CHARACTERIZING RISKS OF HEDGE FUNDS

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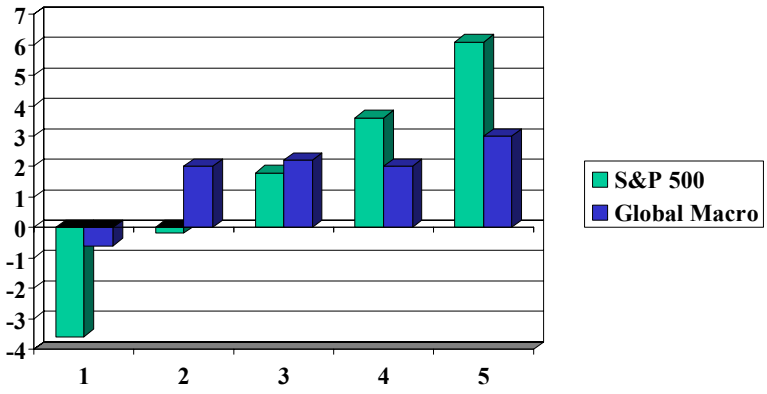
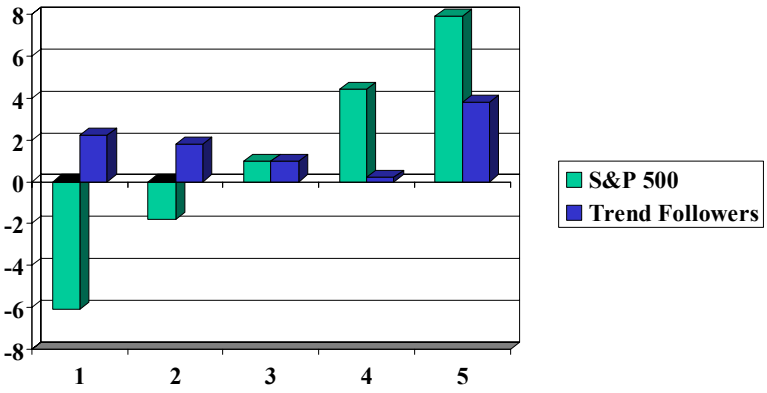
MOTIVATION

- Dynamic trading strategies used by hedge funds
- Non-linear option-like exposures to standard asset classes
- Traditional linear factor models of limited help

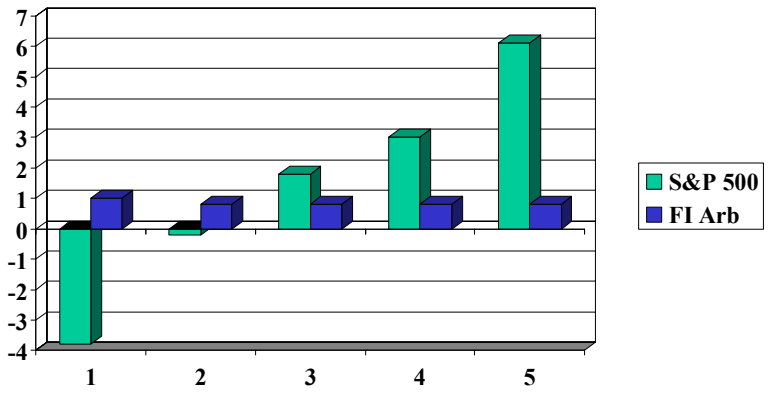
STATE DEPENDENT RETURNS: HFR GLOBAL/MACRO



STATE DEPENDENT RETURNS: TREND FOLLOWERS



STATE DEPENDENT RETURNS: HFR FIXED INCOME ARBITRAGE



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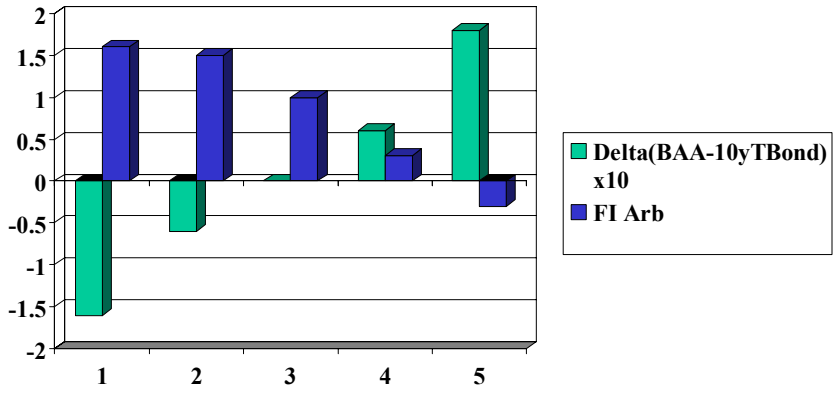


WHY USE OPTIONS?

- Trading in derivatives
- State-contingent bets
- Profit sharing element of manager's compensation

IMPLICATIONS

- Returns should be broken down in two parts
  - Due to Location (Buy-and-Hold component)
  - Due to Trading Strategy (Option component)

OBJECTIVES OF THE PAPER

- Characterize systematic risk exposures of hedge funds
- Replication of hedge fund payoffs
- Importance of option-based strategies

SAMPLE DATA

- Hedge Fund Research (HFR) Database
  - Index performance - Jan '90 to Jun '00
  - Individual fund performance - Jan '90 to Aug '99
- CSFB/Tremont (CSFB) Database
  - Index & Individual fund performance - Jan '94 to Jun '00
- Focus on equity-oriented strategies
  - Event Driven, Relative Value Arbitrage, Equity Hedge (Long/Short Equity), Hedge (Long Bias), Short Selling (Dedicated Short-Bias) and Emerging Markets

CLASSIFICATION OF HEDGE FUNDS

- Non-Directional Strategies
  - Event Driven
  - Relative Value Arbitrage
  - Equity Hedge (Long/Short Equity)
- Directional Strategies
  - Emerging Markets
  - Hedge (Long Bias)
  - Short Selling (Dedicated Short-Bias)

OUR MODEL (I)

$$Hedge\ Fund\ Return_t = c + \lambda \begin{pmatrix} Buy\text{-}and\text{-}Hold \\ Strategies \end{pmatrix}_t + \gamma \begin{pmatrix} Option\text{-}Based \\ Strategies \end{pmatrix}_t + error_t$$

Buy-and-Hold Strategies : Returns on the 12 asset class factors

- Equities
- Size, Book-to-Market and Momentum Factors
- Bonds and Change in Default Spread
- Currencies
- Commodities

Equities - Russell 3000, MSCI Excluding US, MSCI Emerging Markets
Bonds - SB Government & Corporate, SB World Government, Lehman High Yield
Currency - FRB Competitiveness-Weighted Dollar
Commodity - Goldman Sachs Commodity

OUR MODEL (II)

$$Hedge\ Fund\ Return_t = c + \lambda \begin{pmatrix} Buy\text{–}and\text{–}Hold \\ Strategies \end{pmatrix}_t + \gamma \begin{pmatrix} Option\text{–}Based \\ Strategies \end{pmatrix}_t + error_t$$

Option-Based Trading Strategies

Returns on the at-the-money and out-of-the-money call & put options on CME-traded S&P 500 Composite Index

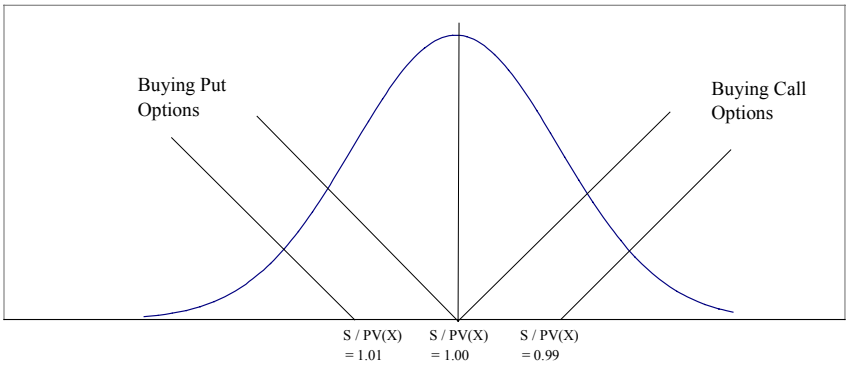
REPLICATING THE OPTION-LIKE PAYOFFS

- Allow buying/writing options on passive indices
- Employ options with varying degree of moneyness:

  At-the-money S/PV(X) = 1.0

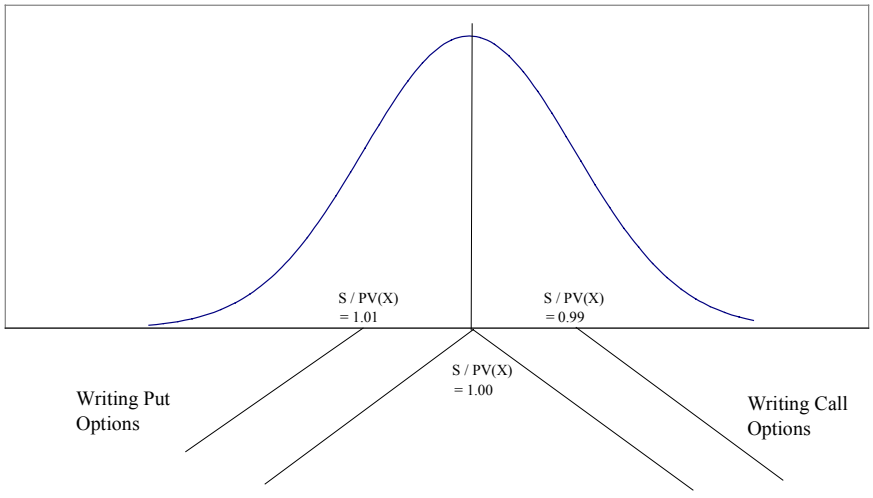
  Out-of-the-money S/PV(X) = 1.0 $\pm$ 0.01

Admissible Trading Strategies



The figures in percentages have been rounded to whole numbers for illustration purpose.

Admissible Trading Strategies



METHODOLOGY

- Classical tradeoff: Statistical confidence Vs Change in risk exposures
- Select 24-month window
- Stepwise Regression approach

VALIDITY OF THE MODEL

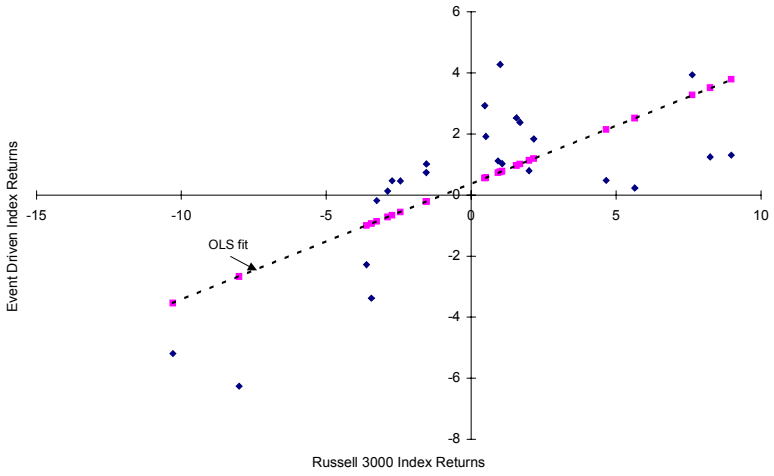
- Little / No information on the portfolio holdings of hedge funds
- Out-of-sample Analysis
- Comparison of our results for Event Driven and Relative Value Arbitrage strategy with those of Mitchell & Pulvino (2001) and Gatev et al (1999)

EVENT DRIVEN STRATEGY

Sub-Period	HFR			CSFB/Tremont		
	c	Sig. Factors	Adj. R^2	c	Sig. Factors	Adj. R^2
Jan 98 – Dec 99	-0.12	$-SPP_o$, SMB, HML, MEM	0.88	-0.83	$-SPP_o$, -SBW, SMB, MXUS, $-SPC_a$	0.94
Jan 96 – Dec 97	0.95	RUS, SMB	0.65	1.09	RUS, MEM, -DEFSPR	0.69
Jan 94 – Dec 95	0.53	RUS	0.40	0.73	LHY, SMB	0.68
Jan 92 – Dec 93	1.54	SMB, HML, SPC_o	0.66			
Jan 90 – Dec 91	-0.24	$-SPP_o$, SMB	0.79			

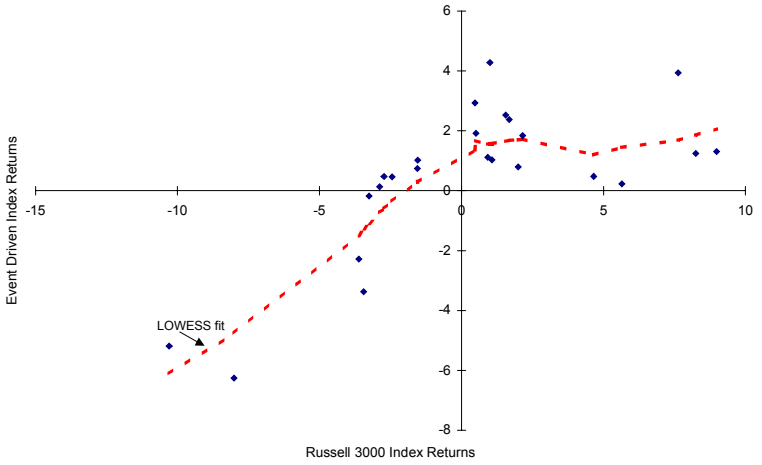
NON-LINEAR RISK EXPOSURE OF EVENT DRIVEN STRATEGY

Event Driven Index: Exposure to Russell 3000 Index (Period: Jan '90 to Dec '91)



NON-LINEAR RISK EXPOSURE OF EVENT DRIVEN STRATEGY

Event Driven Index: Exposure to Russell 3000 Index (Period: Jan '90 to Dec '91)



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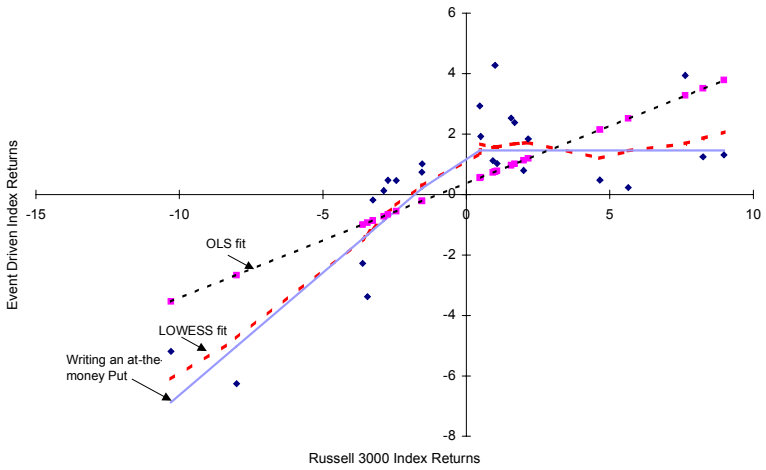
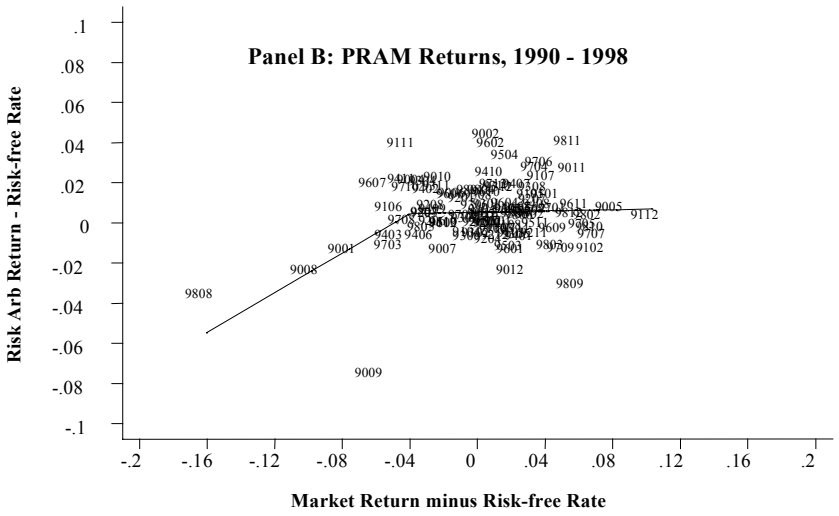
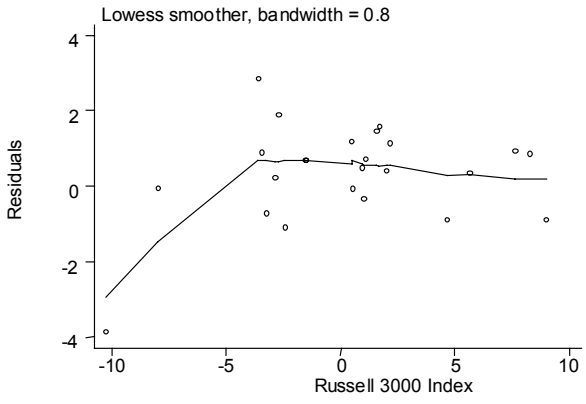
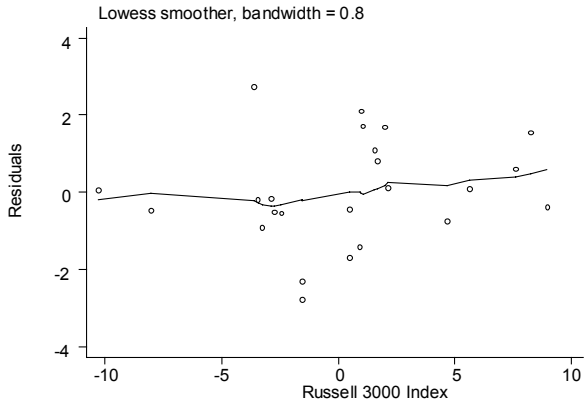




Source: Figure 5 from Mitchell & Pulvino (2000)



Panel B: Residuals from OLS Regression of HFR Event Driven Index against an Out-of-the-money put option on S&P 500 Index and Fama-French Size Factor plotted against the Russell 3000 Index



HFR RELATIVE VALUE ARBITRAGE INDEX

Sub-Period	c	Significant Factors	Adj. R^2
Jan 98 – Dec 99	-0.12	-SPP_o, -MOM, SMB, HML	0.92
Jan 96 – Dec 97	0.39	-SPP_o, SMB	0.66
Jan 94 – Dec 95	0.52	LHY	0.30
Jan 92 – Dec 93	1.64	-MOM, MXUS	0.38
Jan 90 – Dec 91	0.47	-MOM, -SPP_o	0.66

EQUITY HEDGE STRATEGY

Sub-Period	HFR			CSFB/Tremont		
	c	Sig. Factors	Adj. R^2	c	Sig. Factors	Adj. R^2
Jan 98 – Dec 99	2.44	MEM, SMB, SPC_o	0.85	-0.22	$-SPP_a$	0.65
Jan 96 – Dec 97	1.56	-HML	0.47	0.29	RUS, SMB	0.76
Jan 94 – Dec 95	0.62	RUS, SMB	0.76	-0.26	RUS, SMB	0.77
Jan 92 – Dec 93	1.27	RUS, SMB	0.69			
Jan 90 – Dec 91	0.72	$-SPP_o$	0.39			

HFR HEDGE (LONG BIAS) INDEX

Sub-Period	c	Significant Factors	Adj. R^2
Jan 98 – Dec 99	1.55	$-SPP_a$, SMB, SPC_o, MEM	0.94
Jan 96 – Dec 97	-0.30	$-SPP_o$, SMB, RUS	0.93
Jan 94 – Dec 95	0.65	RUS, SMB	0.85
Jan 92 – Dec 93	1.04	SMB, RUS	0.93
Jan 90 – Dec 91	1.03	RUS, SMB	0.84

SHORT SELLING STRATEGY

Sub-Period	HFR			CSFB/Tremont		
	c	Sig. Factors	Adj. R^2	c	Sig. Factors	Adj. R^2
Jan 98 – Dec 99	0.16	-SMB, HML, -RUS	0.84	2.99	SPP_o, FRBI	0.78
Jan 96 – Dec 97	-1.07	HML	0.81	-1.10	HML, -MXUS	0.77
Jan 94 – Dec 95	0.53	-RUS, -SMB, GSCI	0.85	0.46	-RUS, -SMB, GSCI	0.84
Jan 92 – Dec 93	1.05	-SMB, -RUS, GSCI	0.84			
Jan 90 – Dec 91	-0.59	-RUS, SBG, -MXUS	0.80			

EMERGING MARKETS STRATEGY

Sub-Period	HFR			CSFB/Tremont		
	c	Sig. Factors	Adj. R^2	c	Sig. Factors	Adj. R^2
Jan 98 – Dec 99	-0.65	MEM, -SBW, SMB, MOM	0.93	-1.68	MEM, -SBW, MXUS	0.85
Jan 96 – Dec 97	1.66	MEM	0.76	2.32	MEM	0.75
Jan 94 – Dec 95	0.70	MEM, SMB, -MOM, -DEFSPR	0.89	0.73	MEM, -SBW, -MOM	0.63
Jan 92 – Dec 93	2.10	MEM	0.70			
Jan 90 – Dec 91	1.04	RUS , MEM	0.66			

MUTUAL FUNDS: GROWTH STRATEGY

Sub-Period	Large Growth			Small Growth		
	c	Sig. Factors	Adj. R^2	c	Sig. Factors	Adj. R^2
Jan 98 – Dec 99	0.21	$-SPP_a$, -HML, SPC_o	0.92	-0.19	$-SPP_a$, SMB, SPC_o, -FRBI, MOM	0.93
Jan 96 – Dec 97	0.05	RUS, -HML, MOM	0.94	-0.20	-HML, SMB, RUS, MOM	0.95
Jan 94 – Dec 95	0.28	RUS, -HML, SMB, SPC_o	0.96	0.55	RUS, SMB, -HML, SPC_a	0.97
Jan 92 – Dec 93	0.26	RUS, SMB, -HML	0.92	0.26	RUS, SMB, MOM, HML	0.94
Jan 90 – Dec 91	0.06	RUS , -HML	0.93	-0.19	RUS, $-SPP_a$	0.90

MUTUAL FUNDS: VALUE STRATEGY

Sub-Period	Large Value			Small Value		
	c	Sig. Factors	Adj. R^2	c	Sig. Factors	Adj. R^2
Jan 98 – Dec 99	-1.20	RUS, MEM, HML, $-SPP_a$	0.90	-1.62	SMB, RUS, HML, $-SPP_a$, -FRBI	0.94
Jan 96 – Dec 97	0.18	RUS, MEM, MOM	0.95	0.48	RUS, SMB, MOM, MEM, HML	0.96
Jan 94 – Dec 95	0.35	RUS, SPC_a	0.95	0.37	RUS, SMB, SPC_a	0.95
Jan 92 – Dec 93	-0.18	$-SPP_a$, SPC_a, SMB	0.90	-1.18	SMB, $-SPP_a$	0.91
Jan 90 – Dec 91	0.07	RUS	0.93	0.37	RUS, SMB, MXUS, MOM, FRBI	0.98

ROBUSTNESS CHECKS

- Choice of database
- Options on a broader equity index (Russelll 2000)
- Alternative non-linear specifications

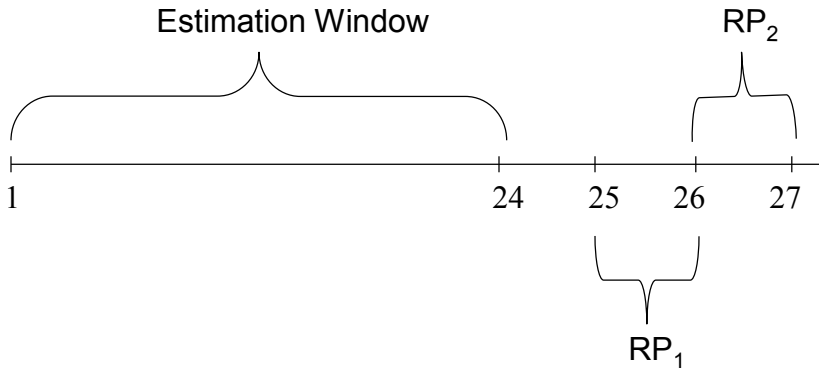
OUT-OF-SAMPLE ANALYSIS (I)

$$Hedge\ Fund\ Return_t = \alpha + \beta \begin{pmatrix} Replicating \\ Portfolio \end{pmatrix}_t + error_t$$

- Rolling window methodology
- Estimate risk exposures over 24-month window
- Estimate replicating portfolio's return over the month after the next month
- Move window by one month each time

OUT-OF-SAMPLE ANALYSIS (II)

$$Hedge\ Fund\ Return_t = \alpha + \beta \begin{pmatrix} Replicating \\ Portfolio \end{pmatrix}_t + error_t$$



EVENT DRIVEN: OUT-OF-SAMPLE

Sub-Period	HFR			CSFB/Tremont		
	α	β	Adj. R^2	α	β	Adj. R^2
Feb 92 – Jun 00	0.65	0.85	0.40	Not Applicable		
Feb 94 – Jun 00	0.49	0.86	0.43			
Feb 96 – Jun 00	0.33#	0.98	0.55	0.51#	0.35	0.19
Feb 98 – Jun 00	0.00#	1.06	0.60	-0.18#	0.40	0.25

# indicates α and β **not** significant at 5% level

HFR RELATIVE VALUE ARBITRAGE: OUT-OF-SAMPLE

Sub-Period	α	β	Adj. R^2
Feb 92 – Jun 00	0.66	0.58	0.15
Feb 94 – Jun 00	0.33	0.83	0.37
Feb 96 – Jun 00	0.29	0.96	0.49
Feb 98 – Jun 00	-0.02[#]	1.06	0.59

[#] indicates α and β **not** significant at 5% level

EQUITY HEDGE: OUT-OF-SAMPLE

Sub-Period	HFR			CSFB/Tremont		
	α	β	Adj. R^2	α	β	Adj. R^2
Feb 92 – Jun 00	1.21	0.81	0.42	Not Applicable		
Feb 94 – Jun 00	1.08	0.80	0.42			
Feb 96 – Jun 00	1.25	0.79	0.41	0.75[#]	0.62	0.57
Feb 98 – Jun 00	1.61	0.83	0.35	1.07[#]	0.58	0.53

[#] indicates α and β **not** significant at 5% level

HFR HEDGE (LONG BIAS): OUT-OF-SAMPLE

Sub-Period	α	β	Adj. R^2
Feb 92 – Jun 00	0.75	0.89	0.66
Feb 94 – Jun 00	0.66	0.88	0.64
Feb 96 – Jun 00	0.62#	0.87	0.62
Feb 98 – Jun 00	0.96#	0.86	0.55

# indicates α and β **not** significant at 5% level

SHORT SELLING: OUT-OF-SAMPLE

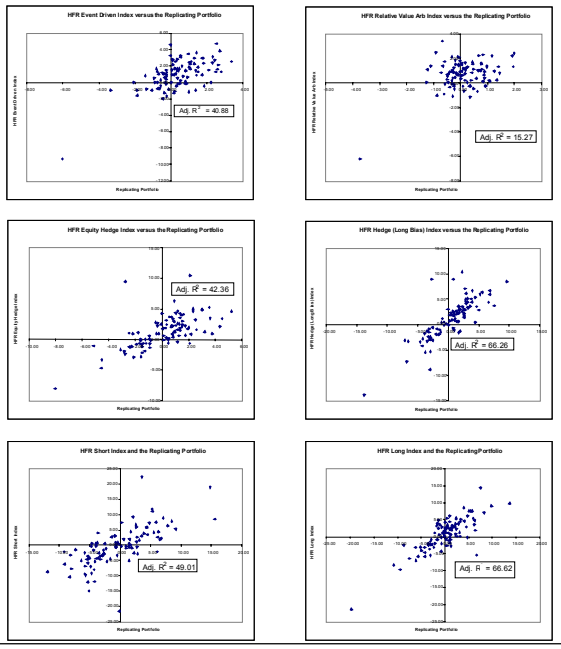
Sub-Period	HFR			CSFB/Tremont		
	α	β	Adj. R^2	α	β	Adj. R^2
Feb 92 – Jun 00	-0.03#	0.89	0.49	Not Applicable		
Feb 94 – Jun 00	0.00#	0.90	0.48			
Feb 96 – Jun 00	-0.35#	0.84	0.43	-0.01#	0.53	0.57
Feb 98 – Jun 00	0.57#	1.13	0.39	0.29#	0.50	0.55

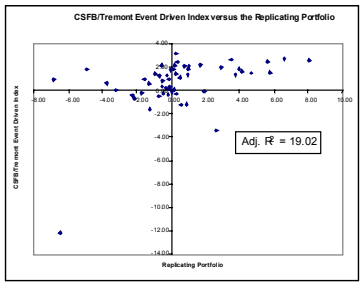
# indicates α and β **not** significant at 5% level

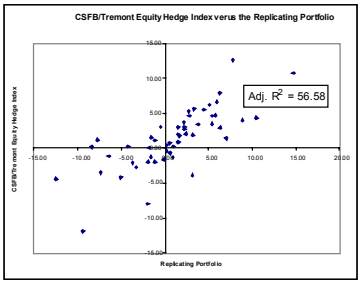
EMERGING MARKETS: OUT-OF-SAMPLE

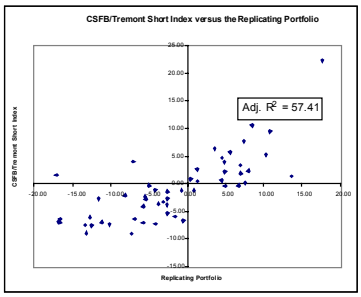
Sub-Period	HFR			CSFB/Tremont		
	α	β	Adj. R^2	α	β	Adj. R^2
Feb 92 – Jun 00	0.73	0.87	0.67	Not Applicable		
Feb 94 – Jun 00	0.34#	0.89	0.69			
Feb 96 – Jun 00	0.29#	0.90	0.69	0.31#	0.76	0.54
Feb 98 – Jun 00	-0.61#	0.94	0.73	-0.96#	0.83	0.56

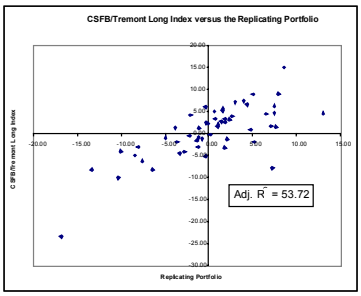
# indicates α and β **not** significant at 5% level

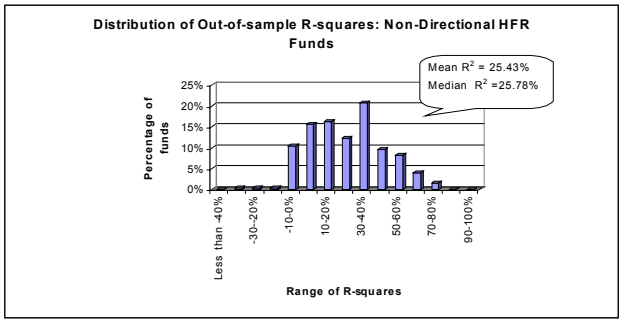


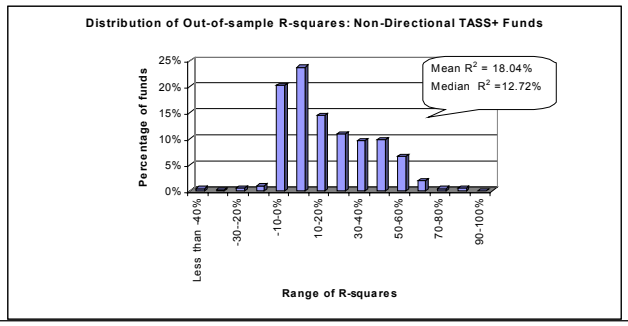

CSFB/Tremont Event Driven Index versus the Replicating Portfolio
Adj. R² = 19.02
CSFB/Tremont Event Driven Index
Replicating Portfolio

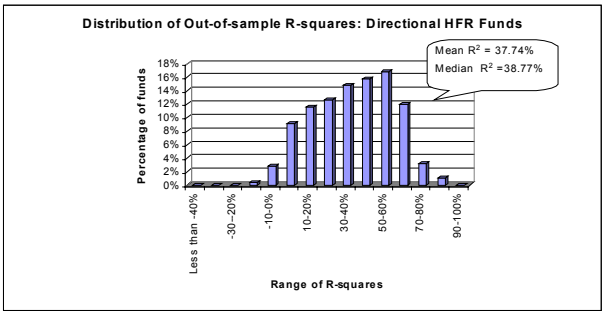

CSFB/Tremont Equity Hedge Index versus the Replicating Portfolio
Adj. R² = 56.58
CSFB/Tremont Equity Hedge Index
Replicating Portfolio

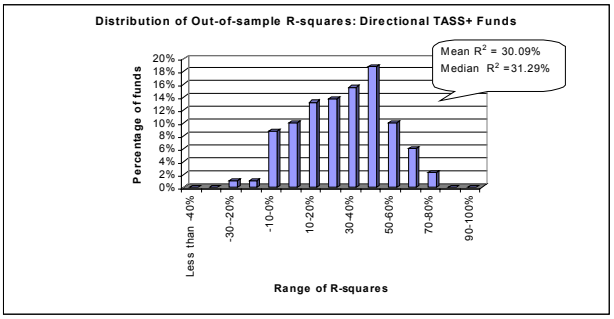

CSFB/Tremont Short Index versus the Replicating Portfolio
Adj. R² = 57.41
CSFB/Tremont Short Index
Replicating Portfolio

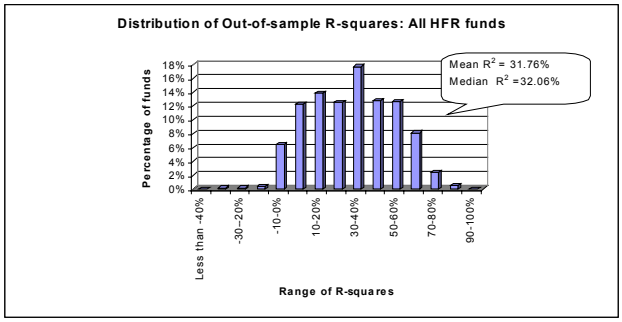

CSFB/Tremont Long Index versus the Replicating Portfolio
Adj. R² = 53.72
CSFB/Tremont Long Index
Replicating Portfolio

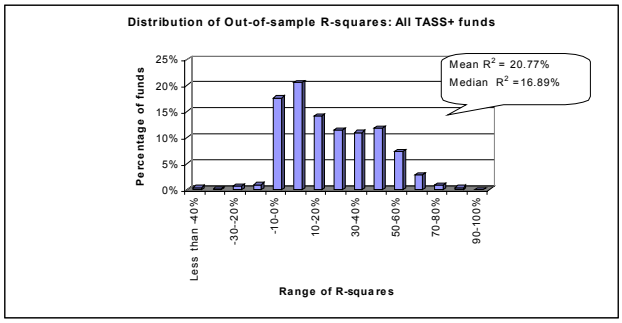

Distribution of Out-of-sample R-squares: Non-Directional HFR Funds
Mean R² = 25.43%
Median R² =25.78%
Percentage of funds
25%
20%
15%
10%
5%
0%
Less than -40%
-30--20%
-10-0%
10-20%
30-40%
50-60%
70-80%
90-100%
Range of R-squares


Distribution of Out-of-sample R-squares: Non-Directional TASS+ Funds
Mean R² = 18.04%
Median R² =12.72%
Percentage of funds
25%
20%
15%
10%
5%
0%
Less than -40%
-30--20%
-10-0%
10-20%
30-40%
50-60%
70-80%
90-100%
Range of R-squares


Distribution of Out-of-sample R-squares: Directional HFR Funds
Mean R^2 = 37.74%
Median R^2 =38.77%
Percentage of funds
18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
Less than -40%
-30--20%
-10-0%
10-20%
30-40%
50-60%
70-80%
90-100%
Range of R-squares


Distribution of Out-of-sample R-squares: Directional TASS+ Funds
Mean R^2 = 30.09%
Median R^2 =31.29%
Percentage of funds
20%
18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
Less than -40%
-30--20%
-10-0%
10-20%
30-40%
50-60%
70-80%
90-100%
Range of R-squares


Distribution of Out-of-sample R-squares: All HFR funds
Mean R^2 = 31.76%
Median R^2 =32.06%
Percentage of funds
18%
16%
14%
12%
10%
8%
6%
4%
2%
0%
Less than -40%
-30--20%
-10-0%
10-20%
30-40%
50-60%
70-80%
90-100%
Range of R-squares


Distribution of Out-of-sample R-squares: All TASS+ funds
Mean R^2 = 20.77%
Median R^2 =16.89%
Percentage of funds
25%
20%
15%
10%
5%
0%
Less than -40%
-30--20%
-10-0%
10-20%
30-40%
50-60%
70-80%
90-100%
Range of R-squares

MUTUAL FUNDS (GROWTH): OUT-OF-SAMPLE

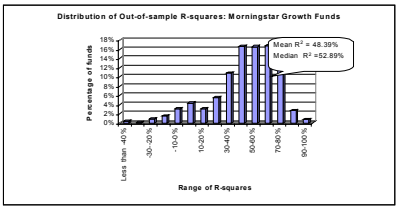
Sub-Period	Large Growth			Small Growth		
	α	β	Adj. R^2	α	β	Adj. R^2
Feb 92 – Jun 00	0.22#	0.97	0.75	0.40#	0.90	0.58
Feb 94 – Jun 00	0.18#	0.97	0.75	0.57#	0.89	0.54
Feb 96 – Jun 00	0.25#	0.97	0.72	0.71#	0.88	0.51
Feb 98 – Jun 00	0.18#	0.99	0.65	1.19#	0.84	0.39

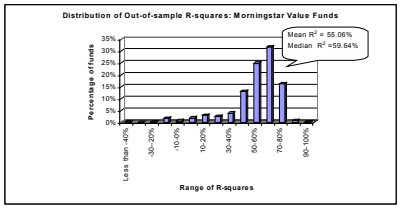
# indicates α and β **not** significant at 5% level

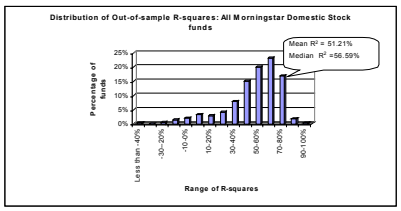
MUTUAL FUNDS (VALUE): OUT-OF-SAMPLE

Sub-Period	Large Value			Small Value		
	α	β	Adj. R^2	α	β	Adj. R^2
Feb 92 – Jun 00	-0.02#	0.87	0.72	0.23#	0.90	0.79
Feb 94 – Jun 00	-0.04#	0.89	0.71	0.14#	0.91	0.79
Feb 96 – Jun 00	-0.22#	0.88	0.69	0.09#	0.90	0.78
Feb 98 – Jun 00	-0.71#	0.86	0.64	-0.41#	0.88	0.75

# indicates α and β **not** significant at 5% level







CONCLUDING REMARKS

- Importance of option-based trading strategies
- Characterization of systematic risks of equity-oriented hedge funds
- General approach applicable across managed portfolios including mutual funds

CONCLUDING REMARKS

- Potentially useful in
  - asset allocation
  - construction of appropriate Fund of Funds
  - risk control
  - design of benchmark & managerial compensation contract