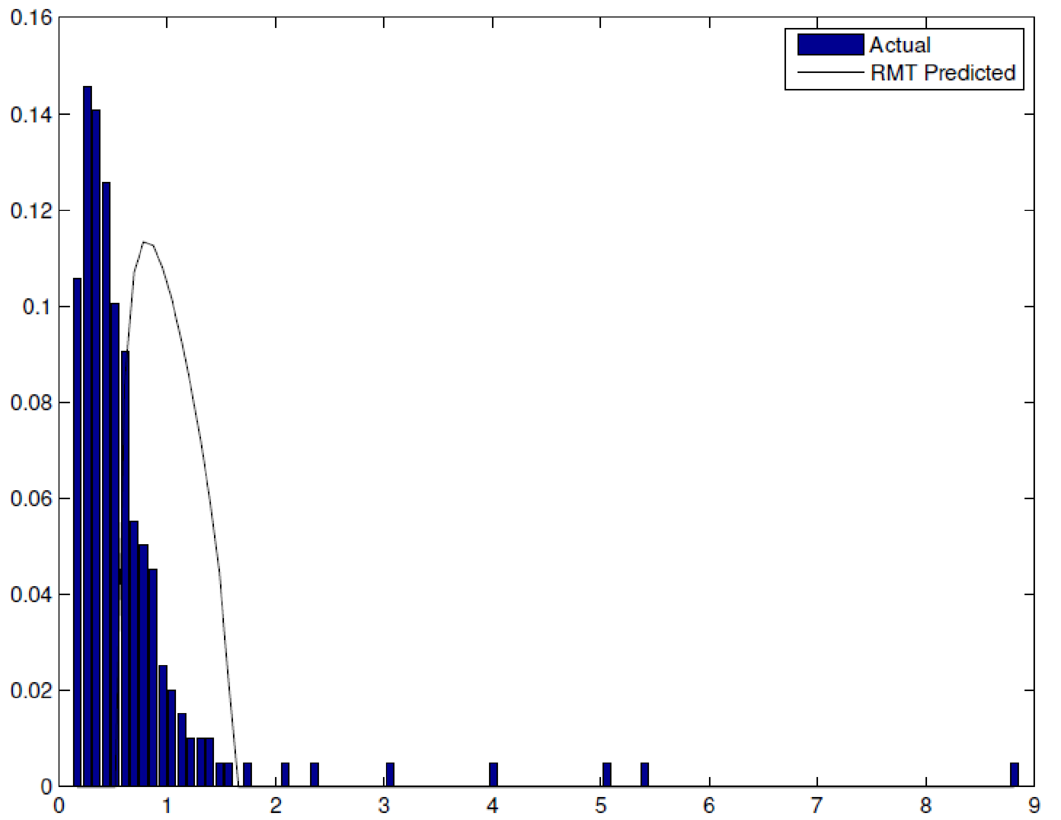


Figure F6: Close-Up of Eigenvalues from Simple Optimization Example and Marchenko-Pastur Distribution

3. Crowded Spaces and Copycat Risk Management

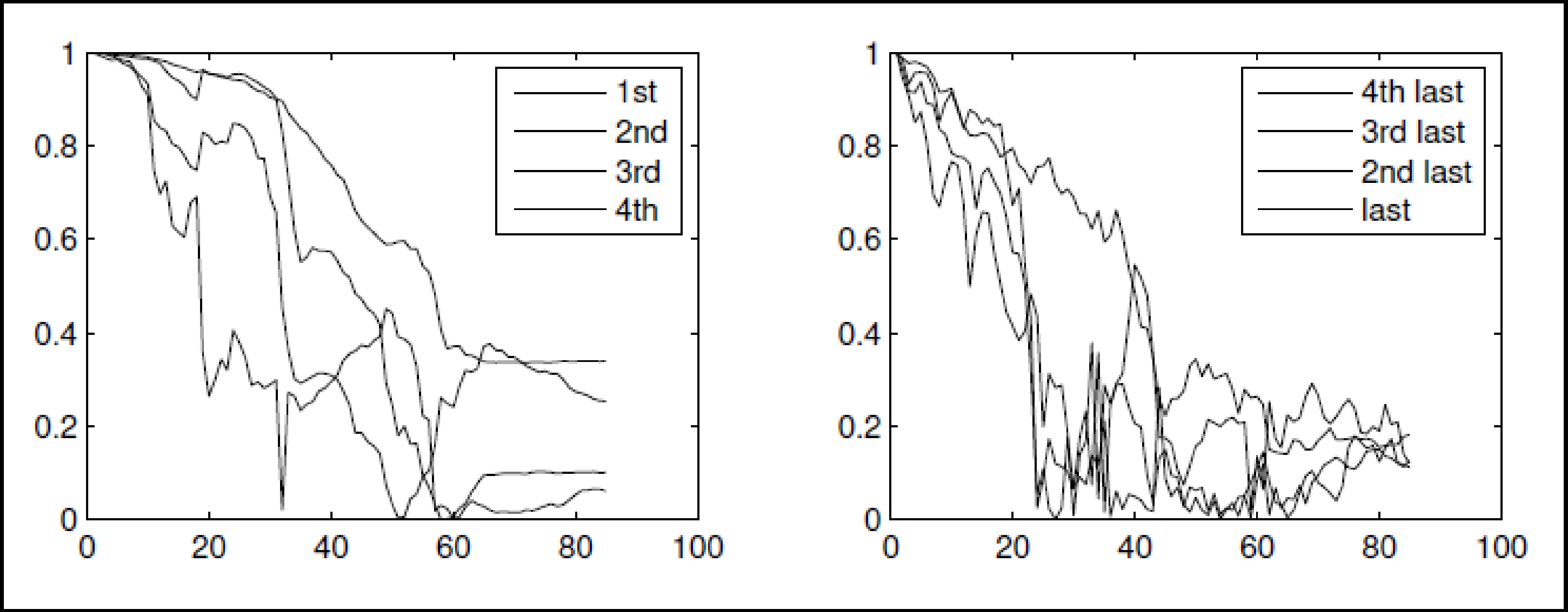
B. A Simple Demonstration

- This portfolio is indistinguishable from random noise.

- Conjecture 1 (Convergence to Noise): In the limit, not only do expected returns of managers not matter for portfolio formation, and not only does just a small slice of the covariance matrix govern the portfolio that all managers will converge to, but that small slice of the covariance matrix is governed by something that is indistinguishable from random.

3. Crowded Spaces and Copycat Risk Management

B. A Simple Demonstration – How are eigenvectors correlated over time?



3. Crowded Spaces and Copycat Risk Management

B. A Simple Demonstration

- As eigenvector indices increase, the correlation between present and past becomes weaker at a faster pace.

- Thus, higher index eigenvectors (small eigenvalues) have less significance in describing future returns as compared to those with lower index.

3. Crowded Spaces and Copycat Risk Management

B. A Simple Demonstration

- If we use different lookback periods and different decay factors (slightly different risk measurement methods), what happens to the eigenvectors of those different measurement techniques?

- The first eigenvectors and the last ones are highly correlated across different risk models.

3. Crowded Spaces and Copycat Risk Management

B. A Simple Demonstration

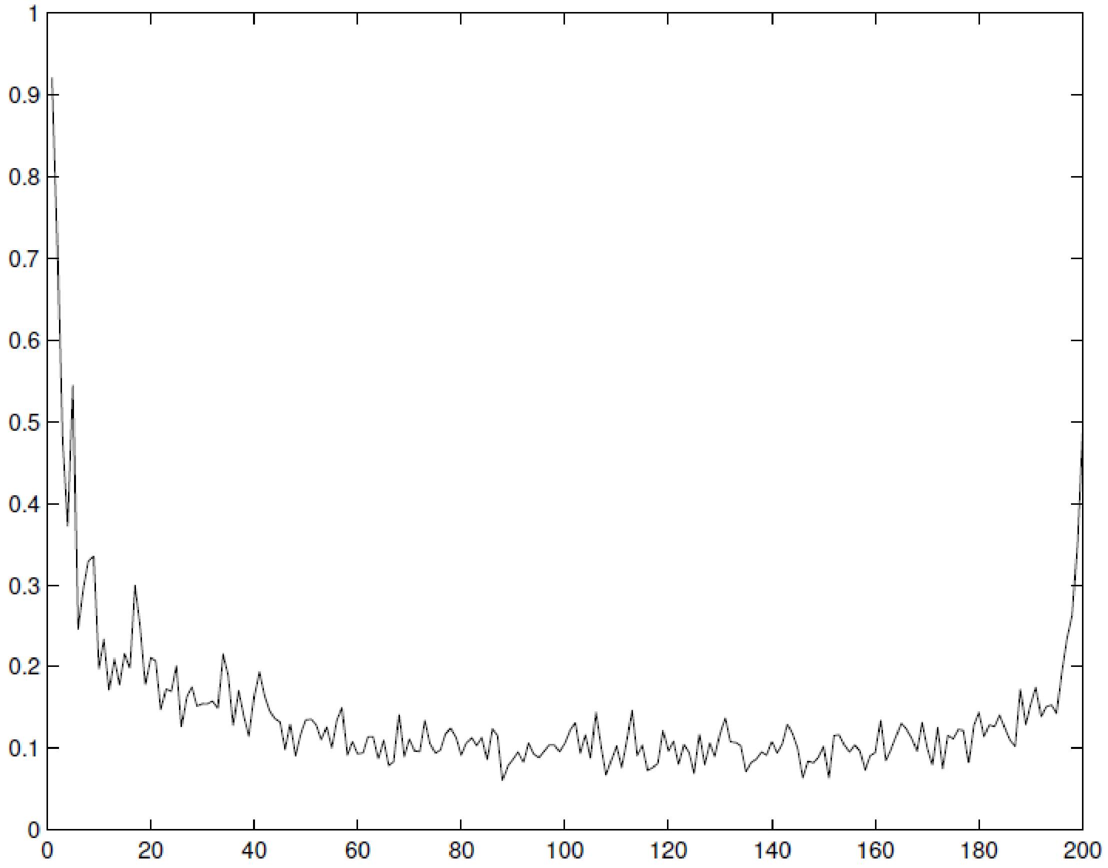


Figure F9: Average Absolute Correlation Evolution. The figure represents the average correlation across eigenvectors computed from difference variance-covariance matrices of returns based upon different decay values and different look-back periods. These were given by $T/N = [1.05\ 1.5\ 2\ 3\ 4\ 5\ 7.5\ 10]$ and $\delta = [1\ 0.995\ 0.99\ 0.94]$. For each of the 200 eigenvectors, the absolute value of the correlation of the eigenvector is computed and plotted.

3. Crowded Spaces and Copycat Risk Management

B. A Simple Demonstration

- Conjecture 2 (Simple Risk Variation and Crowding): Even if managers use different simple empirical covariance matrices, the risk model induced crowding problem seems unavoidable.

3. Crowded Spaces and Copycat Risk Management

C. A Reasonable Solution to the Basic Problem

- Many methods to filter covariance matrices.

- We suggest using the Marchenko-Pastur distribution to eliminate random eigenvectors (eigenvalues).

3. Crowded Spaces and Copycat Risk Management

D. Empirical Investigation of Problem: Data

- In order to examine whether risk-model induced crowding is an issue in the financial industry, we focus on the equity portfolio management world.

- We obtain risk model data from leading risk model providers – BARRA, Northfield, and Axioma.

- We also obtain fundamental and stock return data from Factset.

- Data from 1992 to 2013, but we present results only for 2006-2013.

3. Crowded Spaces and Copycat Risk Management

D. Empirical Investigation of Problem: Alphas

- Random: We generate 100 random alphas for each stock in 3000 stock universe every month. For each stock:

$$\alpha \sim N(0, \Sigma_\alpha)$$

- Non-Random: We use three realistic models of portfolio alpha based on stock fundamentals
  - Value and Momentum
  - PEG
  - Aggregate Z-Score with many factors

3. Crowded Spaces and Copycat Risk Management

D. Empirical Investigation of Problem: Methodology

- **Step 1**: Match stocks from all 3 professional risk models.
- **Step 2**: Every month, create 100 random alphas or 3 non-random.
- **Step 3**: Construct portfolio optimization (a) Long Only; (b) Market Neutral w/o Liquidity; (c) Market Neutral w/ Liquidity. Constraints: Sectors, Beta, Max/Min weights, Dollar Neutral, Leverage=2.
- **Step 4**: Do this for all risk models and all portfolio construction techniques. *Includes OGARCH risk models*
- **Step 5**: Compare the resulting portfolios for crowding.

3. Crowded Spaces and Copycat Risk Management

D. Empirical Investigation of Problem: Measures of Crowding

1. Cosine Similarity amongst portfolios.

$$s_{ij} = \frac{\mathbf{w}_i' \mathbf{w}_j}{|\mathbf{w}_i||\mathbf{w}_j|}$$

$$S = \left(H'H\right) \circ \hat{\hat{H}}$$

2. Crowding

$$C = \frac{\sum_{i=1}^{m} \sum_{j=1}^{m} S_{p:i,j} - m}{m^2 - m}$$

3. Imposed Correlation Bias

$$\Omega = \frac{\sum_{i=1}^{m} \sum_{j=1}^{m} S_{p:i,j} - m}{\sum_{i=1}^{m} \sum_{j=1}^{m} S_{\alpha:i,j} - m}$$

3. Crowded Spaces and Copycat Risk Management

D. Empirical Investigation of Problem: Measures of Crowding

4. Correlation Adjusted Crowding

$$C^* = \frac{\sum_{i=1}^{m}\sum_{j=1}^{m} S^*_{p:i,j} - m}{m^2 - m}$$

5. Concentration Index

$$CI = \frac{H - 1/N}{1 - 1/N}, \text{ where } H = \sum_{i=1}^{N} w_i^2,$$

3. Crowded Spaces and Copycat Risk Management

E. Empirical Results

Summary:

1. Crowding occurs from the use of standard risk models in the industry – even when crowding is absent in alpha models.
2. Crowding seems to be more severe for long-only equity managers.
3. The OGARCH procedure we suggest reduces crowding amongst portfolio managers.
4. Crowding would be less in a financial system where there is a diversification of risk model usage.

3. Crowded Spaces and Copycat Risk Management

E. Empirical Results

Table E1: Summary of Crowding of Random Alpha Models: Minimize Volatility from 2006 to 2009

	Risk Model 1						Risk Model 2						Risk Model 3					
	C	C^*	Ω	Ω^*	S.R.	C.I.	C	C^*	Ω	Ω^*	S.R.	C.I.	C	C^*	Ω	Ω^*	S.R.	C.I.
Alpha	0.00	-0.0003				0.00												
Long Only																		
Regular	0.85	0.9999	1251.17	-2.84	0.01	0.01	0.86	0.9999	1140.19	-176.13	-0.00	0.01	0.86	0.9999	1250.08	-329.81	0.00	0.01
OGARCH	0.73	0.9996	1123.99	-2.81	0.01	0.03	0.73	0.9994	872.10	-175.72	-0.00	0.03	0.72	0.9992	976.13	-329.53	0.00	0.03
Market Neutral																		
Regular	0.00	-0.0011	1.65	0.03	-0.02	0.00	0.00	0.0016	1.76	0.36	-0.01	0.00	0.00	0.0005	1.10	-1.31	-0.00	0.00
OGARCH	0.00	-0.0013	1.24	0.45	-0.02	0.00	0.00	0.0007	1.23	-0.14	0.03	0.00	0.00	-0.0004	1.05	-2.07	0.01	0.00
Market Neutral Liq																		
Regular	0.00	-0.0006	2.02	-0.35	-0.02	0.00	0.00	0.0030	4.23	-0.61	0.03	0.00	0.00	0.0015	1.20	-0.73	-0.00	0.00
OGARCH	0.00	-0.0003	0.78	0.16	-0.01	0.00	0.00	-0.0001	0.73	0.33	0.03	0.00	0.00	-0.0002	0.84	1.84	0.01	0.00

3. Crowded Spaces and Copycat Risk Management

E. Empirical Results

Table E2: Summary of Crowding of Random Alpha Models: Minimize Volatility from 2010 to 2013

	Risk Model 1						Risk Model 2						Risk Model 3					
	C	C^*	Ω	Ω^*	S.R.	C.I.	C	C^*	Ω	Ω^*	S.R.	C.I.	C	C^*	Ω	Ω^*	S.R.	C.I.
Alpha	-0.00	0.0002				0.00												
Long Only																		
Regular	0.71	0.9999	1101.07	-49.26	0.01	0.02	0.71	0.9999	617.27	-63.07	0.01	0.02	0.70	0.9999	689.01	-154.31	0.01	0.02
OGARCH	0.57	0.9997	822.54	-49.26	0.01	0.03	0.57	0.9996	711.50	-63.08	0.01	0.03	0.56	0.9996	607.04	-153.62	0.01	0.03
Market Neutral																		
Regular	-0.00	0.0004	-0.80	0.18	-0.01	0.00	-0.00	-0.0011	3.80	0.19	-0.01	0.00	-0.00	0.0016	5.50	0.71	-0.01	0.00
OGARCH	0.00	-0.0005	1.82	-0.42	-0.01	0.00	0.00	-0.0007	-1.18	0.06	-0.00	0.00	0.00	0.0001	0.34	0.03	-0.00	0.00
Market Neutral Liq.																		
Regular	-0.00	0.0007	1.61	-0.12	-0.00	0.00	-0.00	-0.0008	5.04	0.59	-0.00	0.00	-0.00	0.0018	1.50	-4.32	-0.00	0.00
OGARCH	-0.00	0.0005	1.49	0.21	-0.01	0.00	0.00	-0.0004	-0.51	1.14	-0.00	0.00	0.00	0.0015	-0.30	-3.67	-0.01	0.00

3. Crowded Spaces and Copycat Risk Management

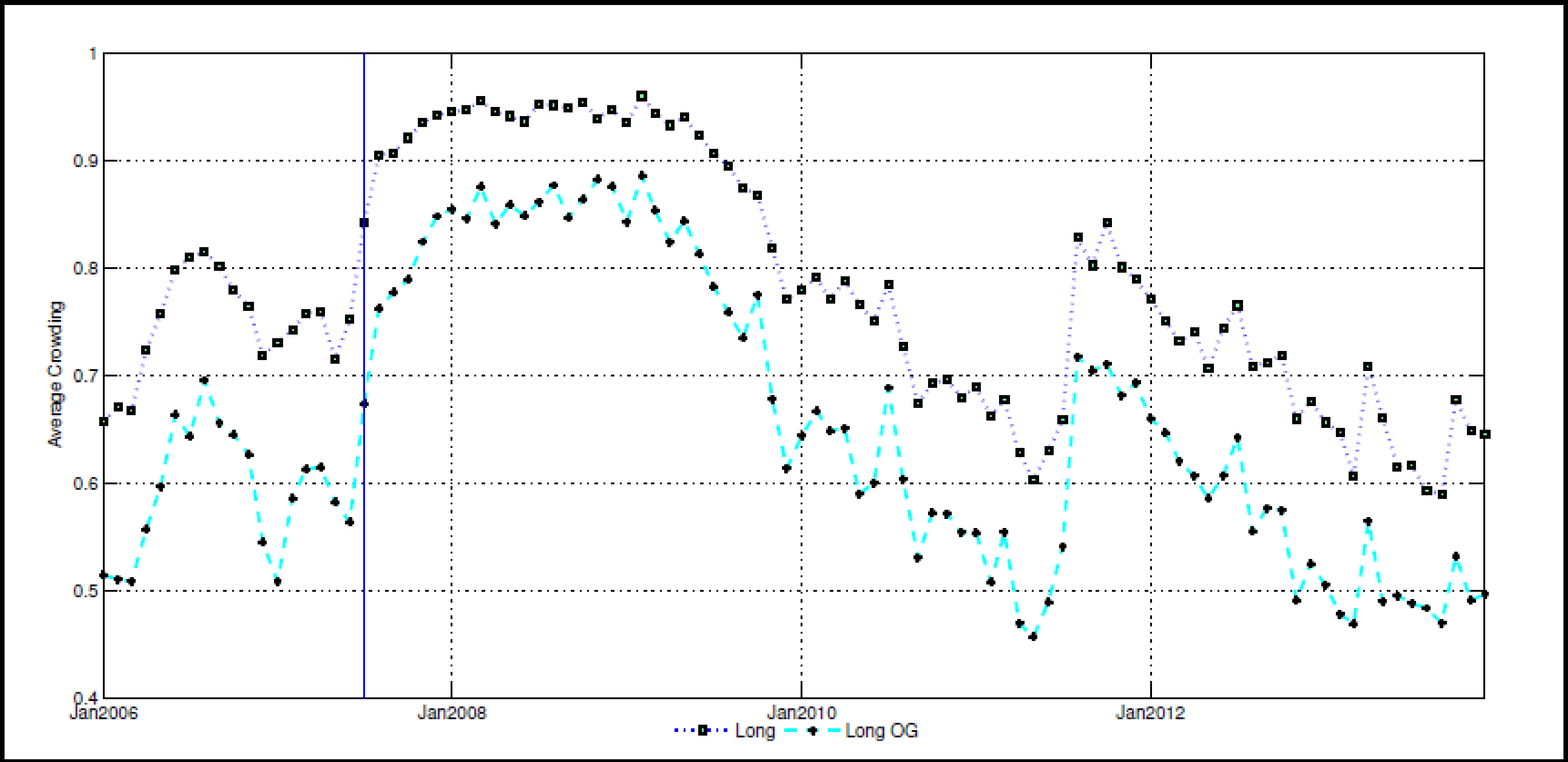
E. Empirical Results

Table E3: Summary of Crowding with Realistic Alpha Models: Minimize Volatility from 2006 to 2009

	Risk Model 1						Risk Model 2						Risk Model 3					
	C	C^*	Ω	Ω^*	S.R.	C.I.	C	C^*	Ω	Ω^*	S.R.	C.I.	C	C^*	Ω	Ω^*	S.R.	C.I.
Alpha	0.21	0.5373				0.00												
Long Only																		
Regular	0.15	0.9949	0.73	0.28	0.00	0.02	0.15	0.9954	0.68	-0.05	0.00	0.02	0.18	0.9958	0.84	-0.26	0.00	0.02
OGARCH	0.12	0.9941	0.58	0.28	0.00	0.03	0.12	0.9942	0.56	-0.05	-0.00	0.03	0.14	0.9932	0.68	-0.26	0.00	0.03
Market Neutral																		
Regular	0.18	0.2845	0.84	-0.20	-0.02	0.00	0.17	0.2686	0.79	-0.60	0.03	0.00	0.12	0.0780	0.57	-0.17	-0.01	0.00
OGARCH	0.07	0.0679	0.34	0.20	-0.09	0.03	0.06	0.0869	0.30	-0.02	0.10	0.04	0.06	-0.0055	0.27	0.31	0.11	0.04
Market Neutral Liq.																		
Regular	0.16	0.3355	0.79	-0.20	-0.01	0.00	0.15	0.1254	0.70	-0.73	-0.01	0.00	0.11	0.0738	0.55	-0.05	-0.01	0.00
OGARCH	0.11	0.1588	0.50	-0.12	0.00	0.02	0.09	0.3265	0.45	-0.02	0.03	0.02	0.07	-0.0447	0.32	0.02	0.02	0.02

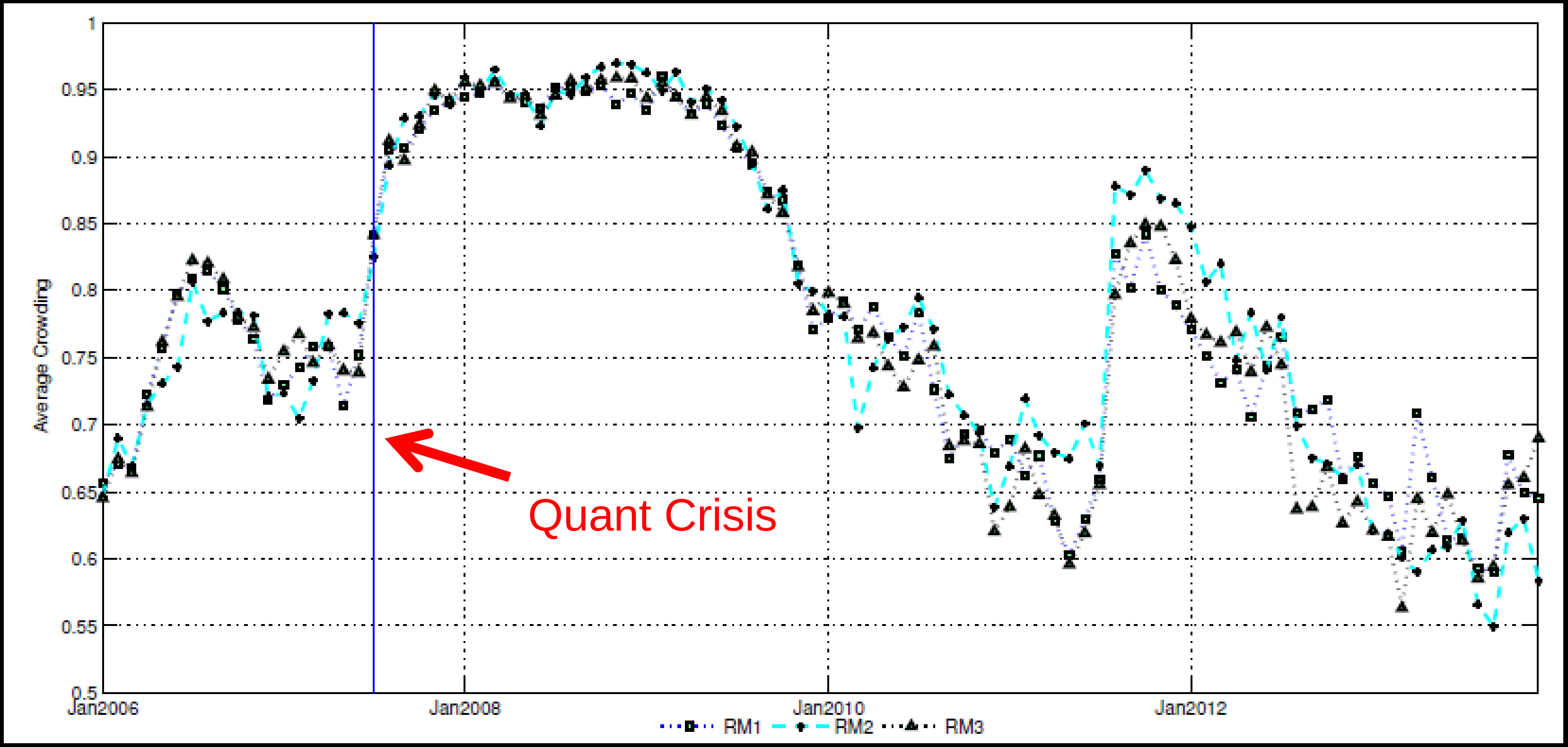
3. Crowded Spaces and Copycat Risk Management

E. Empirical Results



3. Crowded Spaces and Copycat Risk Management

E. Empirical Results



3. Crowded Spaces and Copycat Risk Management

E. Empirical Results

- Risk models all seem to have similar amounts of crowding.
- Does it make any difference whether the universe uses one risk model versus another?

3. Crowded Spaces and Copycat Risk Management

E. Empirical Results

Table E5: Systemic Crowding Risk from Distribution of Risk Model Usage

Percentage of Models Used	Long Only						Market Neutral					
	C	C^*	Ω	Ω^*	S.R.	C.I.	C	C^*	Ω	Ω^*	S.R.	C.I.
100 - 0 - 0	**0.85**	0.9999	1251.17	-2.84	0.01	0.01	0.00	-0.0011	1.65	0.03	-0.02	0.00
0 - 100 - 0	**0.86**	0.9999	1140.19	-176.13	-0.00	0.01	0.00	0.0016	1.76	0.36	-0.01	0.00
0 - 0 - 100	**0.86**	0.9999	1250.08	-329.81	0.00	0.01	0.00	0.0005	1.10	-1.31	-0.00	0.00
80 - 20 - 0	0.65	0.9977	869.71	-2.55	0.01	0.01	0.00	-0.0008	2.96	0.29	-0.02	0.00
80 - 0 - 20	0.76	0.9983	1176.42	-2.64	0.01	0.01	0.00	-0.0012	1.38	0.05	-0.02	0.00
20 - 80 - 0	0.65	0.9977	799.36	-2.55	0.00	0.01	0.00	-0.0001	2.37	0.09	-0.02	0.00
0 - 80 - 20	0.66	0.9980	788.17	-2.56	0.00	0.01	0.00	-0.0016	2.33	-0.72	-0.02	0.00
20 - 0 - 80	0.76	0.9983	1181.01	-2.64	0.01	0.01	0.00	-0.0006	1.29	-0.42	-0.02	0.00
0 - 20 - 80	0.66	0.9980	859.13	-2.56	0.00	0.01	0.00	-0.0006	2.29	-0.44	-0.02	0.00
45 - 45 - 10	0.52	0.9961	623.48	-2.41	0.00	0.01	0.00	0.0001	3.02	-0.53	-0.02	0.00
10 - 45 - 45	0.52	0.9964	620.27	-2.41	0.00	0.01	0.00	-0.0006	3.03	-0.47	-0.02	0.00
45 - 10 - 45	0.63	0.9992	939.13	-176.01	0.00	0.01	0.00	0.0006	2.28	0.43	-0.01	0.00
60 - 40 - 0	0.55	0.9983	672.34	-175.83	0.00	0.01	0.00	0.0012	3.54	0.40	-0.01	0.00
60 - 20 - 20	0.58	0.9988	802.99	-175.93	0.00	0.01	0.00	0.0026	3.05	0.52	-0.00	0.00
40 - 60 - 0	0.55	0.9983	644.00	-175.83	0.00	0.01	0.00	0.0017	2.74	-0.05	-0.00	0.00
0 - 60 - 40	0.56	0.9988	633.06	-175.88	0.00	0.01	0.00	0.0015	3.00	0.85	0.01	0.00
40 - 0 - 60	0.72	0.9997	1152.52	-176.11	0.00	0.01	0.00	0.0010	1.79	0.60	-0.00	0.00
0 - 40 - 60	0.56	0.9988	660.20	-175.88	0.00	0.01	0.00	0.0011	2.73	0.44	-0.01	0.00
33 - 67 - 0	0.58	0.9984	673.88	-175.85	-0.00	0.01	0.00	0.0010	2.31	-0.08	-0.00	0.00
67 - 0 - 33	0.58	0.9981	710.80	-328.02	0.00	0.01	0.00	-0.0005	3.12	0.77	-0.01	0.00
0 - 67 - 33	0.58	0.9977	661.92	-327.87	0.00	0.01	0.00	-0.0017	3.02	-1.30	-0.00	0.00
33 - 33 - 34	**0.51**	0.9974	681.27	-327.58	0.00	0.01	0.00	-0.0009	1.92	0.10	-0.01	0.00
10 - 90 - 0	0.74	0.9992	961.72	-329.03	0.00	0.01	0.00	-0.0018	1.77	-0.14	-0.01	0.00
10 - 0 - 90	0.80	0.9996	1200.84	-329.39	0.00	0.01	0.00	0.0005	0.78	-0.91	0.00	0.00
90 - 10 - 0	0.74	0.9992	1028.33	-328.99	0.01	0.01	0.00	-0.0005	2.35	1.37	-0.01	0.00
0 - 10 - 90	0.75	0.9990	1029.26	-328.93	0.00	0.01	0.00	-0.0001	1.67	-0.99	-0.00	0.00
90 - 0 - 10	0.74	0.9992	1032.74	-328.99	0.01	0.01	0.00	-0.0005	2.37	1.40	-0.01	0.00

3. Crowded Spaces and Copycat Risk Management

E. Empirical Results

- Conjecture 3 (Distribution of Risk Models and Systemic Risk): Crowding in the financial system will be less when there is a diversification of risk models used in the system.

4. Conclusion/Discussion

A. Crowding is a real and important phenomena that needs to be studied more.

B. Crowding is typically thought of to be generated from similar alpha models (Chincarini (2012)).

C. Crowding can also occur due to the risk model process itself.

D. Our research shows that crowding does occur from risk models.

E. Some suggestions from our research: (a) Use an OGARCH implementation to reduce crowding; (b) The financial system might have less crowding when there is a diversification of risk models.

4. Conclusion/Discussion

F. Further work Chincarini, Ludwig B. “Transaction Costs and Crowding”. Very interesting results and paper should be available soon. Please give me card.

Thank you

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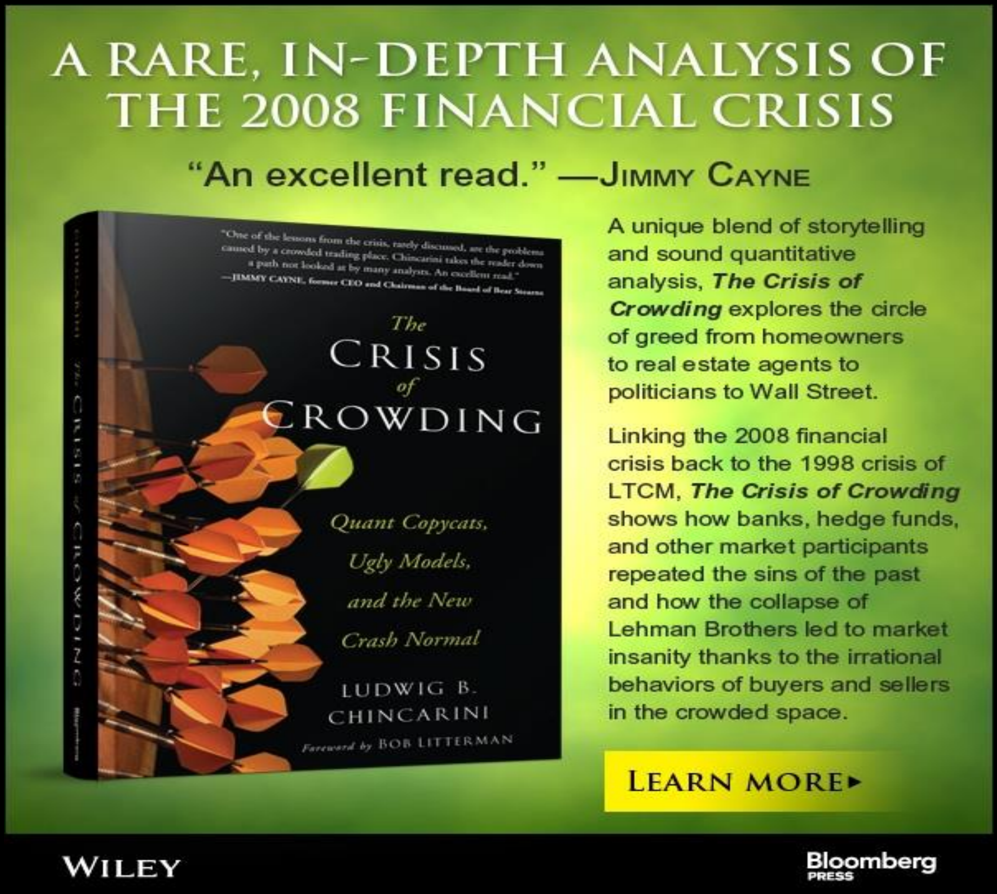

Open Discussion

- 1. How does risk parity play into this – might there be crowding?
- 2. How would these numbers change if the portfolio construction was just n=200 or n=300? Maybe market neutral would then start to get more crowding.
- 3. How is crowding related to Figure F7 in your paper? The declining eigenvalues?
- 4. Should we just stop using risk models?
- 5. What are the downsides of applying the OGARCH adjustment?
- 6. What is the correlation of eigenvectors of different risk models?
- 7. Some of the eigenvalues might just be switching index numbers slightly? Perhaps could look at deciles of indexed eigenvectors.
- 8. How does behavioral play into this crowding? Would it exaggerate the effects of risk model?