QF623: Risk management and investment management
Based on FRM syllabus

Hedge funds

- Explain biases commonly found in hedge fund databases.
- Explain the evolution of the hedge fund industry and describe significant events which led to major changes in the industry.
- Evaluate the role of investors in shaping the industry.
- Explain the relationship between risk and alpha in hedge funds.
- Compare and contrast different hedge fund styles and their return and risk characteristics.
- Describe the portfolio construction and historical performance trend of hedge funds compared to equity indices.
- Describe the problem of risk sharing asymmetry between principals and agents in the hedge fund industry.

Introduction

- Hedge funds differ from mutual funds in some respects
  - Not open to public and hence less regulated
  - Profit from both long and short leg
  - Ability to leverage
  - Charges incentive fees
  - Little transparency but this is beginning to change

Hedge fund databases

- For the sample period between 1997 and 2010, the average annual entry date for hedge funds into commercial databases is 9%, whereas the 'exit' rate is much higher. On average per year, 21% of funds in the databases stop reporting. There exists significant survivorship and self-reporting bias.

- Hedge fund research (HFR) publishes a range of hedge fund indices designed to provide industry performance averages as well as sub-indices that reflect specialized strategies and sectors.

- HFR only started collecting data around 1994. Data prior to this date is mostly "backfilled". Hence, pre-1994 data may be biased in favor of good performance. More reliable data after around 1996.

Hedge fund developments
Greater transparency and governance

- Emergence of intermediaries such as fund of hedge funds who offer investors a diversified portfolio of hedge funds for some management fee led to better disclosure.
- Together with HFR, performance reporting began to standardize and peer-group averages of hedge fund performance became more transparent.
- LTCM collapse led to fall in investor appetite in hedge funds.
- Arrival of institutional investors mean more governance required

Hedge fund returns pre 1994

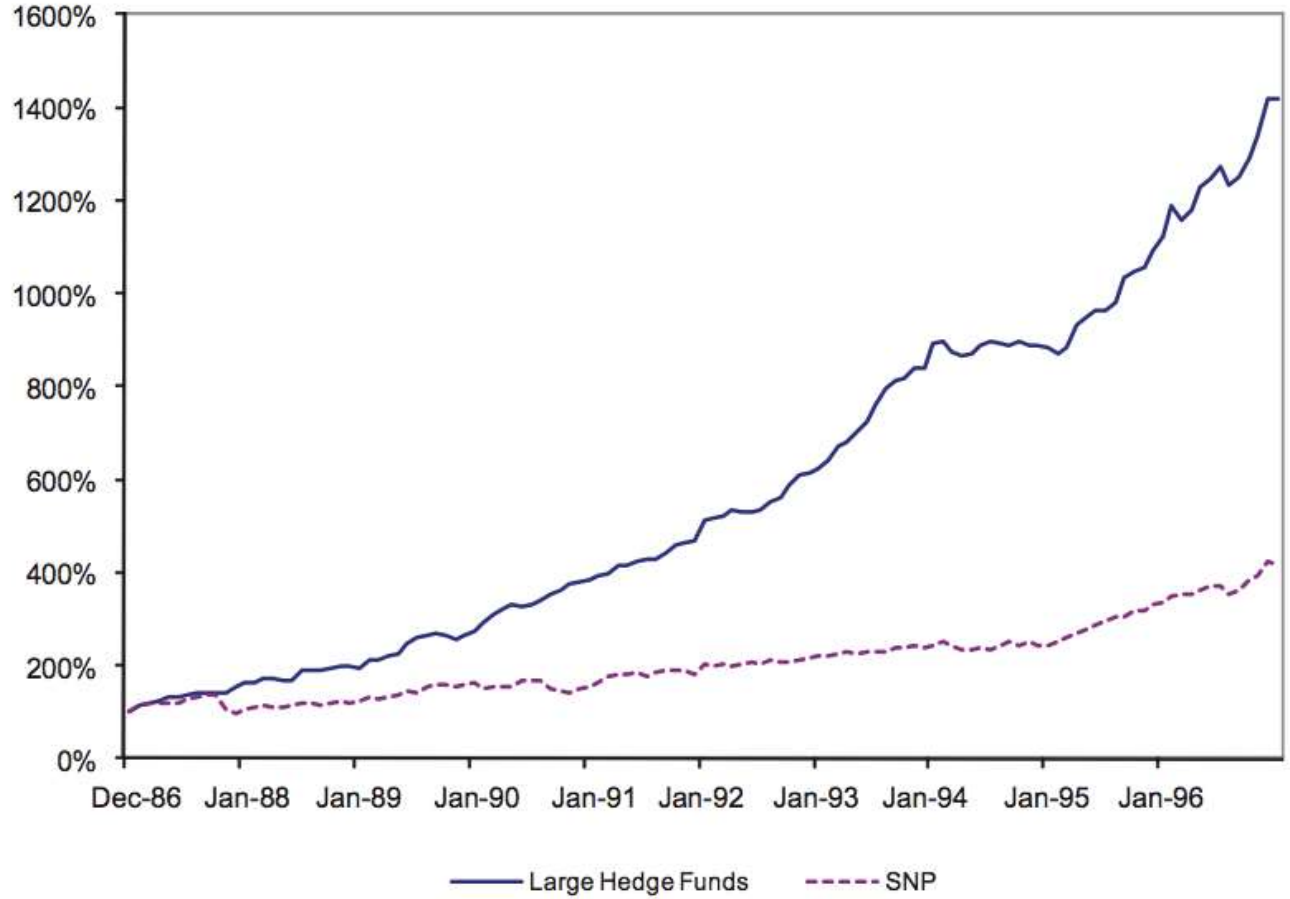


Figure 1 Cumulative returns of large hedge funds and the SNP index: 1987–1996.
Source: Fung and Hiseh, 2000b; Fung, Hsieh, and Tsatsaronis, 2000.

Hedge fund returns (1996-2001)

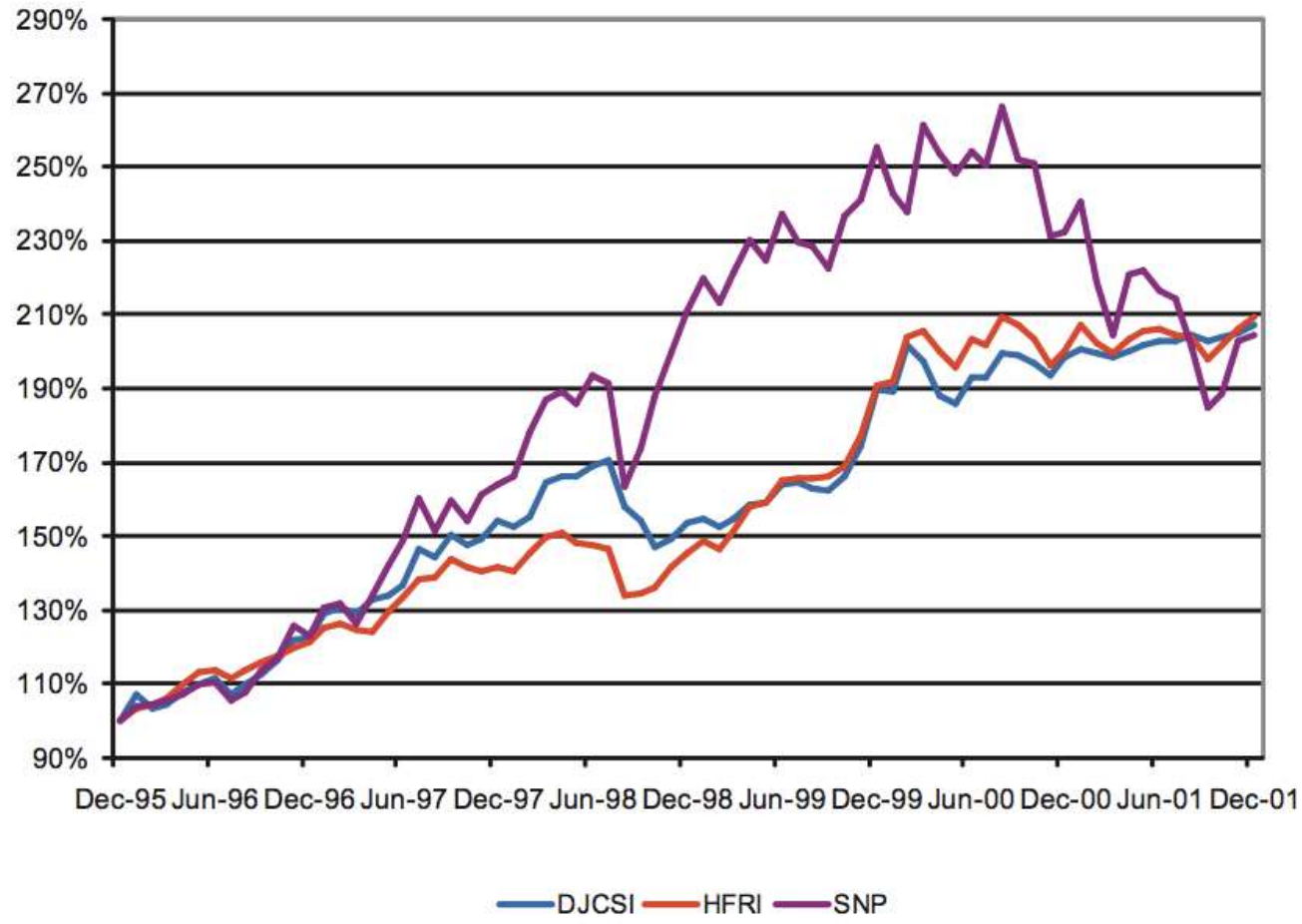


Figure 2 Cumulative return of DJCSI, HFRI, and the SNP index: 1996–2001.

Demand from institutional investors

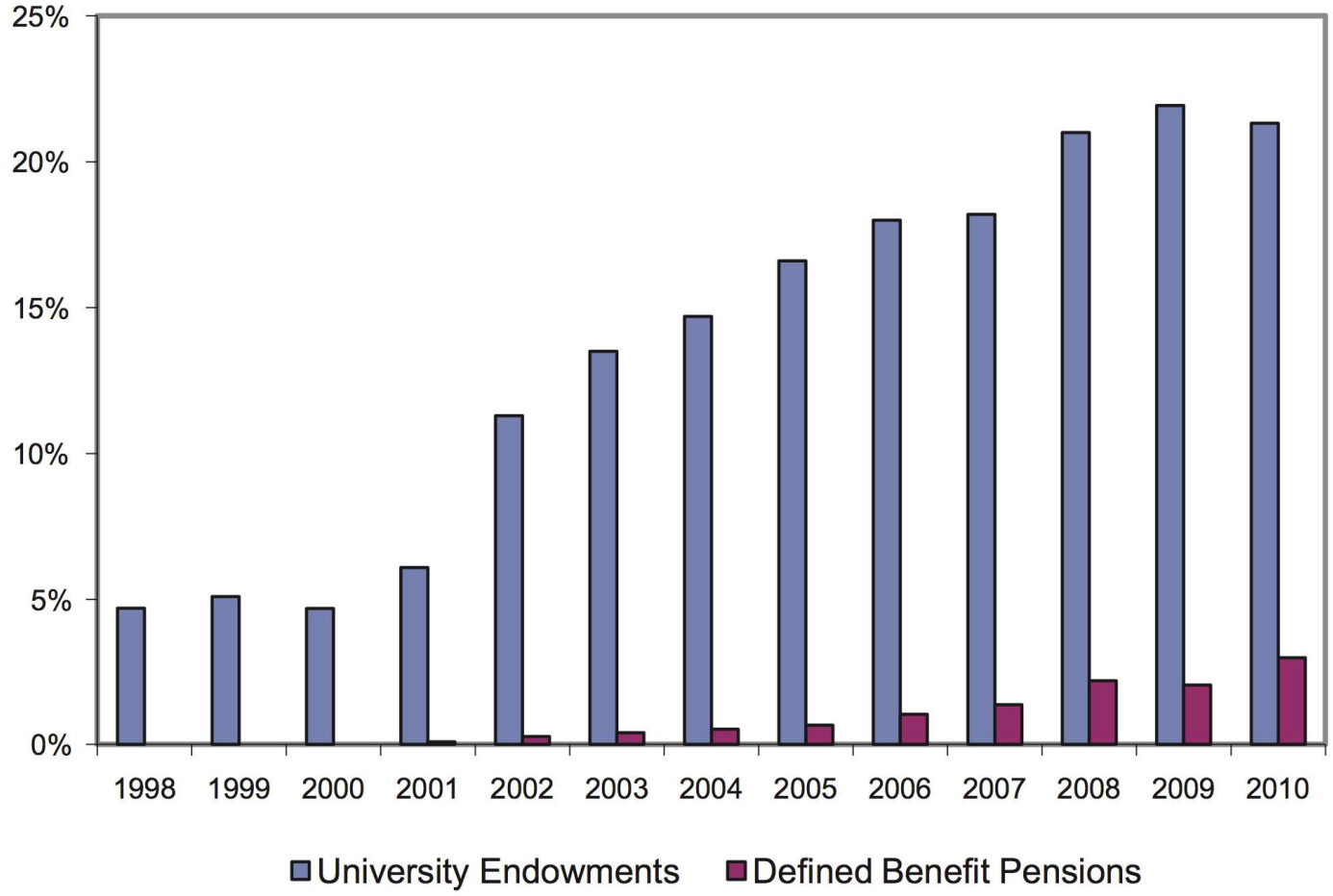


Figure 3 Allocation to hedge funds (% of assets).
Source: Pensions and Investments (1998–2010), NACUBO (1998–2008), NACUBO-Commonfond (2009–2010).

Hedge fund returns post 2002

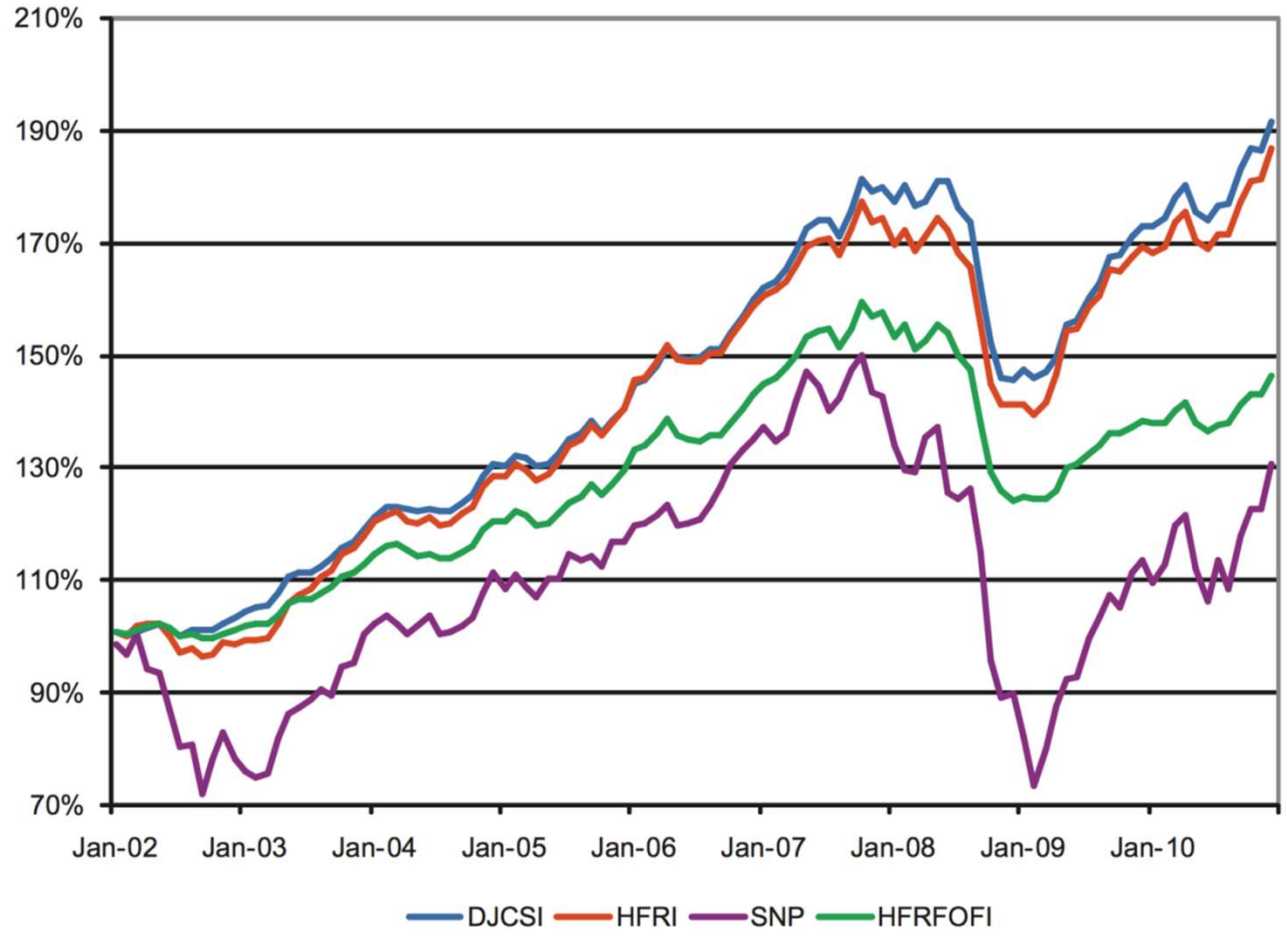


Figure 4 Cumulative return of DJCSI, HFRI, HFRFOFI, and the SNP index: 2002–2010.

Drivers of hedge fund returns

- Fung and Hsieh 8-factor model
- Regression of hedge fund indices on 8 risk factors
  - SP-Rf: Excess return of S&P 500 index (“market”)
  - RL-SP: Russell 2000 index less S&P 500 index (“SMB”)
  - TY-Rf: Excess return of US 10-year treasuries (“bond risk”)
  - BAA-TY: Return of Moody’s BAA corporate bond less the return of US 10-year treasuries (“credit risk”)
  - PTFSBD-Rf: Excess return of a portfolio of bond straddles (“Long bond volatility”)
  - PTFSFX-Rf: Excess return of a portfolio of FX straddles (“Long FX volatility”)
  - PTFSXOM-Rf: Excess return of a portfolio of commodity straddles (“Long commodity volatility”)
  - IFC-Rf: Excess return of international finance corporation’s emerging market index (“EM equities”)

Drivers of hedge fund returns

2A	DJCSI	HFRI	HFRFOFI
	Full sample: 1996–2010		
Const	0.0026	0.0029	0.0005
	0.0012	*0.0009*	*0.0012*
	2.1272	**3.0487**	**0.4451**
SP-Rf	0.1511	0.1884	0.0690
	0.0472	*0.0343*	*0.0337*
	3.2002	**5.4880**	**2.0463**
RL-SP	0.1083	0.1632	0.0870
	0.0661	*0.0389*	*0.0417*
	1.6388	4.1918	2.0889
TY-Rf	0.1321	0.0091	0.0309
	0.0719	*0.0459*	*0.0513*
	1.8375	0.1986	0.6019
BAA-TY	0.2034	0.0945	0.1597
	0.0563	*0.0342*	*0.0532*
	3.6154	**2.7667**	**3.0047**
PTFSBD-Rf	−0.0223	−0.0042	−0.0121
	0.0116	*0.0073*	*0.0098*
	−1.9205	−0.5786	−1.2359
PTFSFX-Rf	0.0068	0.0047	0.0051
	0.0070	*0.0041*	*0.0046*
	0.9730	1.1668	1.1104
PTFSCOM-Rf	0.0171	0.0043	0.0078
	0.0104	*0.0056*	*0.0073*
	1.6503	0.7751	1.0655
IFC-Rf	0.0797	0.1282	0.1207
	0.0244	*0.0171*	*0.0194*
	3.2729	**7.5163**	**6.2172**
Adj R^2	0.4666	0.7838	0.5713

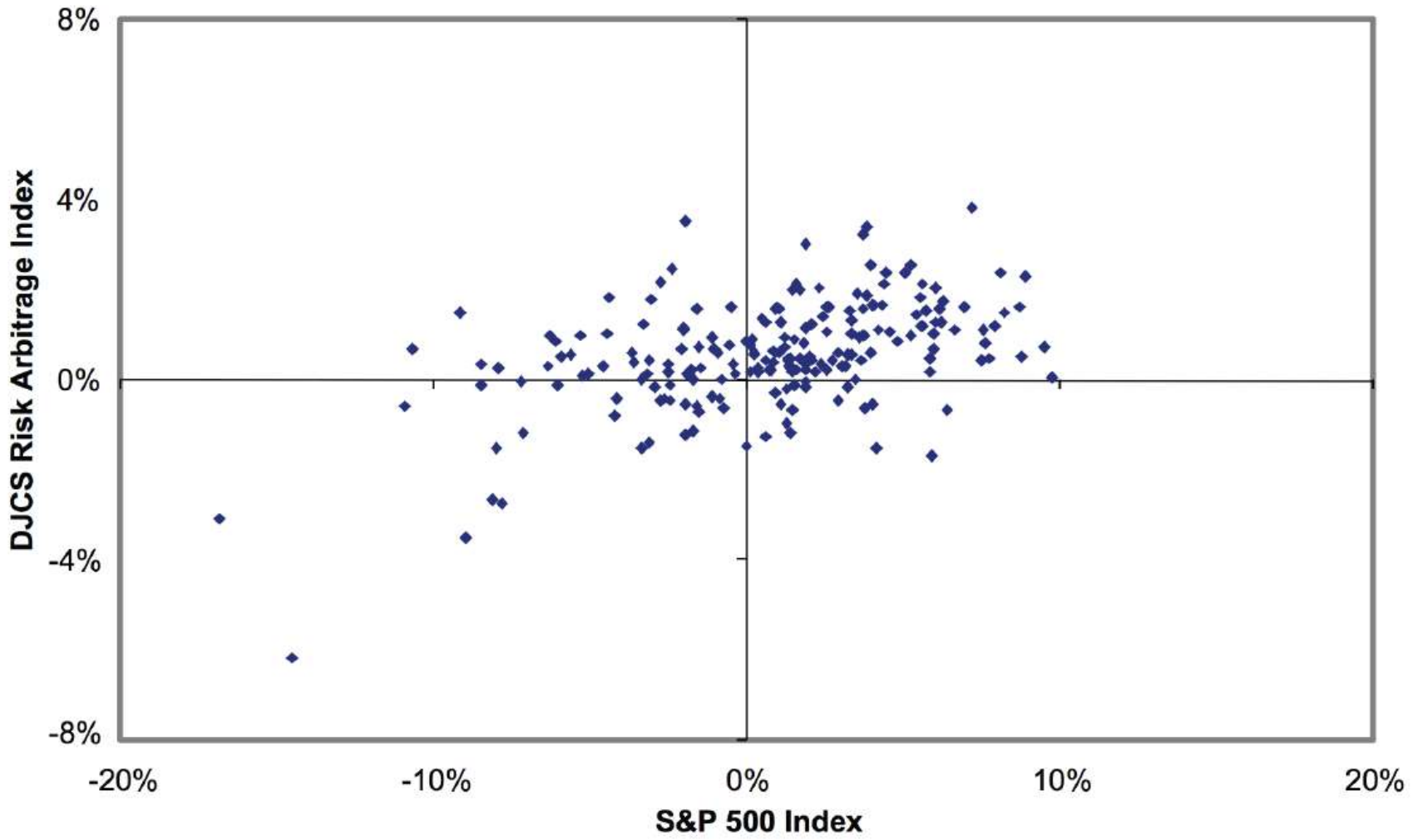
Global macro/ trend following

- Managed futures funds (CTAs) typically focus on investing in listed equity, bond and commodity futures and currency forwards.
- Managed futures funds employ systematic trading strategies that largely rely on historical price trends.
- Significant leverage may be employed to achieve some volatility target and they exhibit variable bias over time.
- Fung and Hsieh (2001) find that CTAs tend to follow a trend following strategy, with a payoff resembling a straddle.

Merger arbitrage

- Michell and Pulvino (2001) created an index of merger arbitrage returns, using announced mergers from 1964 to 2000. They showed that the merger arbitrage returns are similar to those of merger arbitrage hedge funds.
- The largest negative monthly returns from the DJCS Risk Arbitrage index all occur in months when the S&P 500 experienced large negative returns.
- Merger arbitrageurs are betting on the completion of a merger – in general, they are long 'deal' risk. Their return can be viewed as the insurance premium from selling a policy against the failure to complete a merger.
- Typically, individual merger failures a stock-specific in nature and can be diversified away in a portfolio of such transactions. However, when the broader stock market underperforms significantly, mergers tend to be called off due to negative sentiment.

DJCS Risk Arbitrage index vs. S&P 500

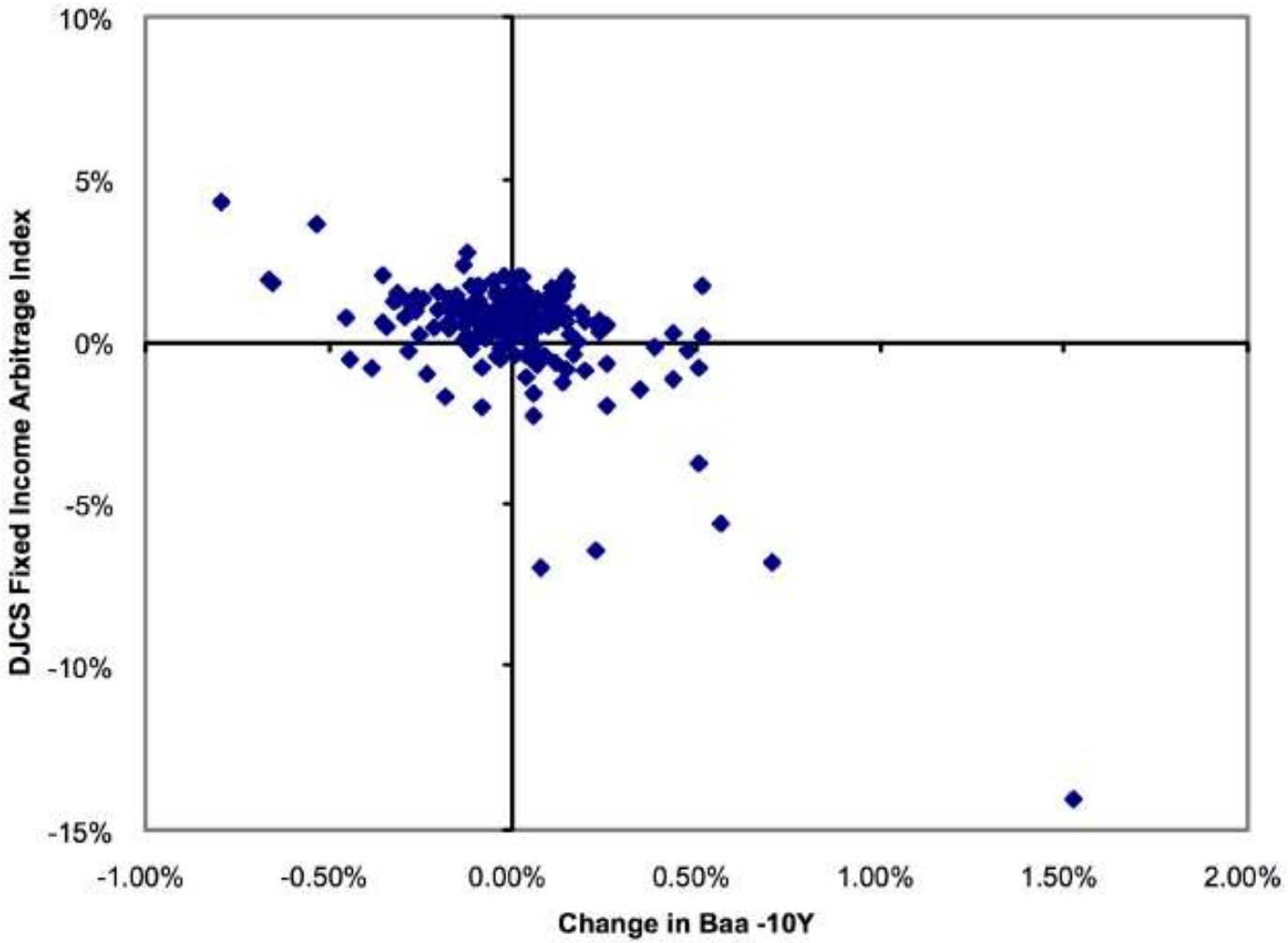


Fixed income arbitrage

- Durate, Longstaff and Yu 92007) created return series of fixed income arbitrage trades frequently used by hedge funds
  - Swap spreads
  - Yield-curve spreads
  - Mortgage spreads
  - Capital structure arbitrage

- Strong correlation between the return of these strategies and the returns of fixed income arbitrage hedge funds. In addition, many of these strategies have significant exposure to risks in the equity and bond markets.

Fixed income arbitrage vs. change in Baa-10Y spread



Equity long/short

- Long/short equity managers take long or short positions in equity securities which are deemed to be under-or-overvalued.

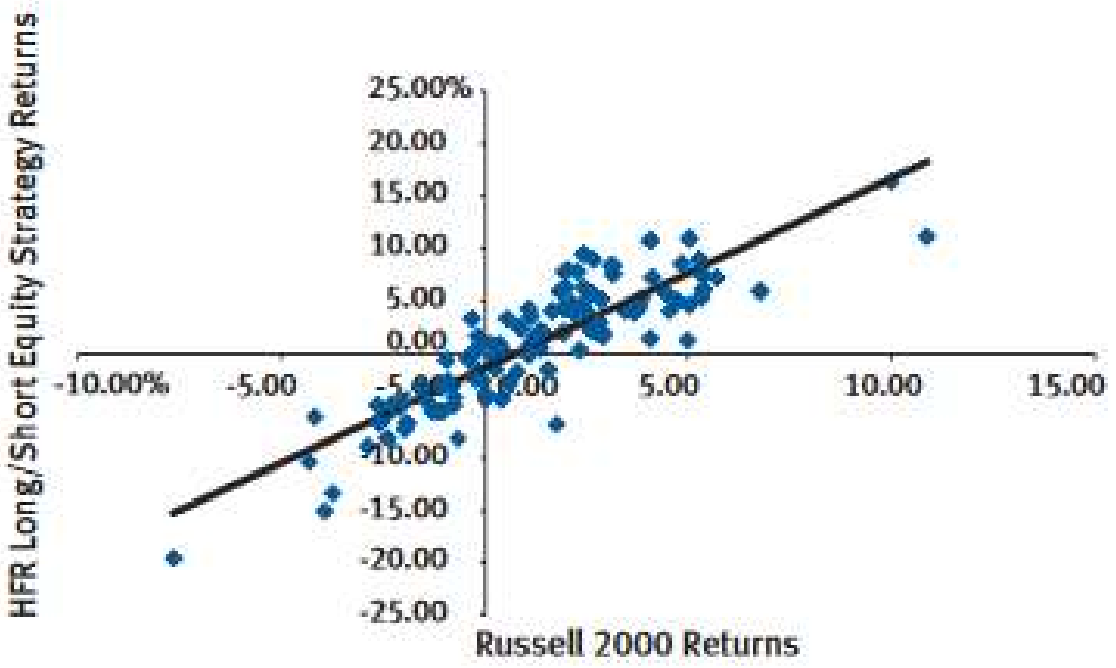
- Managers are generally not market neutral, i.e. they will either be net long or net short.

- Tend to have a net long exposure between 10% and 40%, which helps explain why the managers do well in a rising market.

HFR long/short equity vs. Russell 2000

Exhibit 12:

A scatter plot of HFR long/short equity returns vs. Russell 2000 returns



Source: Hedge Fund Research, Bloomberg L.P.

Other hedge fund strategies

- Short bias equity strategies
  - Generally used to hedge equity exposure in other parts of a portfolio
  - Provides downside protection in times of severe market dislocation
- Market neutral strategies
  - FS could not find a single common component in these strategies.
  - Different index providers have different definitions with regards to market neutrality.
- Emerging market strategies
  - High correlation with the EM index, e.g. Regression of DJCS EM index against MSCI EM has a coefficient of 0.49 and a R^2 of 63%.
  - EM hedge funds are generally long bias.

Performance trends by segments

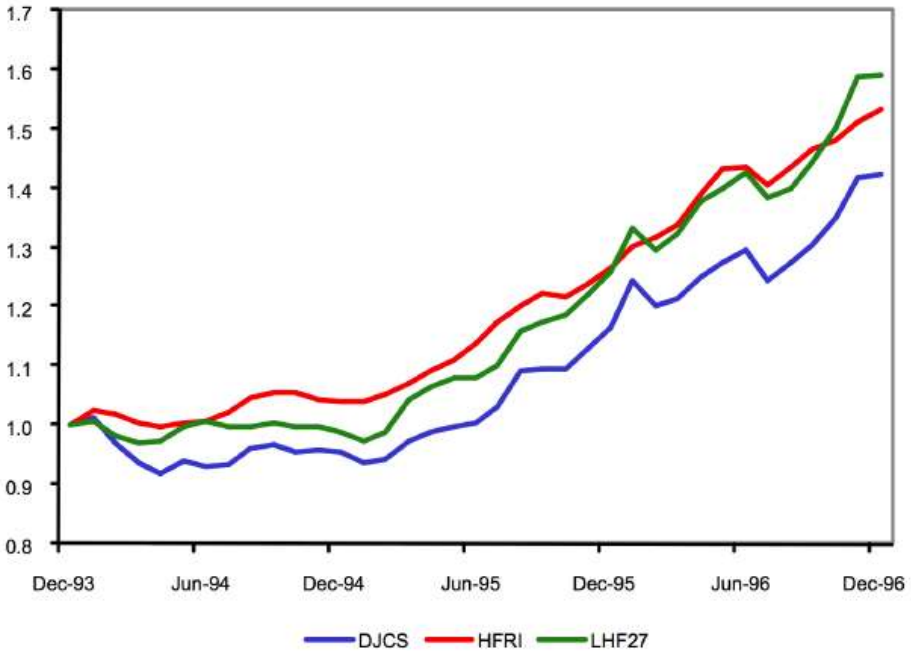


Figure 16 Cumulative return of DJCSI, HFRI indices and the LHF27 portfolio: 1994–1996.

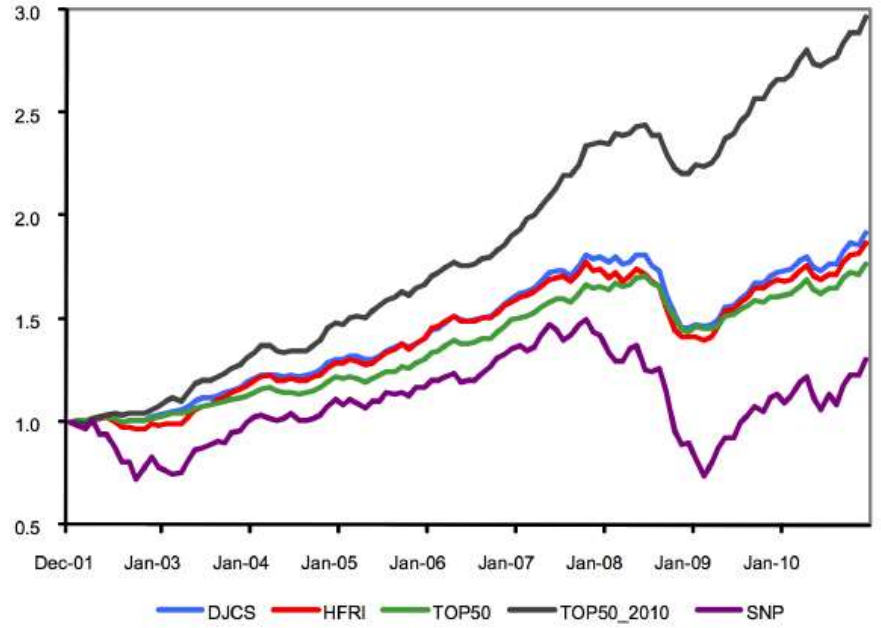


Figure 17 Cumulative return of DJCS, HFRI, SNP indices and the TOP50 and TOP50_2010 portfolios: 2002–2010.

Risk sharing asymmetry

- Asymmetry in risk sharing between principal and agent inherent in variable compensation schemes employed by hedge funds.

- Incentive fee which hedge fund managers are entitled to, typically 15-20% of new profits (i.e. profits above a high water mark), may result in the manager taking on very large bets.

- Historically, there have been numerous instances of fund managers re-emerging from a failed fund to raise capital for new hedge fund ventures.

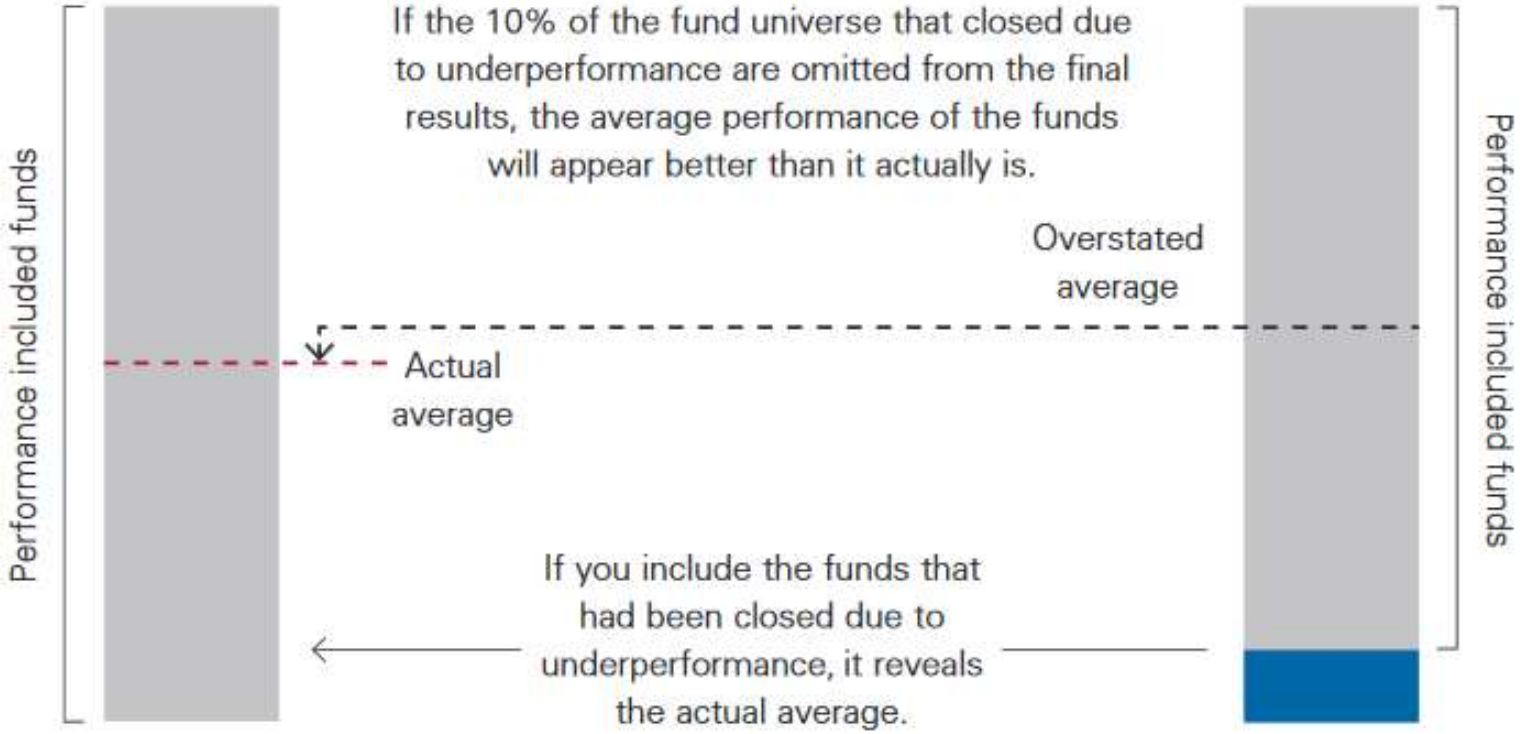
Survivorship bias

- Few hedge fund databases maintain historical performances of funds that have shut down, in part due to legal reasons and the fact that primary users of the database are investors looking to evaluate existing managers they can invest in.

- Survivorship bias occurs when an analyst calculates the performance results of a group of investments using only the survivors at the end of the period and excluding those that no longer exist.

Survivorship bias overstates average performance

Figure 1. The distorting effect of survivorship bias



Source: Vanguard advisor brief (2015) – What is 'survivorship bias; and why does it matter?

Event-driven contagion risk

- **March-April 1994**: 7 out of 10 style-specific sub-indices in the DJCS family lost money. Negative performance across strategies may be attributed to liquidation of leveraged positions following the unexpected US rate hike.

- **August 1998** leading up to the collapse of LTCM: In this month, 8 out of 10 DJCS style sub-indices suffered sizeable losses ranging from -23% for EM hedge funds to -0.85% for equity market neutral.

- **July-October 2008**: All hedge fund styles except for short equity lost money. Forced liquidation was one of the reasons.

Risk management for hedge funds

- Risk management can contribute to expected return and alpha
- But which risk metric to use?
  - Volatility
  - Value-at-risk
  - Copulas
- Risk management approaches
  - Volatility targeting
  - Risk-parity
  - Sufficient diversification

Options overwriting strategy
Capital Decimation Partners (CDP) example

- Investment strategy consists of shorting out-of-the-money S&P 500 put options on each monthly expiration date for maturities less than or equal to 3 months, with strikes approximately 7% out of the money.

Table 3. Capital Decimation Partners, LP, January 1992–December 1999

Statistic	CDP	S&P 500
Monthly mean (%)	3.7	1.4
Monthly standard deviation (%)	5.8	3.6
Minimum month (%)	–18.3	–8.9
Maximum month (%)	27.0	14.0
Annual Sharpe ratio	1.94	0.98
Number of negative months (out of total)	6/96	36/96
Correlation with S&P 500	59.9	100.0
Total return (%)	2,721.3	367.1

Options overwriting strategy
Capital Decimation Partners (CDP) example

- Track record in the previous table now looks less impressive in light of the 'simple' strategy on which it is based.

- Few investors will pay hedge-fund-type fees for such a vanilla strategy.

- However, given the secrecy surrounding most hedge fund strategies and the broad discretion that managers are given by the fund offering memorandum, it is difficult for investors to identify the strategy type without using more sophisticated risk analytics.

Options overwriting strategy
Capital Decimation Partners (CDP) example

- Stable positive return profile (insurance premium) of options overwriting strategy punctuated with occasional extreme negative losses that can wipe out accumulated gains quickly.

- Traditional risk measures such as volatility and Value-at-risk do not fully capture the large negative drawdown associated with the strategy.

- Allocation decisions based on traditional risk measures may incorrectly allocate a large budget to these type of strategies.

Capturing non-linear risks

- Correlations are linear measures. They do not capture non-linear dynamics such as the 1998 episodes where many strategies became highly coupled.

- One way to capture this non-linearity is to capture 'upside' and 'downside' betas.

$$R_{it} = \alpha_i + \beta_i^+ \Lambda_t^+ + \beta_i^- \Lambda_t^- + \varepsilon_{it},$$

where

$$\Lambda_t^+ = \begin{cases} \Lambda_t \text{ if } \Lambda_t > 0 \\ 0 \text{ otherwise} \end{cases},$$

$$\Lambda_t^- = \begin{cases} \Lambda_t \text{ if } \Lambda_t \leq 0 \\ 0 \text{ otherwise} \end{cases},$$

Capturing non-linear risks

Table 8. Nonlinearities in Hedge-Fund Index Returns: Monthly Data, January 1996–November 1999

Style Index	$\hat{\alpha}$	$t(\hat{\alpha})$	$\hat{\beta}^+$	$t(\hat{\beta}^+)$	$\hat{\beta}^-$	$t(\hat{\beta}^-)$	R^2
Currencies	0.93	1.97	0.05	0.34	0.13	0.81	0.01
ED—distress	1.95	7.84	–0.11	–1.50	0.58	6.95	0.36
ED—merger arb	1.35	7.99	0.04	0.91	0.27	4.78	0.27
EM—equity	3.78	2.41	0.16	0.34	1.49	2.84	0.11
EM	2.64	3.20	0.21	0.88	1.18	4.27	0.23
EM—fixed income	1.88	3.99	0.07	0.49	0.56	3.56	0.16
ED	1.61	9.35	–0.01	–0.26	0.43	7.37	0.41
Fund of funds	1.07	6.89	0.08	1.84	0.27	5.13	0.33
Futures trading	0.69	1.35	0.18	1.23	0.13	0.76	0.04
Growth	1.49	3.65	0.69	5.80	0.98	7.13	0.62
High yield	1.11	8.05	–0.08	–1.92	0.19	4.10	0.15
Macro	0.61	1.09	0.30	1.84	0.05	0.28	0.05
Opportunistic	1.35	3.95	0.33	3.31	0.52	4.53	0.37
Other	1.41	5.58	0.23	3.05	0.69	8.19	0.57
RV	1.36	12.22	–0.04	–1.27	0.15	4.02	0.15
RV—convertible	1.25	8.44	–0.01	–0.31	0.18	3.55	0.14
RV—EQLS	0.87	5.64	0.09	2.04	0.14	2.65	0.17
RV—option arb	4.48	4.29	–0.78	–2.56	0.33	0.95	0.07
RV—other—stat arb	1.40	4.38	–0.02	–0.18	0.11	0.99	0.01
Short selling	0.04	0.07	–0.67	–3.94	–1.25	–6.41	0.51
Value	1.46	4.49	0.24	2.54	0.69	6.41	0.45

Liquidity and credit risk

- Leverage has the effect of exaggerating small profit/ losses into larger ones.

- When adverse changes in market prices reduce the market value of collateral, credit is withdrawn quickly and the subsequent forced liquidation of large positions over a short time period can lead to a wider sell-off.

- Complex network of creditor/ obligor relationships, revolving credit agreements, and other financial interconnections is largely unmapped.

Liquidity and credit risk

- One way to gauge hedge fund liquidity risk is to examine its return autocorrelation coefficient.
- Idea is that the more efficient the market, the more random price movements will be. Market frictions (e.g. liquidity constraints), on the other hand, contribute to the possibility of serial correlation in asset returns.
- Given the compensation structure of hedge funds, managers are incentivized to 'smooth' their returns to achieve a higher Sharpe ratio.
- To measure autocorrelation, the Ljung-Box Q-statistic can be used.
- Typically, mutual funds exhibit low autocorrelation in returns, while hedge funds tend to show statistically significant serial correlation.

Weighting portfolio performance

- Time-weighted returns
  - Adjusts for cash flow effects
  - Measures the true performance of the portfolio manager as cash in/out flows are beyond the control of the manager
- Dollar-weighted returns
  - The IRR equating the investments and cash flow returns, which does not adjust for timing of cash flows (inflows/ outflows)

Different performance measurement metrics

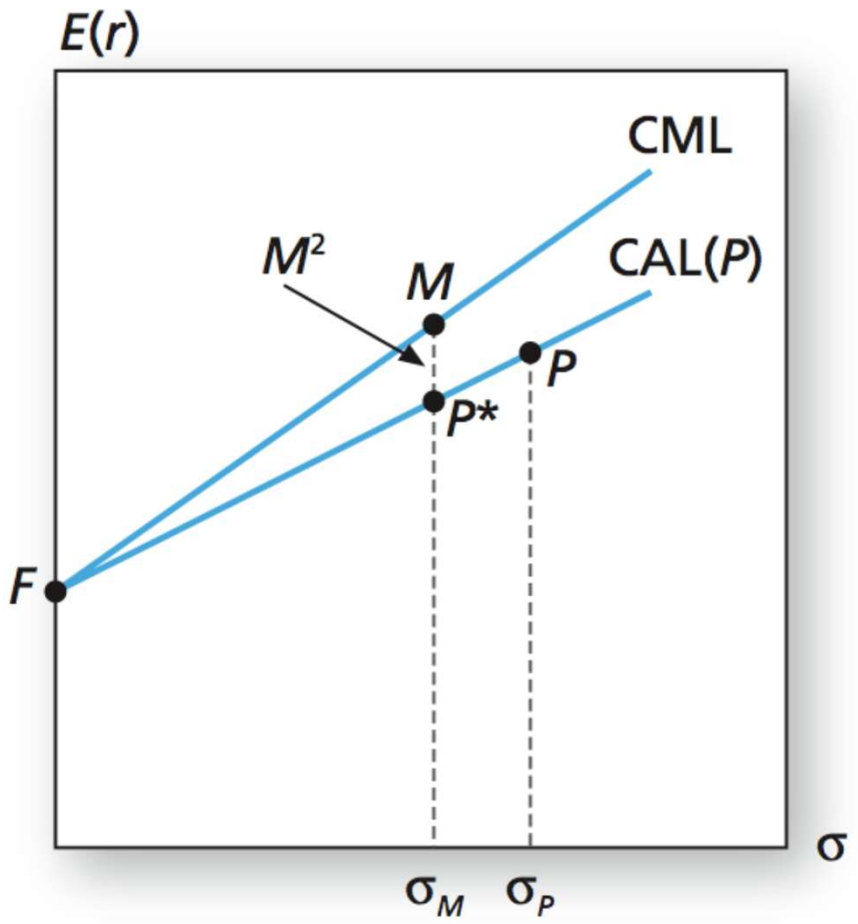
- Sharpe ratio: $\left(R_p - R_f\right)/\sigma_p$
  - Absolute return basis
  - Measures the portfolio excess return (over the risk-free rate) per unit of total risk
- Treynor ratio: $\left(R_p - R_f\right)/\beta_p$
  - Like the Sharpe ratio, Treynor's measures gives excess return per unit of risk, but it uses systematic risk instead of total risk.
- Jensen measure: $\alpha_p = r_p - \left[r_f + \beta_p\left(r_m - r_f\right)\right]$
  - Measures portfolio alpha, the average return on the portfolio over and above that predicted by CAPM, given the portfolio's beta and market return.

Different performance measurement metrics

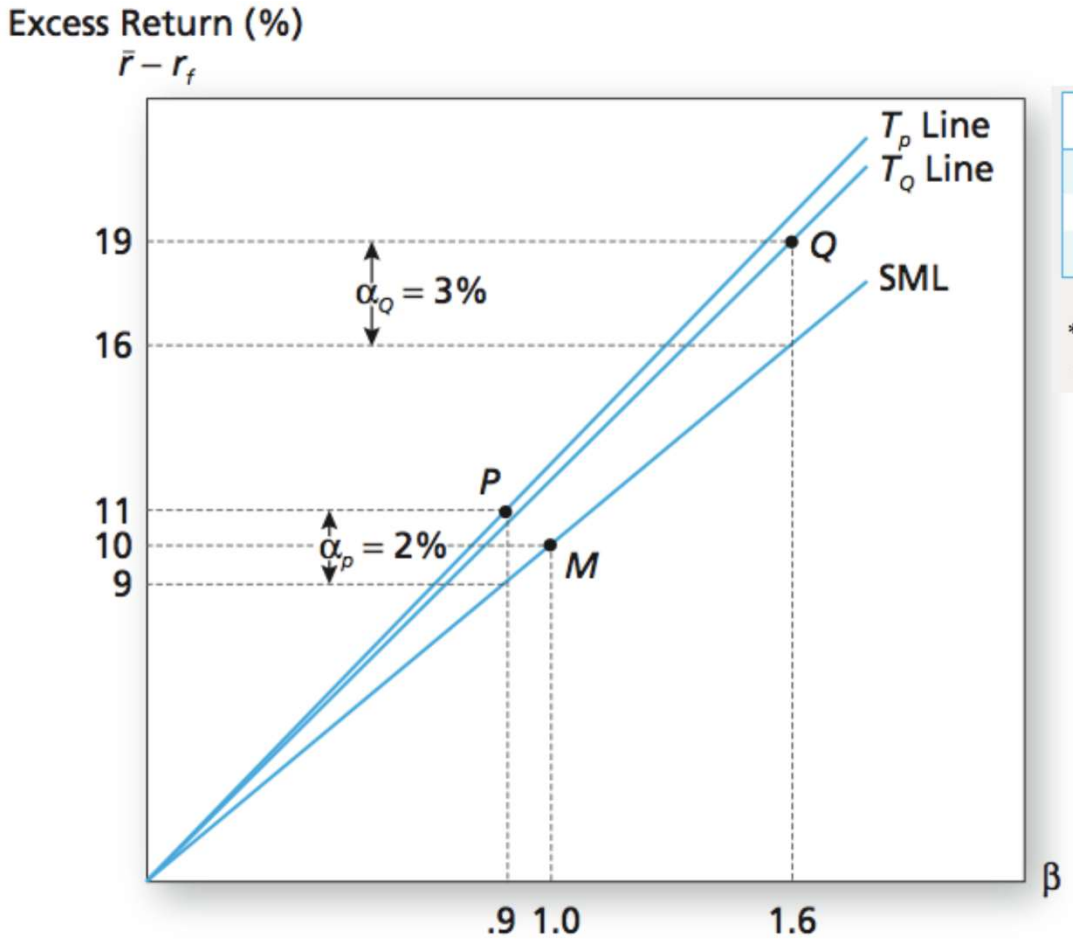
- M^2 or Modigliani-squared measure
  - Measures the return of the volatility adjusted of the portfolio less the market return
  - Portfolio is mixed with a position in T-bills so that its volatility is equal to the market volatility. Long or short position in T-bills depends on whether we are levering up or down to achieve market volatility.
- Information ratio: $\left(R_p - R_b\right)/\sigma_{p-b}$
  - Relative return basis
  - Measures a portfolio manager's ability to generate excess returns per unit of tracking risk relative to a benchmark.

Modigliani-squared measure

- Assume that the volatility of portfolio P and the market is 42% and 30%.
- To equalize the portfolio volatility with the market, the adjusted portfolio P* will consist of 71.4% in P and 28.6% in bills.



Treynor's measure



	Portfolio *P*	Portfolio *Q*	Market
Beta	.90	1.60	1.0
Excess return ($\bar{r} - \bar{r}_f$)	11%	19%	10%
Alpha*	2%	3%	0

*Alpha = Excess return − (Beta × Market excess return)
$= (\bar{r} - \bar{r}_f) - \beta(\bar{r}_M - \bar{r}_f) = \bar{r} - [\bar{r}_f + \beta(\bar{r}_M - \bar{r}_f)]$

Fund performance evaluation example

- Which fund is better?
- Depends on investment mandate
  - Entire fund investment
  - As a sub-portfolio
  - As an active portfolio mixed with index portfolio

Month	Jane's Portfolio *P*	Alternative *Q*	Benchmark *M*
1	3.58%	2.81%	2.20%
2	−4.91	−1.15	−8.41
3	6.51	2.53	3.27
4	11.13	37.09	14.41
5	8.78	12.88	7.71
6	9.38	39.08	14.36
7	−3.66	−8.84	−6.15
8	5.56	0.83	2.74
9	−7.72	0.85	−15.27
10	7.76	12.09	6.49
11	−4.01	−5.68	−3.13
12	0.78	−1.77	1.41
Average	2.76	7.56	1.63
Standard deviation	6.17	14.89	8.48

	Portfolio *P*	Portfolio *Q*	Portfolio *M*
Sharpe's measure	0.45	0.51	0.19
M^2	2.19	2.69	0.00
SCL regression statistics			
Alpha	1.63	5.28	0.00
Beta	0.69	1.40	1.00
Treynor	4.00	5.40	1.63
T^2	2.37	3.77	0.00
σ(e)	1.95	8.98	0.00
Information ratio	0.84	0.59	0.00
R-SQR	0.91	0.64	1.00

Difficulties in measuring hedge fund performance

- Dynamic risk profile of hedge funds who have greater freedom to change investment strategy opportunistically. This makes it difficult to measure exposure at any given point in time.

- Hedge funds tend to invest in illiquid assets – Disentangle liquidity premium from true alpha. Infrequent trading of these assets make mark-to-market challenging.

- Hedge funds pursue strategies with apparently stable returns over long periods of time, punctuated with infrequent severe losses.

- Survivorship bias can overstate historical performance due to much higher turnover in hedge funds versus mutual funds.

Measuring market timing ability

- Treynor and Mazuy (1966): Add a squared term to the market model

$$R_{pt} - R_{ft} = \alpha + \beta_1\left(R_{mt} - R_{ft}\right) + \beta_1\left(R_{mt} - R_{ft}\right)^2 + \varepsilon_t$$

- Henriksson and Merton (1981): Measuring upside and downside beta

$$R_{pt} - R_{ft} = \alpha + \beta_u X_{ut} + \beta_d X_{dt} + \varepsilon_t$$

where $X_{ut} = max\left[0, R_{mt} - R_{ft}\right]$ (up-market) and $X_{dt} = min\left[0, R_{mt} - R_{ft}\right]$ (down-market)

Measuring market timing ability

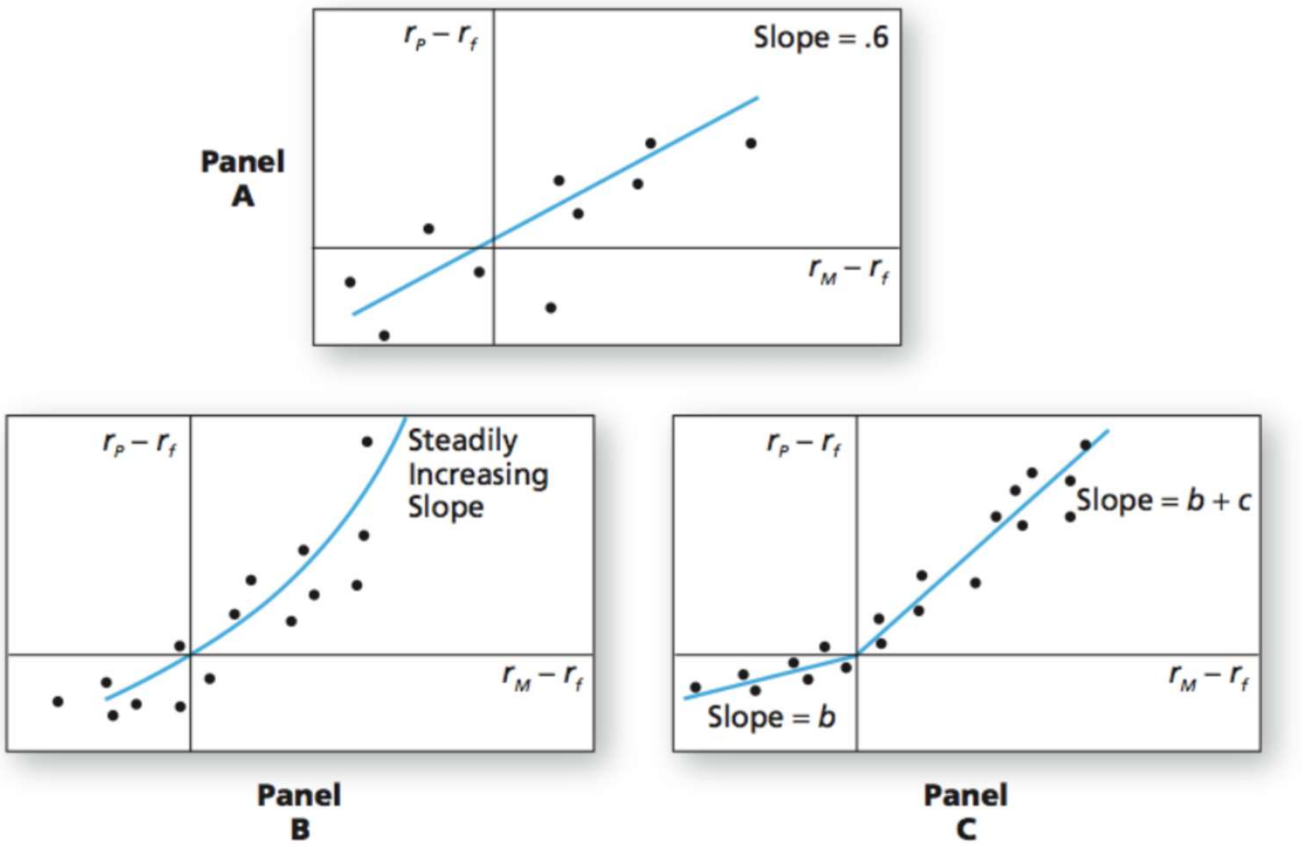


Figure 24.5 Characteristic lines. ***Panel A:*** No market timing, beta is constant. ***Panel B:*** Market timing, beta increases with expected market excess return. ***Panel C:*** Market timing with only two values of beta.

Performance attribution

- Isolating asset allocation and security selection

Contribution from asset allocation	$(w_{Pi} - w_{Bi})r_{Bi}$
+ Contribution from security selection	$w_{Pi}(r_{Pi} - r_{Bi})$
= Total contribution from asset class i	$w_{Pi}r_{Pi} - w_{Bi}r_{Bi}$

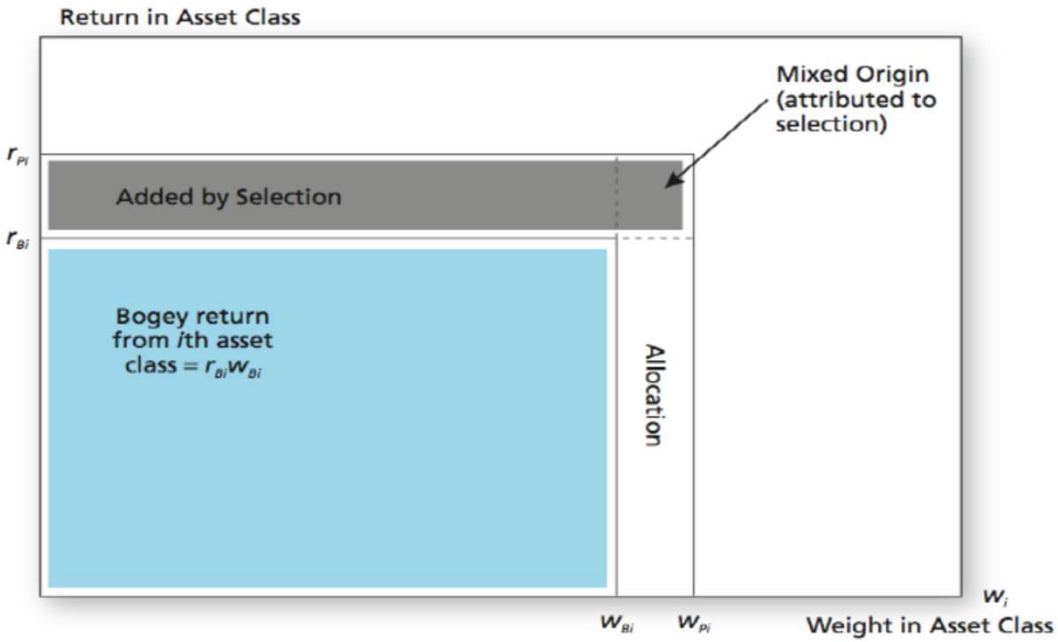


Figure 24.10 Performance attribution of ith asset class. Enclosed area indicates total rate of return.

Performance attribution example (1)

Component	Bogey Performance and Excess Return	
	Benchmark Weight	Return of Index during Month (%)
Equity (S&P 500)	.60	5.81
Bonds (Barclays Aggregate Index)	.30	1.45
Cash (money market)	.10	0.48
Bogey = (.60 × 5.81) + (.30 × 1.45) + (.10 × 0.48) = 3.97%		
Return of managed portfolio	5.34%	
– Return of bogey portfolio	3.97	
Excess return of managed portfolio	1.37%	

Performance attribution example (2)
Disentangling top-down and bottom-up effects

A. Contribution of Asset Allocation to Performance

Market	(1) Actual Weight in Market	(2) Benchmark Weight in Market	(3) Active or Excess Weight	(4) Market Return (%)	(5) = (3) × (4) Contribution to Performance (%)
Equity	.70	.60	.10	5.81	.5810
Fixed-income	.07	.30	−.23	1.45	−.3335
Cash	.23	.10	.13	.48	.0624
Contribution of asset allocation					.3099

B. Contribution of Selection to Total Performance

Market	(1) Portfolio Performance (%)	(2) Index Performance (%)	(3) Excess Performance (%)	(4) Portfolio Weight	(5) = (3) × (4) Contribution (%)
Equity	7.28	5.81	1.47	.70	1.03
Fixed-income	1.89	1.45	0.44	.07	0.03
Contribution of selection within markets					1.06

Performance attribution example (3)
Sector allocation vs security selection

	(1)	(2)	(3)	(4)	(5) = (3) × (4)
	Beginning of Month Weights (%)				
Sector	Portfolio	S&P 500	Active Weights (%)	Sector Return (%)	Sector Allocation Contribution
Basic materials	1.96	8.3	−6.34	6.9	−0.4375
Business services	7.84	4.1	3.74	7.0	0.2618
Capital goods	1.87	7.8	−5.93	4.1	−0.2431
Consumer cyclical	8.47	12.5	−4.03	8.8	0.3546
Consumer noncyclical	40.37	20.4	19.97	10.0	1.9970
Credit sensitive	24.01	21.8	2.21	5.0	0.1105
Energy	13.53	14.2	−0.67	2.6	−0.0174
Technology	1.95	10.9	−8.95	0.3	−0.0269
TOTAL					1.2898

Summary Attribution

		Contribution (basis points)
1. Asset allocation		31
2. Selection		
a. Equity excess return (basis points)		
i. Sector allocation	129	
ii. Security selection	18	
	147 × .70 (portfolio weight) =	102.9
b. Fixed-income excess return	44 × .07 (portfolio weight) =	3.1
Total excess return of portfolio		137.0

Differences between traditional and alternative offerings

Exhibit 9.1. Characteristics of Traditional and Alternative Investment Portfolios

	Publicly Traded Securities	Non-Publicly Traded Securities
Instruments	Equities, fixed income, commodity futures, REITs, high yield	Private equity, direct real estate, direct commodities, distressed
Portfolio construction	Diversified	Concentrated
Portfolio transparency	High	Low
Liquidity	High	Low
Funding	Quick implementation	Commitment implemented over time
Information sources	Much, publicly available	Much, privately collected
Fund accessibility	Commonly open	Commonly limited
Asset accessibility	Open	Limited
Asset ownership	Passive	Active
Leverage	Uncommon	Financial leverage common
Fees	Lower	Higher, performance based