Institutional Crowding and Momentum Tail Risk

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Background

Theory: Arbitrage without coordination

$\Rightarrow$ Random & occasionally severe crowding
(especially with feedback effects)

$\Rightarrow$ bubbles and crashes

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$\Rightarrow$ Random & occasionally severe crowding
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$\Rightarrow$ bubbles and crashes

- Abreu and Brunnermeier [2003]
  Arbitrageurs may ride a bubble (destabilize) rather than trade against it (stabilize) if they cannot coordinate its popping.

- Stein [2009]
  Unanticipated competition in an unanchored can do more harm than good (decreased pricing efficiency).

- Both settings fit a momentum investment strategy well.

Background

Implication: Many authors have conjectured that crowding could explain momentum crashes*

- Piazzesi and Schneider [2009], Chabot et al. [2014], Barroso and Santa-Clara [2015], Lou and Polk [2013], Huang [2015].

*Momentum is known to be a crash-prone strategy,
see e.g. Daniel and Moskowitz [2016].

Our analysis

Theory: Careful treatment of equilibrium crowding effects

- Stein [2009] restricts the momentum strategy space to linear (myopic) beliefs; predicts feedback effects / destabilization;
- We use rational beliefs (fixed point in price) and get a very different conclusion:
  - nonlinear demands,
  - no predicted feedback effects or destabilization.

Empirical:

- Previous studies use returns-based approaches to infer crowding.
- We use institutional holdings to form direct proxies. If anything, crowding inversely relates to momentum toxicity.

Our theoretical setting

Initial conditions

- Homogeneous information; everybody holds the market.
- Three investor types: informed; momentum, and counterparty. All are risk averse and capital constrained.
- Three stock types: winner; loser; or neutral.

Two periods

- Portfolio formation period
  - Informed investors observe noisy signal of all stocks' type.
  - Market clears in a call auction.
- Evaluation period
  - Stock values are realized.
  - Information and holdings revert to a homogeneous state.

Setting

- **Informed investors**
  - Observe private signal of dividends for winners (δ/2) and losers (-δ/2).
  - Realized dividends add a noise component, ϵ;
    $\Rightarrow$ Informed leave some expected value on the table.

- **Momentum investors**
  - No private signals, but form $E_M(\delta|f)$ conditioning on f, the formation-period return differential, winners minus losers;
    $\Rightarrow$ Pick up some of the value informed investors leave behind.

Setting

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We refer to

- δ as the "fundamental value" and
  f as the "price" of the momentum portfolio.
- m $= \delta - f$ is the momentum return (disregarding ϵ)

key variables

Setting

- Third investor type: **Counterparty investors**
  - Myopic beliefs: trade against deviation from historical value.
  - Essentially noise traders who facilitate market clearing.

Preferences and the investment opportunity set

- CRRA
  - Risk capacity proportional to wealth.
  - Essentially treat every dollar equally to give content to crowding.

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- CRRA
  - Risk capacity proportional to wealth.
  - Essentially treat every dollar equally to give content to crowding.
- Three assets:
  - Market portfolio
  - Momentum portfolio $\longleftarrow$ *what we care about*
  - A risk-free investment.

Demands

- Investor i's demand for the momentum portfolio is

$$\frac{E_{type(i)}\left[m+\epsilon\right]}{\gamma Var_{type(i)}\left[m+\epsilon\right]}K_i.$$

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$$\frac{E_{type(i)}\left[m+\epsilon\right]}{\gamma Var_{type(i)}\left[m+\epsilon\right]}K_i.$$

- Beliefs of the three investor types:

$$\begin{aligned} E_I\left[m|\delta,f\right] &= \delta - f, & Var_I\left[m|\delta,f\right] &= \sigma_\epsilon^2; \\ E_M\left[m|f\right] &= \delta^E - f, & Var_M\left[m|f\right] &= \delta^V + \sigma_\epsilon^2; \\ E_C\left[m|f\right] &= -f, & Var_C\left[m|f\right] &= \sigma_\delta^2 + \sigma_\epsilon^2. \end{aligned}$$

- Solve for Momentum investors' beliefs.

(δ^E & δ^V: shorthand for momentum expectation and variance)

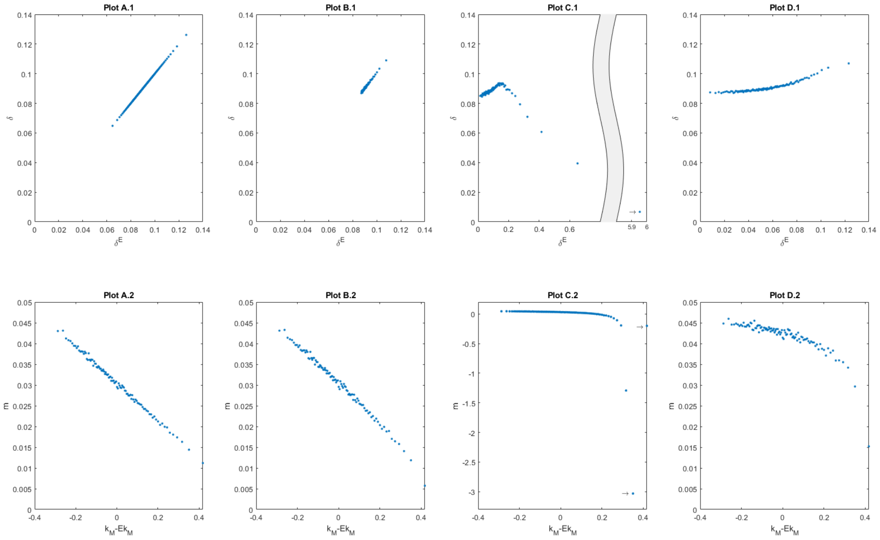
Market clearing

We consider 4 cases for momentum investors' beliefs.

- **Known capital** (yields linear beliefs)
- **Rational beliefs**:
  Conjecture a relation between f and d that generates demands that cause f to relate to d as conjectured.
- **Myopic beliefs**:
  Unknown capital, but that uncertainty is ignored
  (follow a linear strategy, as above)
- **Optimal linear**:
  Grid search over linear slopes to maximize the average utility in 100,000 simulations.

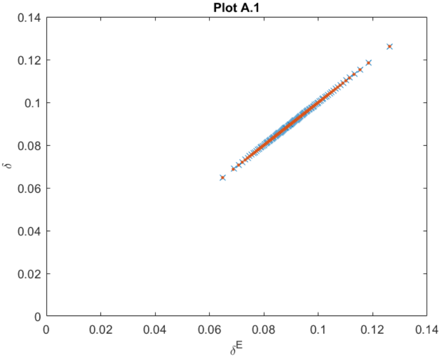
Plot actual δ vs. beliefs... 100,000 simulations

Known capital | Rational beliefs | Myopic beliefs | Optimal linear



Plot actual δ vs. beliefs... 100,000 simulations

Known capital



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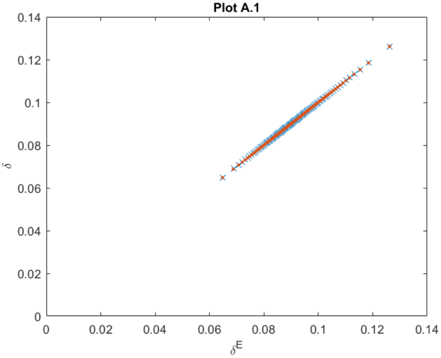

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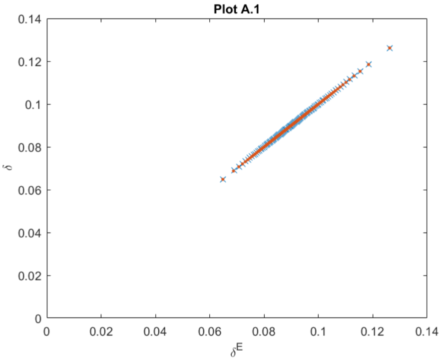
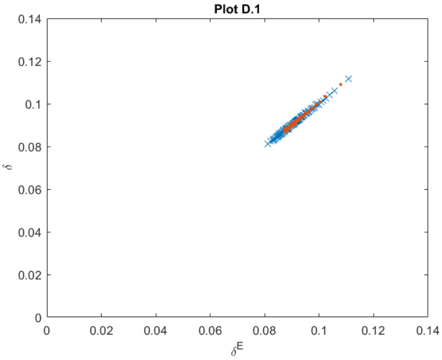
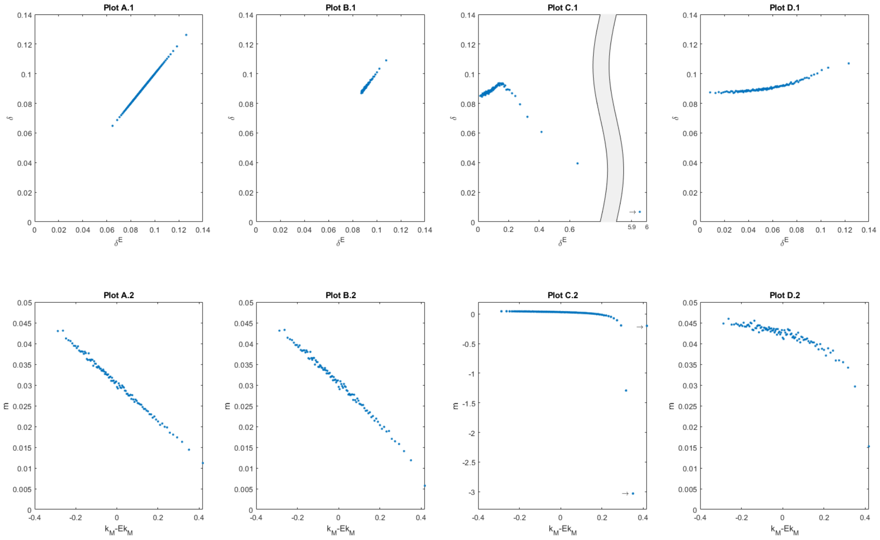


Rational beliefs



Plot actual δ vs. beliefs... 100,000 simulations

Known capital | Rational beliefs | Myopic beliefs | Optimal linear



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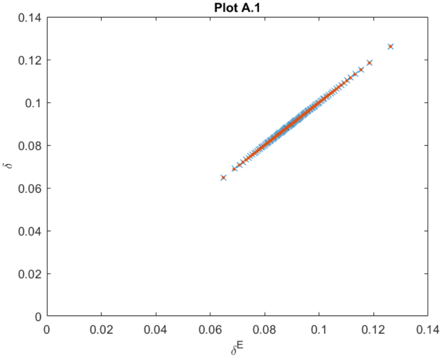
Known capital



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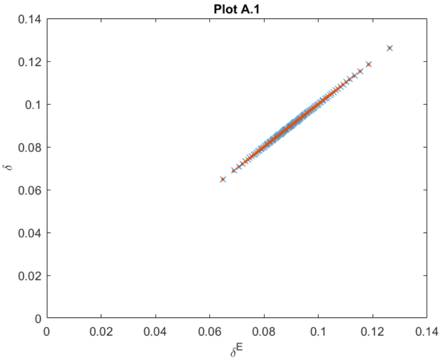
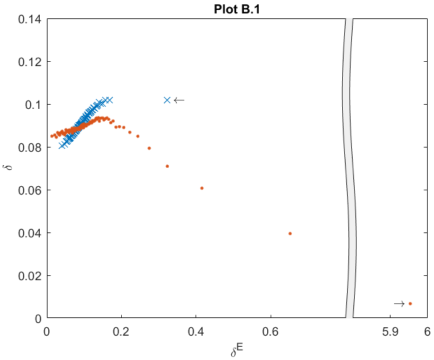


Myopic beliefs



Simulated momentum returns

Belief spec.	known	rational	myopic	optimal linear
λ^{-1}			1.50	1.12
Expected momentum returns m				
mean	3.0%	3.0%	-2.4%	4.2%
stdev	1.4%	1.6%	174.2%	2.0%
skew	0.6	0.4	-151.3	-0.3
kurt	3.1	3.0	29218.7	10.8
min	0.05%	-2.55%	-38957.17%	-53.10%
max	10.26%	11.53%	13.16%	13.28%
Realized momentum returns $m + \epsilon$				
mean profit	3.65%	3.44%	-4863.08%	0.65%
cer(2)	2.62%	2.53%	-100.00%	0.74%
cer(4)	1.30%	1.25%	-100.00%	0.37%
cer(10)	0.52%	0.50%	-100.00%	0.15%

Model conclusions

- There is a theoretical basis for crowding-induced momentum crashes...

  ...if and only if momentum investors hold myopic beliefs.

- Momentum returns negatively relate to realized crowd size.

Proxies for momentum investing from 13-F data

- Assess institution i's trading in quarters $q - 3$ through q for alignment with a momentum strategy
  - GTW: Correlation with prior quarter returns
  - BEK: Net trading in the now-standard 12-1 momentum portfolio
- If all 4 quarters align, i, q is a momentum investor (in qtr. q)
- Crowd measure:
  - Primary: #Institutions labeled a momentum investor
  - Cap: Their assets under management
- We also consider 1qrt measures requiring no consistency in strategy.

Transition probabilities: Momentum investors and stocks

Institutions' type					
	probabilities			likelihood	
	q+1	q+4	All q	q+1	q+4
GTW_1qtr	0.54	0.54	0.45	1.20	1.19
GTW_4qtr	0.71	0.34	0.10	7.05	3.32
BEK/BEKcap_1qtr	0.57	0.56	0.49	1.17	1.16
BEK/BEKcap_4qtr	0.71	0.31	0.12	5.99	2.62

Stock returns							
	q+1			q+4			All
	Win.	mid	Los.	Win.	mid	Los.	
Winner	0.56	0.42	0.02	0.16	0.60	0.23	0.13
mid	0.08	0.82	0.09	0.12	0.74	0.14	0.67
Loser	0.02	0.33	0.65	0.17	0.52	0.31	0.19

Presentation focuses on crowding measures constructed using four-quarter trading.

Crowding and momentum returns

- Three specifications of the crowding variables:
  - $\Delta \text{Crowd}_{\text{q}}$ is the change in the variable.
  - $\text{Crowd}_{\text{q-1}}$ is the level of variable.
  - $\hat{\sigma}_{\text{Crowd}}$ is the GARCH(1,1) volatility of residual crowding.
- We control for known predictors of momentum returns:
  - Dynamic betas [Grundy and Martin, 2001].
  - Momentum's volatility computed with daily returns in the previous quarter [Barroso and Santa-Clara, 2015, Daniel and Moskowitz, 2016].

Crowding and momentum returns

The dependent variable is the quarterly return of momentum.

Model:	cumulative returns			dynamic FF3		
Measure:	GTW	BEK	BEKcap	GTW	BEK	BEKcap
$\Delta \text{Crowd}_{\text{q}}$	-0.29	-0.41	-0.27	-0.33	-0.44	-0.22
	(-1.4)	(-2.1)	(-0.9)	(-1.8)	(-2.4)	(-0.6)
$\text{Crowd}_{\text{q-1}}$	-0.50	-0.15	0.28	-0.58	-0.12	0.33
	(-3.4)	(-1.1)	(1.0)	(-4.3)	(-1.3)	(1.6)
$\hat{\sigma}_{\text{Crowd}}$	4.61	1.83	0.14	6.61	1.60	-0.13
	(2.3)	(0.8)	(0.2)	(3.7)	(0.8)	(-0.2)
Realized vol.	-0.29	-0.34	-0.32	-0.25	-0.30	-0.27
of Mom rets.	(-1.6)	(-1.8)	(-1.7)	(-2.2)	(-2.5)	(-2.3)
Adj-rsquare	12.1%	10.1%	9.3%	37.7%	33.3%	32.3%

The controls for the dynamic FF3 are not tabulated.
T-statistics are calculated with White standard errors.

Predicting momentum crashes

The table contains the coefficients of probit models for the chance of a crash (10% left tail).

Dependent variable:	cumulative returns			dynamic FF3 residuals		
4qtr Crowding measure:	GTW	BEK	BEKcap	GTW	BEK	BEKcap
ΔCrowd_{q}	12.9	20.2	14.6	16.5	20.7	12.3
	(1.1)	(2.1)	(1.1)	(1.3)	(2.0)	(0.8)
[1ex] $\text{Crowd}_{q\text{-}1}$	16.1	10.9	-2.6	21.6	10.4	-4.5
	(2.0)	(2.0)	(-0.3)	(2.2)	(1.9)	(-0.5)
$\hat{\sigma}_{\text{Crowd}}$	57.1	48.2	5.7	-186.7	86.0	28.1
	(0.4)	(0.8)	(0.2)	(-1.3)	(1.4)	(1.2)
[1ex] Realized vol.	14.8	12.8	11.4	11.7	11.9	9.9
of Mom rets.	(3.9)	(4.1)	(3.8)	(3.8)	(3.8)	(3.3)

Predicting momentum crashes

The table contains the coefficients of probit models for the chance of a crash (10% left tail). Square brackets indicate Wald test for difference in tails [p-values].

Dependent variable:	cumulative returns			dynamic FF3 residuals		
4qtr Crowding measure:	GTW	BEK	BEKcap	GTW	BEK	BEKcap
ΔCrowd_q	12.9	20.2	14.6	16.5	20.7	12.3
	(1.1)	(2.1)	(1.1)	(1.3)	(2.0)	(0.8)
	[0.45]	[0.12]	[0.72]	[0.92]	[0.58]	[0.99]
[1ex] $\text{Crowd}_{q\text{-}1}$	16.1	10.9	-2.6	21.6	10.4	-4.5
	(2.0)	(2.0)	(-0.3)	(2.2)	(1.9)	(-0.5)
	[0.44]	[0.13]	[0.51]	[0.91]	[0.10]	[0.34]
$\hat{\sigma}_{\text{Crowd}}$	57.1	48.2	5.7	-186.7	86.0	28.1
	(0.4)	(0.8)	(0.2)	(-1.3)	(1.4)	(1.2)
	[0.28]	[0.17]	[0.56]	[0.90]	[0.07]	[0.71]
[1ex] Realized vol.	14.8	12.8	11.4	11.7	11.9	9.9
of Mom rets.	(3.9)	(4.1)	(3.8)	(3.8)	(3.8)	(3.3)
	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]

Higher moments of momentum returns: Tercile portfolios, sort on [column header], T1 low

	ΔCrowd			Crowd			Realized vol. of Mom rets.
	GTW	BEK	BEKcap	GTW	BEK	BEKcap	
Volatility							
T1	25.7	27.9	32.0	32.6	33.5	21.8	15.3
T2	26.3	27.0	18.5	26.5	19.3	26.3	17.3
T3	25.9	22.9	25.7	16.5	23.2	29.4	38.7
	(0.0)	(-1.0)	(-1.2)	(-3.5)	(-2.2)	(1.8)	(5.7)
Skewness							
T1	-1.8	-2.5	-1.2	-1.7	-2.0	-0.4	-0.3
T2	-1.2	-1.3	-0.5	-1.1	0.0	-2.4	-0.3
T3	-1.5	0.2	-2.1	-0.6	0.0	-1.2	-1.2
	(0.2)	(4.1)	(-0.8)	(1.8)	(3.3)	(-0.9)	(-2.0)
Kurtosis							
T1	15.4	15.4	8.5	10.5	10.5	4.7	4.0
T2	9.0	8.5	4.2	8.2	3.8	15.3	4.1
T3	10.5	5.4	14.1	4.7	5.6	9.7	6.5
	(-1.0)	(-3.6)	(1.2)	(-2.8)	(-2.4)	(1.7)	(2.1)

Crowding and momentum volatility

Dependent variable is realized volatility of quarterly momentum returns/residuals.

Dependent variable:	vol of returns			vol of dynamic FF3 residuals		
Crowding measure:	GTW	BEK	BEKcap	GTW	BEK	BEKcap
$\Delta Crowd_q$	-0.06	-0.16	-0.01	-0.05	-0.11	-0.10
	(-0.4)	(-0.9)	(-0.0)	(-0.5)	(-0.6)	(-0.4)
$Crowd_{q-1}$	-0.05	-0.10	0.02	-0.10	-0.09	0.00
	(-0.5)	(-1.8)	(0.2)	(-1.2)	(-2.0)	(0.0)
$\hat{\sigma}_{Crowd}$	-1.69	0.74	0.71	-0.75	0.51	0.56
	(-0.9)	(0.6)	(1.5)	(-0.6)	(0.6)	(1.9)
Realized vol.	0.77	0.77	0.76	0.74	0.74	0.73
of Mom rets.	(9.1)	(7.3)	(7.8)	(9.1)	(6.7)	(7.5)
Adj-rsquare	63.5%	63.4%	63.8%	59.5%	59.2%	59.8%

T-statistics are calculated with Newey-West standard errors with 3 lags.

Determinants of crowding

Dependent variables are 4qtr crowding measures.
Regress on past characteristics of momentum returns.

Crowding horizon:	4qtr		
Crowding measure:	GTW	BEK	BEKcap
1yr $\text{return}_{\text{q-1}}$	0.39	0.28	0.28
	(2.6)	(1.1)	(2.3)
1yr $\text{return}_{\text{q-5}}$	0.53	0.49	0.12
	(3.0)	(2.2)	(1.1)
1yr $\text{volatility}_{\text{q-1}}$	-0.38	-0.38	-0.03
	(-4.4)	(-2.9)	(-0.6)
1yr $\text{volatility}_{\text{q-5}}$	0.19	0.08	-0.09
	(2.4)	(0.6)	(-1.2)
Adj-rsquare	18.9%	16.3%	18.0%

T-statistics with Newey-West standard errors, 3 lags.

Empirical conclusions

- Crowding matters (first moment),
  - $\rightarrow$ though it seems best characterized with the count of momentum-trading institutions rather than dollars invested.
  - $\rightarrow$ this is consistent with trading intensity chosen to optimize against crowding effects.
- The crowd seems to react to *and anticipate* higher moments of momentum (volatility, skewness, kurtosis).
  - $\rightarrow$ Consistent with model's prediction: uncertain crowding need not generate tail risk...
  - $\rightarrow$ and empirically *does not* seem to generate tail risk.

Further analysis

Thank you very much for your attention.

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Direct versus indirect crowding measures

	Mom Gap	orthogonal to					
		ΔMom Inst	Win Inst	Crowd GTW	Crowd BEK	Crowd BEKcap	Realized vol. of Mom rets.
Volatility							
T1	12.8	12.2	13.5	12.7	13.2	13.3	21.0
T2	19.2	19.9	18.7	19.4	19.0	19.2	17.8
T3	38.6	38.5	38.6	38.6	38.6	38.4	35.6
	(6.4)	(6.7)	(6.2)	(6.6)	(6.4)	(6.4)	(3.2)
Skewness							
T1	-0.3	-0.4	-0.3	-0.3	-0.2	-0.5	-0.7
T2	0.0	0.0	0.0	-0.1	0.0	0.3	-0.2
T3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.5
	(-2.4)	(-2.2)	(-2.6)	(-2.5)	(-2.7)	(-2.0)	(-1.4)
Kurtosis							
T1	3.3	3.4	3.2	3.4	3.4	3.4	6.4
T2	3.8	3.7	4.2	3.8	3.9	4.8	4.8
T3	6.6	6.6	6.6	6.6	6.6	6.5	8.4
	(2.9)	(2.8)	(3.1)	(2.9)	(3.0)	(2.8)	(1.1)

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