Hedge Fund Contagion and Liquidity

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"If you have leverage, you're stuffed"

-- Alex Allen, CIO of Eddington Capital Management, Ltd., a London-based hedge fund manager

- Recently, a number of hedge funds have been forced to liquidate because their lenders raised borrowing rates with new claims for extra collateral

  - Hedge funds must sell assets to meet banks' margin calls

- Source: "Hedge Funds Reel From Margin Calls Even on Treasuries" (Bloomberg.com, March 10, 2008)

Financial contagion and hedge funds

- Contagion: Co-occurrence of extremely bad returns in two or more asset classes *over and above that predicted by normal correlations*

  - Do hedge funds in one style category perform extremely poorly when hedge funds in other styles or when broad markets perform extremely poorly?

  - Extremely poorly $\longrightarrow$ Performance is in bottom 10% of all returns ("negative tail" event)

Number of 10% negative tail events by month

Legend: Convertible Arbitrage, Distressed Securities, Event Driven, Equity Hedge, Equity Market Neutral, Merger Arbitrage, Global Macro, Relative Value

Who is affected by contagion?

- Investors: diversification benefits of hedge funds could be overstated

- Risk managers of hedge funds and their lenders: models that rely on historical correlations can fail dramatically

- Regulators: extremely poor performance could be pervasive across the hedge fund sector, endangering banks and investment banks

Main results

1. Little evidence of contagion between hedge funds and main markets, but strong evidence of contagion between hedge fund styles

2. Contagion is magnified when prime brokerage firms have poor performance and when asset market liquidity is low

3. Performance in the currency markets is worse when hedge fund contagion is high

Contagion literature review: general

- ## Currency crises

  - Eichengreen, Rose, and Wyplosz (1996)

- ## International contagion

  - Longin and Solnik (2001)

- ## Contagion after market crises

  - Forbes and Rigobon (2002)

- ## Contagion from Latin America

  - Bae, Karolyi, and Stulz (2003)

Contagion literature review: hedge funds (1)

- Theory

  - Funding and asset liquidity spirals

    - Brunnermeier and Pedersen (2008), Cifuentes, Ferruci, and Shin (2005)

  - Banks raise leverage during booms and reduce it during downturns

    - Adrian and Shin (2008)

- Empirical

  - Models include non-linear realizations of factors

  - Bank returns and other liquidity and credit risk factors can help explain contagion

    - Chan, Getmansky, Haas, and Lo (2005), Billio, Getmansky, and Pelizzon (2007), Khandani and Lo (2007)

Contagion literature review: hedge funds (2)

- ## Empirical
  - Dependencies among hedge funds increase in times of stress
    - Adrian and Brunnermeier (2008)
  - Some evidence of contagion between hedge funds in negative markets
    - Geman and Karoubi (2003) and Bacmann and Gawron (2004)
  - Hedge funds are not "tail-neutral"; i.e., they have greater exposure to the market when the market falls dramatically; this risk is not diversifiable
    - Brown and Spitzer (2006)

Why contagion and not correlation?

- Correlation is a linear measure that assumes dependence is the same for all returns

  - Hard to design statistical tests of changes in correlations

    - Baig and Goldfajn (2002), Forbes and Rigobon (2002)

  - Hedge funds pursue strategies with non-linear payoffs

    - Mitchell and Pulvino (2001), Agarwal and Naik (2004), Fung and Hsieh (2004)

- Contagion is a non-linear dependence at tails

  - We use logit regressions to test for contagion

Data

- Hedge funds: Indices from Hedge Fund Research (HFR)

  - Convertible Arbitrage, Distressed Securities, Equity Hedge, Equity Market Neutral, Event Driven, Macro, Merger Arbitrage, and Relative Value Arbitrage

  - January 1990 – August 2007: 212 observations

  - No size requirement; no track record requirement; 1600 funds

  - Constructed to reduce survivorship and backfilling biases

- Main markets: from Datastream

  - Russell 3000

  - Lehman Brothers bond index

  - Change in dollar-weighted exchange rate

Table I: Summary statistics monthly hedge fund data

	HFR Hedge Fund Indices								Main Markets		
	CA	DS	ED	EH	EMN	MA	GM	RV	Stock	Bond	Dollar
Mean	0.79%	1.18%	1.14%	1.31%	0.72%	0.83%	1.19%	0.94%	0.94%	0.58%	0.07%
Std. Deviation	1.00%	1.68%	1.83%	2.46%	0.88%	1.20%	2.31%	1.01%	4.01%	1.09%	1.81%
Correlations											
CA	1.00	0.55	0.57	0.45	0.22	0.46	0.40	0.60	0.30	0.18	-0.03
DS		1.00	0.79	0.59	0.20	0.52	0.47	0.68	0.44	0.03	-0.06
ED			1.00	0.78	0.24	0.73	0.56	0.64	0.69	0.06	-0.02
EH				1.00	0.38	0.50	0.60	0.54	0.72	0.07	0.04
EMN					1.00	0.25	0.28	0.28	0.16	0.19	0.04
MA						1.00	0.32	0.47	0.50	0.08	-0.02
GM							1.00	0.40	0.41	0.33	-0.02
RV								1.00	0.39	0.06	-0.06
Stock									1.00	0.12	0.06
Bond										1.00	0.21
Dollar											1.00

Standardizing returns

- Monthly hedge fund returns are autocorrelated

    - Consistent with Getmansky, Lo, and Makarov (2004)

- We use AR-GARCH models to control for autocorrelation and volatility clustering, and use residuals from these models in our analyses

    - See Embrechts, Frey, and McNeil (2005)

    - Ljung-Box tests indicate that our approach removes this autocorrelation

The regression approach

- Estimates the probability that a hedge fund index has a 10% tail event on a given date

  - Risk factors enter model linearly **and** as 10% tail event contagion indicator variables

  - Positive and significant coefficients on the contagion indicator variable imply contagion

$$Pr[\text{Extreme return}_t] = f \, (\text{Linear Risk Factors}_t \, , \text{Contagion Indicator Variable}_t)$$

Table II: Contagion from main markets and between hedge fund indices

- Dependent variable: (0,1) indicator variable set to 1 if the hedge fund index has 10% tail return at time t

- Explanatory variables include:
  - Main market returns (continuous and *indicator*)
  - Equally weighted return on other seven hedge fund indices
  - COUNT: an *indicator* variable for the number of other hedge fund indices (0-7) that have a 10% tail return at time t

Table II Selected Results

	Convertible Arbitrage	Distressed Securities	Event Driven	Equity Hedge	Equity Market Neutral	Merger Arbitrage	Global Macro	Relative Value
Contagion Indicator Vars.								
10% Tail Russell 3000	-0.456	-0.875	1.119*	-0.425	2.294***	-0.771	0.928	0.297
10% Tail LB Bond	-1.378	0.744	-1.286	-0.776	-0.235	0.040	-0.117	-0.708
10% Tail FRB Dollar	0.561	2.065***	-1.327*	0.916	-1.640*	-0.380	-0.830	-2.172**
COUNT (other HF indicator)	-0.005	0.886***	0.307*	0.307*	1.136***	0.439***	0.331*	0.115
R^2 Max	0.490	0.656	0.732	0.244	0.915	0.414	0.541	0.416

NOTE: Coefficients marked with *,**,*** are significant at the 10%, 5%, and 1% levels, respectively.

Table III: Adding additional controls to Table II

- Dependent variable: (0,1) indicator variable set to 1 if the hedge fund index has 10% tail return at time t

- Additional explanatory variables include:
  - Volatility on main markets (extracted from GARCH models)
  - Non-linear risk factors from Fung and Hsieh (2004)
  - 3-month t-bill return

Problem

- When using all the variables, we encounter the problem of quasi-separability

- To avoid this problem, we use a stepwise regression approach

- We keep including the explanatory variable with the largest impact until we cannot obtain a regression where all variables have a level of significance of at least 0.2

- We then add COUNT to the regression

Table III Selected Results

	Convertible Arbitrage	Distressed Securities	Event Driven	Equity Hedge	Equity Market Neutral	Merger Arbitrage	Global Macro	Relative Value
Selected Continuous Vars.								
FRB Dollar Index Volatility	.	.	.	0.230***	.	-0.215***	-0.163***	.
Size Spread	-0.288***	-0.176***	-0.275***	.	-0.337***	-0.251***	.	.
BAA-AAA Spread	.	.	.	.	.	.	1.004***	.
Lookback Straddle: Equities	.	.	-3.097***	.	.	.	.	.
Contagion Indicator Vars.								
10% Tail Russell 3000	.	.	.	.	.	-2.807***	.	.
10% Tail LB Bond	.	.	.	.	.	.	.	.
10% Tail FRB Dollar	.	1.867***	.	1.865***	.	.	.	.
COUNT (other HF indicator)	0.099	0.605***	0.293*	0.473***	0.822***	0.150	0.482***	0.020
R^2 Max	0.637	0.703	0.782	0.457	0.961	0.669	0.708	0.369

NOTE: Coefficients marked with *,**,*** are significant at the 10%, 5%, and 1% levels, respectively.

Economic significance of results

- For each style index, calculate the probability of an extreme return for different realizations of COUNT

  - Set all explanatory variables, except COUNT, to their mean values and evaluate the regression at all levels of the COUNT variable (0 to 7)

  - Average (median) probability that style index has 10% tail return increases from 2% for COUNT=0 to 21% for COUNT=7

Probability of contagion conditional on COUNT variable

Figure 3:
Probability of Contagion Conditional on the Count Variable
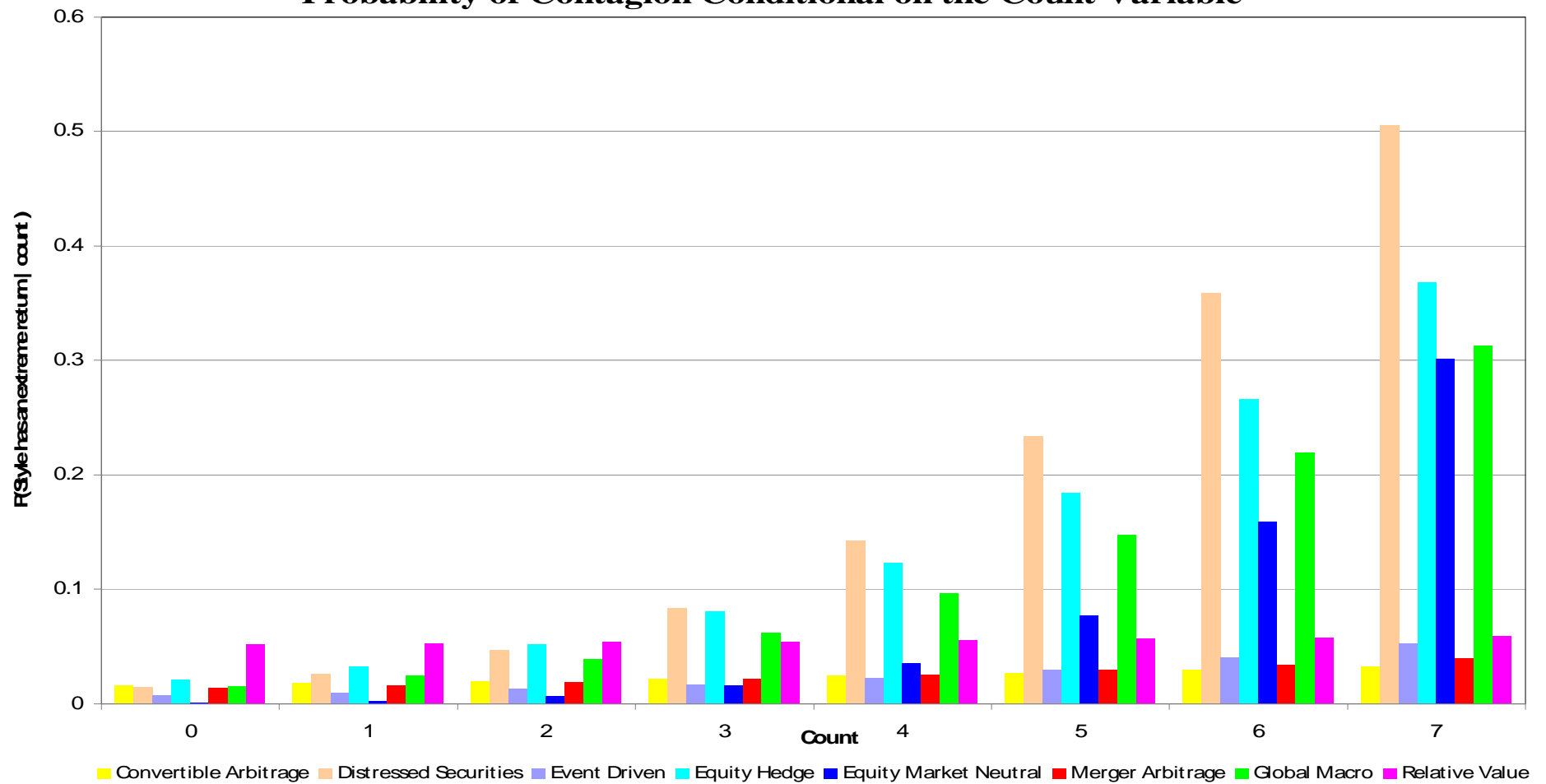
Determinants of contagion:
Funding liquidity and asset liquidity

- Funding liquidity: losses in one style of hedge funds reduces lending across the board

- Asset liquidity: levered funds reduce leverage and sell holdings, putting pressure on prices and reducing asset liquidity

- Reductions in funding and asset liquidity lead to trading liquidity and funding liquidity spirals, leading to poor returns across all hedge fund styles

    - Brunnermeier and Pedersen (2008)

Contagion Channel Proxies

- Funding Liquidity Proxies
  1. Prime Broker Index (PBI)
  2. Datastream Bank Index (BANK)
  3. Changes in BAA-AAA Credit Spread (CRSPRD)
  4. Changes in Repo Volume (REPO)

- Asset Liquidity Proxies
  1. Amihud's Illiquidity Measure (STKLIQ)
  2. Flows from other hedge funds (FLOW)

Univariate Tests

- Create six quartile indicator variables representing reduced liquidity for each channel

- Create COUNT8 variable which takes a value of 0-8 representing the number of hedge funds that have a 10% tail return on a given date

Difference in means=$[\text{Mean(COUNT8)}|_{\text{Channel}=1} - \text{Mean(COUNT8}|_{\text{Channel}=0}]$

Table V: Selected Univariate Results

Indicator Variable = Bottom Decile Return for Prime Broker Index (PBI)		
	Number	Mean of *COUNT8*
PBI = 0	189	0.59
PBI = 1	21	2.71
Difference in *COUNT8* Means: (PBI=1 less PBI=0)		2.11***
t-test for difference in means		(4.23)

Indicator Variable = Decile with Largest Amihud Illiquidity Measure (STKLIQ)		
	Number	Mean of *COUNT8*
STKLIQ = 0	189	0.86
STKLIQ = 1	21	3.14
Difference in *COUNT8* Means: (STKLIQ=1 less STKLIQ=0)		2.28***
t-test for difference in means		(2.60)

More Univariate Results

- Additional joint test: When PBI is in bottom DECILE *AND* STKLIQ is in top DECILE, COUNT8 variable has a mean of 4.33 and 0.70 otherwise, significant at the 1% level

- Across the board, results are even stronger when using deciles versus quartiles

Contagion channels: Multivariate tests (Table VI)

- Poisson regression
- Dependent variable is COUNT8

$COUNT8_t = f$ (Risk Factors$_t$, **Linear Contagion Channel Variables$_t$, Contagion Channel Indicator Variables$_t$**)

- Positive and significant coefficient on the contagion channel indicator means that a higher value of COUNT8 is more likely
- Use quartile, not decile, indicators because of multi-collinearity problems using deciles

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Table VI: Selected Results

	Liquidity Proxy = PBI	Liquidity Proxy = BANK	Liquidity Proxy = STKLIQ	Liquidity Proxy = CRSPRD	Liquidity Proxy = REPO	Liquidity Proxy = $FLOW_t$ and $FLOW_{t+1}$	ALL Liquidity Proxies Included
Liquidity Proxies: Indicator							
PBI	1.161^{***}						0.633^{*}
	(3.80)						(1.70)
BANK		0.186					-0.167
		(0.69)					(-0.48)
STKLIQ			1.172^{***}				0.847^{**}
			(4.05)				(2.15)
CRSPRD				0.566^{*}			0.572
				(1.82)			(1.63)
REPO					-0.512		-0.340
					(-1.27)		(-0.81)
$FLOW_t$						0.209	0.582
						(0.69)	(1.62)
$FLOW_{t+1}$						0.626^{**}	0.650
						(2.10)	(1.63)
Pseudo R^2	0.646	0.616	0.651	0.618	0.790	0.634	0.843

Is hedge fund contagion associated with tail outcomes for main markets?

- We estimate logit regressions with the dependent variable equal to one for 10% tail event in a main market

- We control for levels and volatility of main markets, as well as equally-weighted return on hedge funds

- COUNT8 is not significant for the stock market and the bond market

Table VIII: Selected Results

	Stock Market: Russell 3000	Bond Market: Lehman Brothers Bond Index	Currency Market: FRB Dollar-Weighted Index
Constant	-3.822***	-2.323***	-2.932***
	(-11.10)	(-9.75)	(-9.79)
Return on 3 month T-bill	2.917	-10.489***	-6.064
	(0.96)	(-2.59)	(-1.60)
S&P volatility	0.069***	0.012	-0.050***
	(5.63)	(0.82)	(-2.94)
FRB dollar index volatility	-0.008	-0.092*	-0.009
	(-0.11)	(-1.82)	(-0.16)
LB bond index volatility	0.062	-0.020	0.070
	(0.54)	(-0.23)	(0.66)
Return on Russell 3000	NA	-0.237	-0.719***
	NA	(-0.74)	(-2.15)
Return on Lehman Brothers bond index	0.088	NA	0.444***
	(0.44)	NA	(-2.26)
Return on FRB Dollar-weighted index	0.154	-0.394*	NA
	(0.67)	(-1.94)	NA
Equally weighted return on hedge fund indices	-2.175***	-0.020	1.470***
	(-3.15)	(-0.45)	(3.41)
Hedge Fund Index Indicator Contagion Variable			
COUNT8	-0.051	-0.13	0.55***
	(-0.29)	(-0.75)	(3.20)
R^2 MAX	0.650	0.135	0.204

Hedge fund contagion and FX market

- We find that the coefficient on COUNT8 in the FX market regression is 0.55 and significant at the 5% level

- Supportive of a role of carry-trade (Plantin and Shin)

Hedge fund contagion and main markets: Channel variables

- Same logit regression, but we add channel variables
- Strong impact of stock liquidity and hedge fund flows for FX market, but COUNT8 is still significant

	Stock Market: Russell 3000	Bond Market: Lehman Brothers Bond Index	Currency Market: FRB Dollar-Weighted Index
Hedge Fund Index Indicator Contagion Variable			
COUNT8	0.060	0.002	0.483***
	(0.32)	(0.01)	(2.64)
Liquidity Variable			
STKLIQ: Continuous	0.799***	0.156	-0.603*
	(2.56)	(0.54)	(-1.88)
STKLIQ: Indicator	-1.620**	-1.379*	1.326**
	(-2.19)	(-1.80)	(1.99)
R^2 MAX	0.676	0.166	0.232

Conclusion

- No systematic evidence of contagion between broad markets and individual hedge fund styles

- Strong evidence of contagion between different hedge fund styles

- Both funding and asset liquidity appear to be important hedge fund contagion channels

- Hedge fund contagion is associated with tail events in FX markets, but no other main markets