



# Systemic Risk and Hedge Funds

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# Motivation

## Hedge Funds and Systemic Risk:

- Currently \$1 Trillion In Assets and Growing
- About 8,000 Funds Worldwide
- Hedge Funds Are Hyperactive Investors
- Hedge Funds Provide Liquidity
- Hedge Funds Have Unique Risks
- Banks Are Related To Hedge Funds
- August 1998 and LTCM



# Motivation

## Lessons From August 1998:

- Liquidity and Credit are Important
- Multiplier/Accelerator Effect of Leverage
- Correlations Can Change Quickly
- Nonlinearities in Risk and Expected Return
- Systemic Risk Involves Hedge Funds



# Contributions

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Two Themes: Liquidity and Nonlinearities

1. Individual and Aggregate Measures of Illiquidity Exposure
2. Aggregate Measures of Volatility and Distress in Hedge-Fund Sector
3. Risk Models for Hedge Funds
4. Hedge Funds and Banking Sector



# Literature Review

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- Hedge funds: Ackerman, McEnally and Ravenscraft (1999), Fung and Hsieh (1999, 2000, 2001), Liang (1999, 2000, 2001), and Brown and Goetzmann (2003)
- Liquidity: Asness, Krail and Liew (2001), Getmansky, Lo and Makarov (2004)
- Liquidation: Brown, Goetzmann and Ibbotson (1999), Liang (2000, 2001) and Getmansky, Lo, and Mei (2004)



# Capital Decimation Partners, L.P.

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- Performance Summary, Jan. 1992 to Dec. 1999

<b>Statistic</b>	<b>SP 500</b>	<b>CDP</b>
Monthly Mean	1.4%	3.7%
Monthly Std. Dev.	3.6%	5.8%
Min Month	-8.9%	-18.3%
Max Month	14.0%	27.0%
Annual Sharpe Ratio	0.98	1.94
# Negative Months	36/96	6/96
Correlation with SP 500	100.0%	59.9%
Total Return	367.1%	2721.3%



# The Data

## Aggregate and Individual Data:

- CSFB/Tremont Hedge-Fund Indexes
  - 14 Indexes (13 Style Categories)
  - Jan 1994 to August 2004
- TASS Individual Hedge-Fund Returns
  - Feb 1977 to August 2004
  - 11 Style Categories
  - Monthly Returns, AUM, Style, Fund Info



# TASS Data

## 11 Categories:

Convertible Arbitrage  
Dedicated Shortseller  
Emerging Markets  
Equity Market Neutral  
Event Driven  
Fixed Income Arbitrage

Global Macro  
Long/Short Equity  
Managed Futures  
Multi-Strategy  
Fund of Funds

- 1,837 Funds with Minimum 5-Year History
- Individual Estimates of Illiquidity
- Weighted Autocorrelations
- Hedge Fund Liquidations



## Individual Hedge-Fund Data:

$$R_t^o = \theta_0 R_t + \theta_1 R_{t-1} + \cdots + \theta_k R_{t-k}$$

$$1 = \sum_{j=0}^k \theta_j$$

$$\hat{\theta}_j \Leftarrow \text{MLE of renormalized MA}(k)$$



# Smoothing Estimates

Category	Number of Funds	MA(2) Coefficient Estimates								Test Statistic $z(\theta_0)$ for $H: \theta_0 = 1$
		$\theta_0$		$\theta_1$		$\theta_2$		$\xi$		
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Convertible Arbitrage	79	0.719	0.161	0.201	0.148	0.080	0.101	0.621	0.327	15.558
Dedicated Short Bias	16	1.070	0.484	0.045	0.166	-0.115	0.331	1.508	2.254	-0.579
Emerging Markets	136	0.836	0.145	0.146	0.098	0.018	0.106	0.762	0.285	13.179
Equity Market Neutral	65	0.891	0.203	0.047	0.189	0.062	0.138	0.895	0.396	4.326
Event Driven	183	0.786	0.143	0.158	0.105	0.056	0.102	0.687	0.235	20.307
Fixed Income Arbitrage	65	0.775	0.169	0.147	0.104	0.078	0.120	0.682	0.272	10.714
Global Macro	88	0.999	0.202	0.047	0.161	-0.047	0.147	1.090	0.501	0.036
Long/Short Equity	532	0.880	0.179	0.092	0.125	0.028	0.142	0.851	0.398	15.453
Managed Futures	230	1.112	0.266	-0.032	0.193	-0.080	0.162	1.379	0.942	-6.406
Other	47	0.805	0.157	0.113	0.128	0.082	0.076	0.713	0.270	8.503
Fund of Funds	396	0.874	0.638	0.102	0.378	0.024	0.292	1.409	10.917	3.931
All	1837	0.890	0.357	0.092	0.223	0.017	0.188	1.014	5.096	



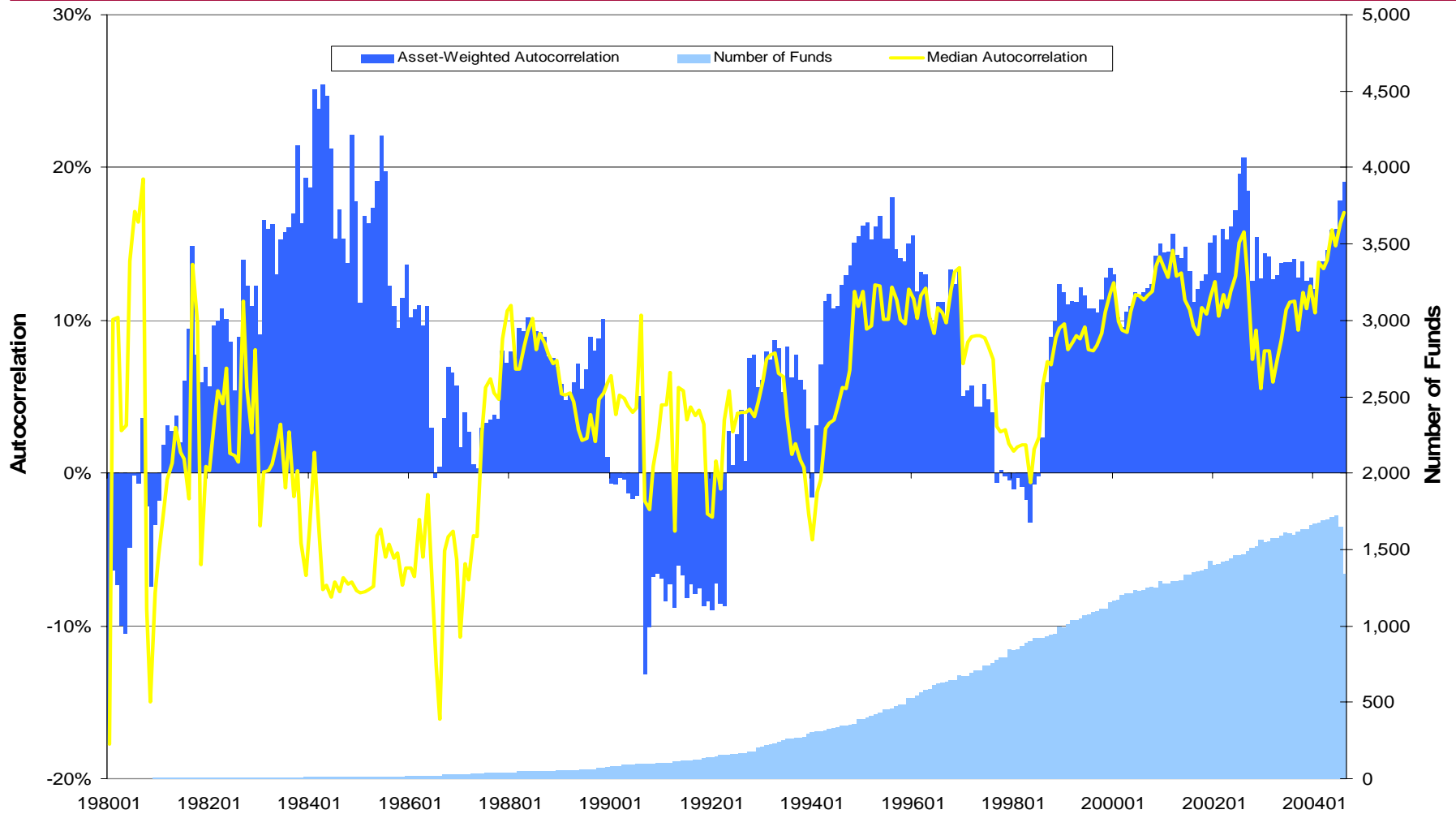
## Individual Hedge-Fund Data:

$\rho_{1t,j}$  = Rolling First-Order Serial  
Correlation of Fund  $j$ , Month  $t$

$$\rho_{1t}^* \equiv \sum_{j=1}^{N_t} \omega_{jt} \rho_{1t,j} \quad \text{Aggregate Measure}$$



# $\rho^*_t$ Indicator





# CSFB/Tremont Data

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## 14 Categories:

Hedge Funds	Event-Driven Multi-Strategy
Convertible Arbitrage	Risk Arbitrage
Dedicated Shortseller	Fixed Income Arbitrage
Emerging Markets	Global Macro
Equity Market Neutral	Long/Short Equity
Event Driven	Managed Futures
Distressed	Multi-Strategy

- Regime-Switching Process
- Risk Models, Bank Index Regressions



# Phase-Locking Risk

$$R_{it} = \alpha_i + \beta_i \Lambda_t + I_t Z_t + \varepsilon_{it}$$

$$E[\Lambda_t] = \mu_\lambda, \quad \text{Var}[\Lambda_t] = \delta_\lambda^2$$

$$E[Z_t] = 0, \quad \text{Var}[Z_t] = \delta_Z^2$$

$$E[\varepsilon_{it}] = 0, \quad \text{Var}[\varepsilon_{it}] = \delta_{\varepsilon_i}^2$$

$$I_t = \begin{cases} 1 & \text{with prob. } p \\ 0 & \text{with prob. } 1 - p \end{cases}$$



# Phase-Locking Correlations

$$\text{Corr}[R_{it}, R_{jt} | I_t = 0] = \frac{\beta_i \beta_j \delta_\lambda^2}{\sqrt{\beta_i^2 \delta_\lambda^2 + \delta_{\varepsilon_i}^2} \sqrt{\beta_j^2 \delta_\lambda^2 + \delta_{\varepsilon_j}^2}} \approx 0 \quad \text{for } \beta_i \approx \beta_j \approx 0$$

$$\text{Corr}[R_{it}, R_{jt} | I_t = 1] = \frac{\beta_i \beta_j \delta_\lambda^2 + \delta_Z^2}{\sqrt{\beta_i^2 \delta_\lambda^2 + \delta_{\varepsilon_i}^2 + \delta_Z^2} \sqrt{\beta_j^2 \delta_\lambda^2 + \delta_{\varepsilon_j}^2 + \delta_Z^2}} \approx \frac{1}{\sqrt{1 + \frac{\delta_{\varepsilon_i}^2}{\delta_Z^2}} \sqrt{1 + \frac{\delta_{\varepsilon_j}^2}{\delta_Z^2}}} \quad \text{for } \beta_i \approx \beta_j \approx 0$$

$$\text{Corr}[R_{it}, R_{jt}] = \frac{\beta_i \beta_j \delta_\lambda^2 + p \delta_Z^2}{\sqrt{\beta_i^2 \delta_\lambda^2 + \delta_{\varepsilon_i}^2 + p \delta_Z^2} \sqrt{\beta_j^2 \delta_\lambda^2 + \delta_{\varepsilon_j}^2 + p \delta_Z^2}} \approx \frac{p}{\sqrt{p + \frac{\delta_{\varepsilon_i}^2}{\delta_Z^2}} \sqrt{p + \frac{\delta_{\varepsilon_j}^2}{\delta_Z^2}}} \quad \text{for } \beta_i \approx \beta_j \approx 0$$

$$\text{Corr}[R_{it}, R_{jt}] \approx \frac{p}{\sqrt{p+0.1} \sqrt{p+0.1}} = \frac{0.001}{0.101} = 0.0099$$



## Aggregate Hedge-Fund Indexes:

- Regime-Switching Model

$$R_t = I_t \cdot R_{1t} + (1 - I_t) \cdot R_{2t}$$

$$R_{it} \sim \mathcal{N}\left(\mu_i, \sigma_i^2\right)$$

$$I_t = \begin{cases} 1 & \text{with probability } p_{11} \text{ if } I_{t-1} = 1 \\ 1 & \text{with probability } p_{21} \text{ if } I_{t-1} = 0 \\ 0 & \text{with probability } p_{12} \text{ if } I_{t-1} = 1 \\ 0 & \text{with probability } p_{22} \text{ if } I_{t-1} = 0 \end{cases} .$$

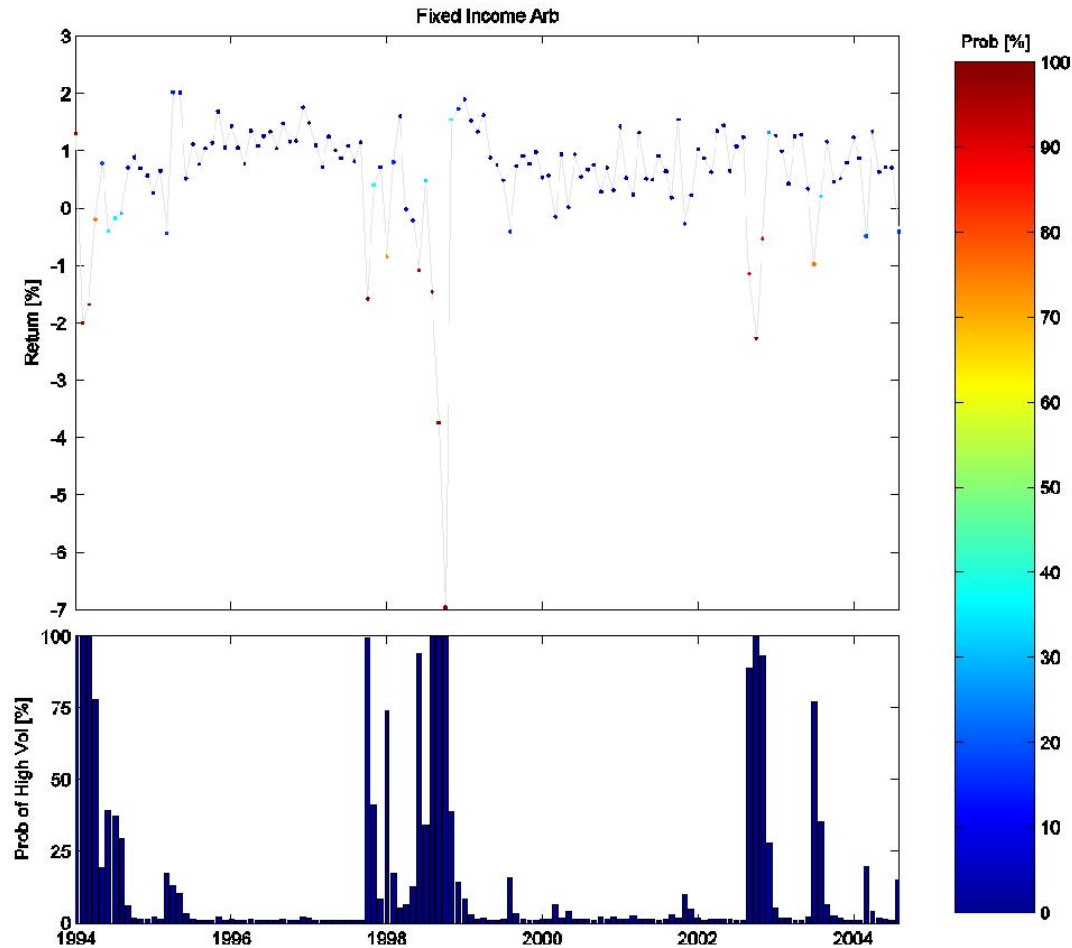


# Regime-Switching

Index	p <sub>11</sub>	p <sub>21</sub>	p <sub>12</sub>	p <sub>22</sub>	Annualized Mean		Annualized SD		Log(L)
					State 1	State 2	State 1	State 2	
Hedge Funds	100.0%	1.2%	0.0%	98.8%	6.8%	12.4%	2.9%	9.9%	323.6
Convertible Arbitrage	89.9%	17.9%	10.1%	82.1%	16.1%	-1.6%	1.9%	6.1%	404.0
Dedicated Shortseller	23.5%	12.6%	76.5%	87.4%	-76.2%	11.7%	2.3%	16.5%	208.5
Emerging Markets	100.0%	1.2%	0.0%	98.8%	11.5%	6.6%	8.2%	20.3%	218.0
Equity Mkt Neutral	95.0%	2.4%	5.0%	97.6%	4.4%	13.8%	2.1%	3.1%	435.1
Event Driven	98.0%	45.0%	2.0%	55.0%	13.3%	-47.0%	3.8%	14.0%	377.0
Distressed	97.9%	58.0%	2.1%	42.0%	15.2%	-57.5%	4.8%	15.6%	349.4
ED Multi-Strategy	98.7%	38.4%	1.3%	61.6%	12.0%	-55.2%	4.5%	15.0%	363.6
Risk Arbitrage	89.4%	25.6%	10.6%	74.4%	9.6%	3.1%	2.7%	6.9%	391.8
Fixed Income Arb	95.6%	29.8%	4.4%	70.2%	10.0%	-12.2%	1.9%	6.6%	442.3
Global Macro	100.0%	1.2%	0.0%	98.8%	13.6%	14.0%	3.2%	14.2%	286.3
Long/Short Equity	98.5%	2.5%	1.5%	97.5%	6.1%	21.1%	6.3%	15.3%	285.0
Managed Futures	32.0%	22.2%	68.0%	77.8%	-6.0%	10.7%	3.8%	13.7%	252.1
Multi-Strategy	98.2%	25.0%	1.8%	75.0%	10.8%	-7.6%	3.2%	9.2%	387.9

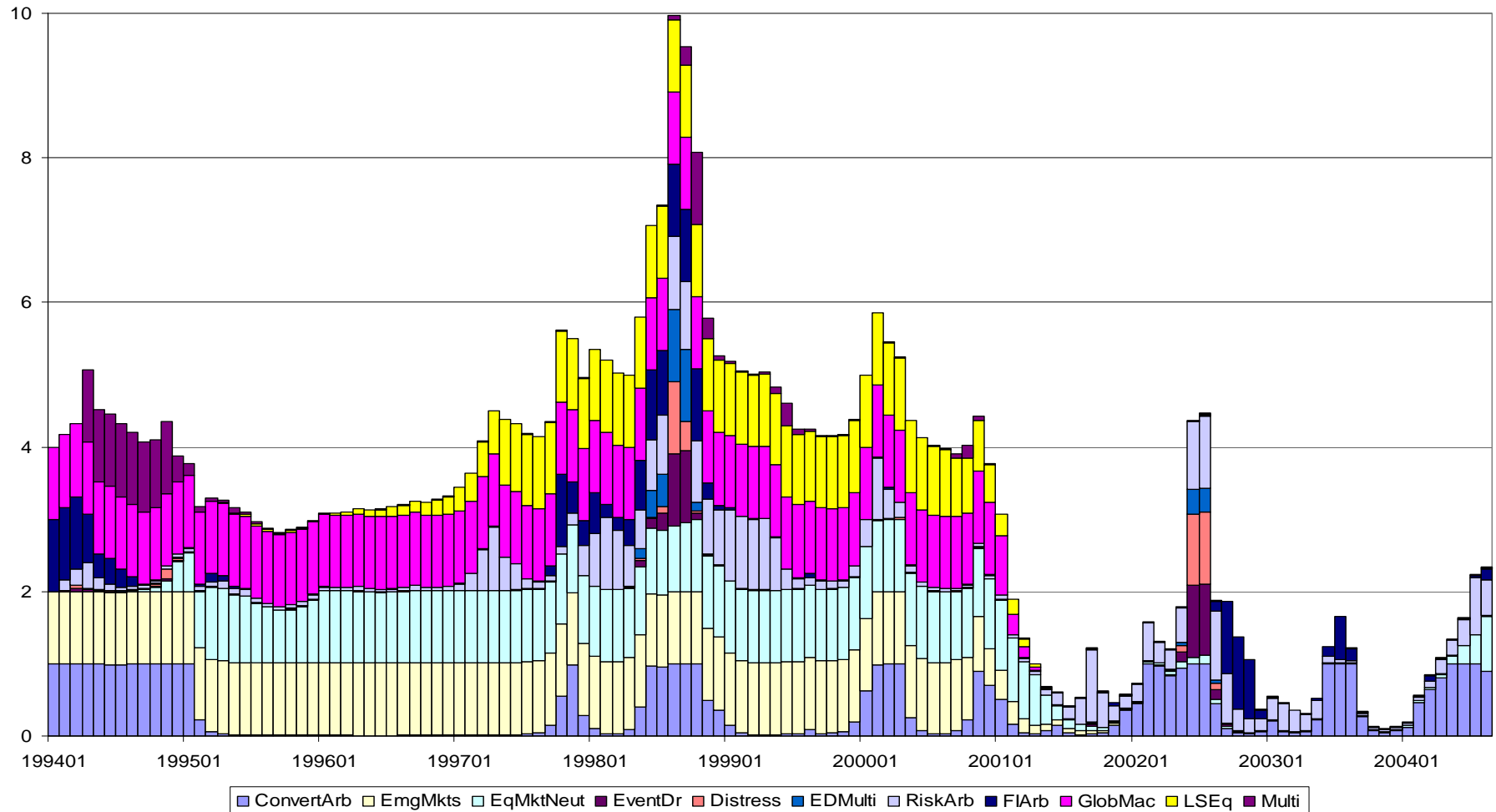


# Regime-Switching



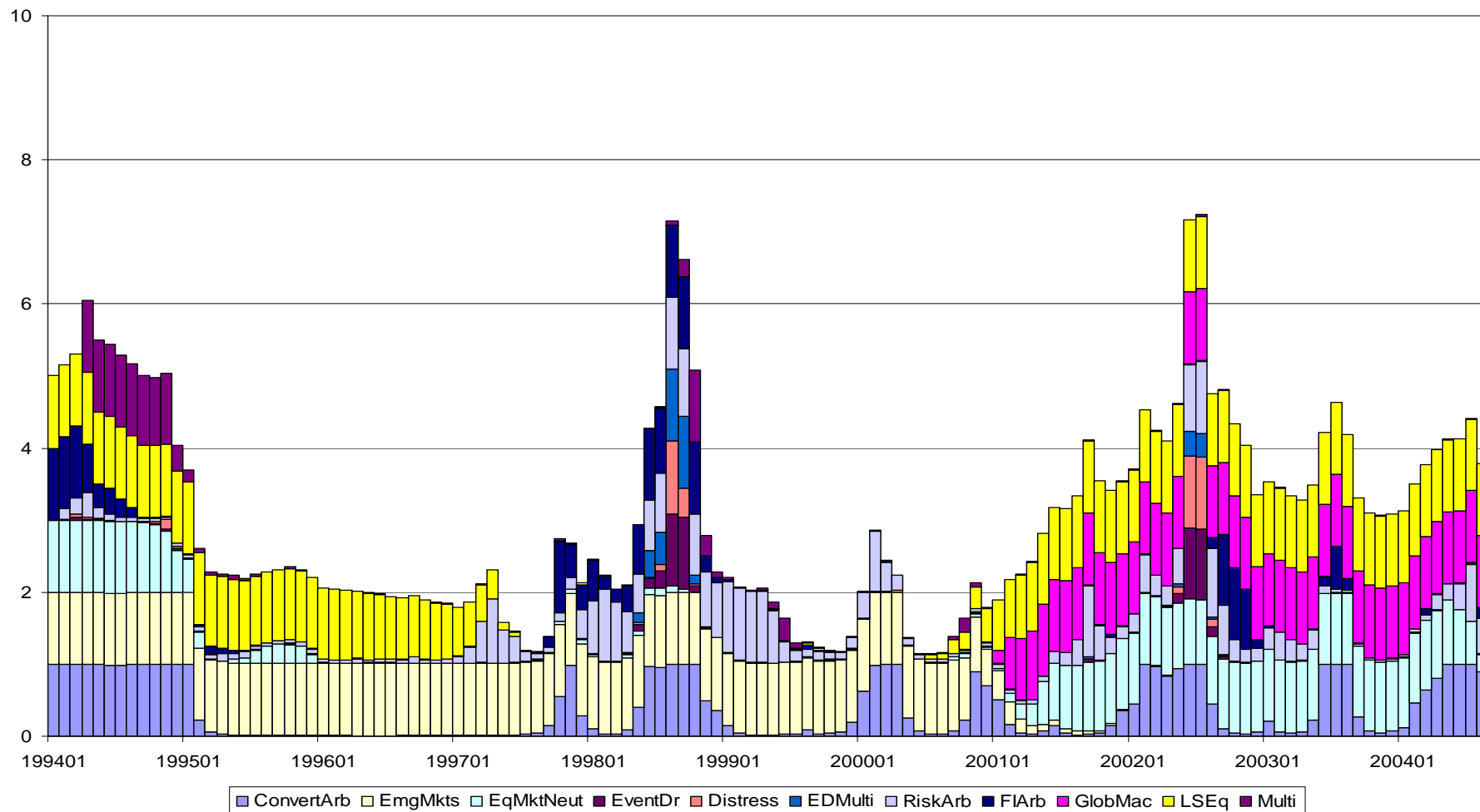


# HF Volatility Indicator (High Volatility State)





# HF Distress Indicator (Low Mean State)





## Aggregate Hedge-Fund Indexes:

- Risk Models and Bank-Index Regressions

$$R_{it} = \alpha_i + \sum_{j=1}^k \beta_{ij} \Lambda_{jt} + \epsilon_{it}$$

$$\text{Banks}_t = \alpha + \sum_{j=1}^{k_1} \beta_j \Lambda_{jt} + \sum_{j=1}^{k_2} \gamma_j R_{jt} + \zeta_t$$



## Aggregate Hedge-Fund Indexes:

- Risk Model Factors (Current and Lagged)

SP500	Banks	Oil	MarketCap	Credit Spread
SP500 <sup>2</sup>	LIBOR	Gold	Value/Growth	Term Spread
SP500 <sup>3</sup>	USD	VIX	Lehman Bond	

- Bank Index Regressors

SP500	14 CSFB/Tremont Indexes
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# HF and Banks

- Constructed equal-weighted and value-weighted bank returns.
- Regressed on SP500 + lags and CSFB/Tremont HF returns + lags
- Equal-weighted bank returns: contemporaneous and lagged SP 500 are important. Positive exposure to Event Driven, Risk Arb., FI Arb., and Global Macro indices. Negative exposure to the aggregate HF, Conv. Arb., Dedicated Short, and L/S Equity. Managed futures are not correlated.



# HF and Banks

- Value-weighted bank returns: Only contemporaneous SP 500 return matters.
- The explanatory power is higher than for equal-weighted model.
- Most of the coefficients are positive.



# HF and Banks

- Larger banking institutions are involved in similar investment activities through their proprietary trading desks.
- Large banks offer fee-based services to HFs, and do well when their clients are better off.
- Summary: the banking industry has clear ties to the hedge-fund industry.



# Conclusions

## Hedge Funds Affect Systemic Risk:

- Volatile Mix of Illiquidity and Leverage
- Phase-Locking Behavior
- Nonlinearities in Risk Exposures
- Banking Sector Is Vulnerable
- Recent upward trend in weighted autocorrelation and increased mean and median liquidation probabilities for hedge funds – systemic risk is on the rise.