

# From Niche to Mainstream: A New Approach to Utilizing Hedge Funds in Strategic Asset Allocation<sup>1</sup>

Ban ZHENG<sup>†</sup>, PhD

<sup>†</sup>Lyxor Asset Management, France

joint work with Zélia CAZALET

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<sup>1</sup>The opinions expressed in this presentation are those of the author and are not meant to represent the opinions or official positions of Lyxor Asset Management.

## Main results

- 1 A panorama of the stylized facts of hedge funds from 2000 to 2013  
**The behavior of hedge funds has profoundly changed!**
- 2 A detailed presentation of investment vehicles in hedge fund investment  
**Hedge funds are more accessible than before!**
- 3 An investor's view: benefits and risks in hedge fund investment  
**More expertise is needed in hedge fund investing!**
- 4 A new approach to utilizing hedge funds in Strategic Asset Allocation (SAA):
  - 1 A new process to classify hedge funds: equity/bond substitutes or diversifiers
  - 2 A new model to study the allocation of hedge funds in extreme regime and normal regime

**Appropriate solution to introduce heterogeneous hedge funds in SAA!**

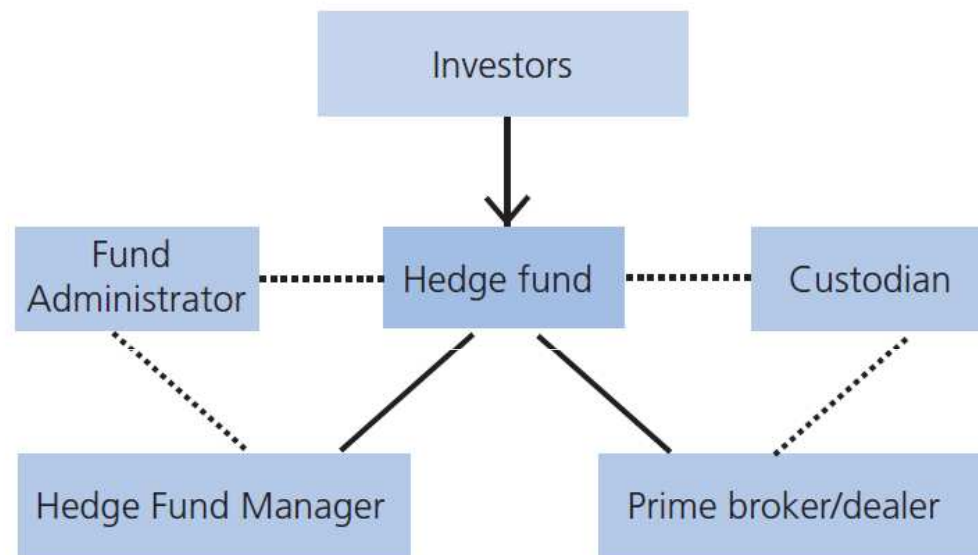
# Outline

- 1 Introduction
- 2 Hedge fund overview
  - Hedge fund databases
  - Stylized facts of hedge funds
  - Quantitative classification of hedge funds
- 3 Investment vehicles
- 4 Benefits and risks in hedge fund investments
  - Benefits in hedge fund investments
  - Risks in hedge funds investments
- 5 Smart strategic asset allocation with hedge funds
  - A new vision of hedge funds after the subprime crisis
  - A new process to classify hedge funds
  - How much should we invest in hedge funds?
- 6 Conclusion

# What are hedge funds?

- 1 Hedge funds are investment vehicle using unconventional strategies in a wide range of financial instruments
- 2 The objective of hedge funds consists in generating Alpha (absolute positive performance)
- 3 Hedge funds receive management fee which is proportional (around 2%) to the amount of assets under management and incentive fee which is proportional (around 20%) to the profit
- 4 The fund manager is key to hedge funds: he determines its governance structure, the level of transparency towards investors and selects the fund's service providers

# The structure of hedge fund



<sup>1</sup> Dashed lines indicate optional relationships  
Sources: AIMA and ASSIRT Hedge Fund Booklet

## A little history of hedge funds

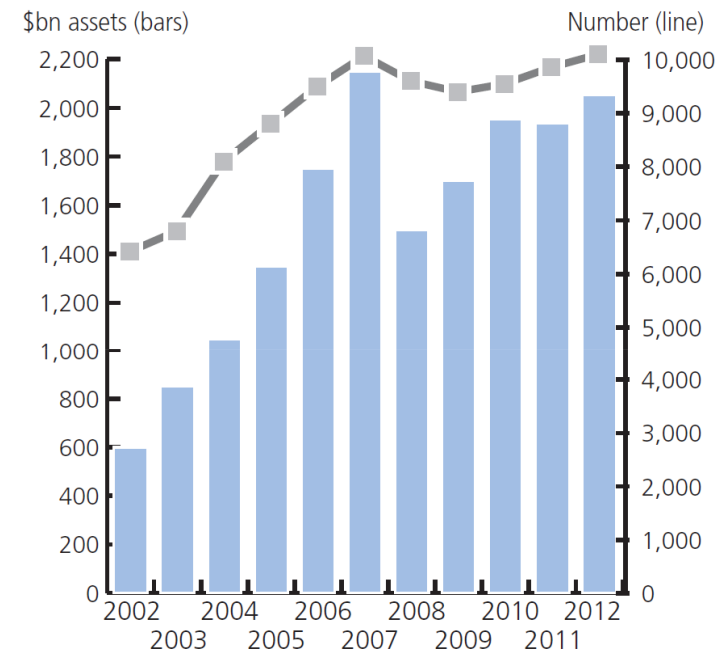
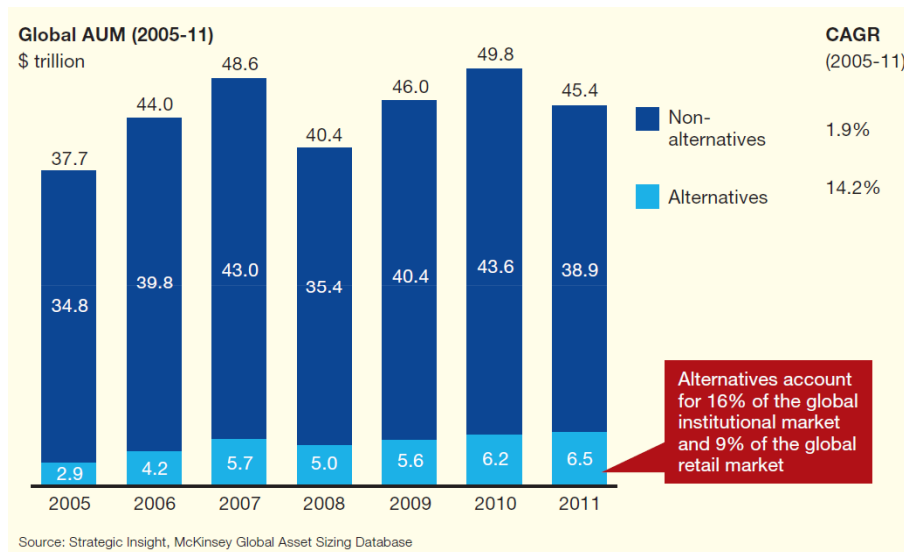
- 1 In 1931, Karsten introduced the key principles of hedge funds in his book *Scientific Forecasting*
- 2 In 1949, Jones created the first large hedge fund by buying undervalued stocks, selling overvalued stocks and adding leverage
- 3 During the 1950s and 1960s, hedge fund industry experienced strong growth in the bull market: 140 out of 215 investment partnerships were hedge funds in 1968. **Buffett Partnership, WJS Partnership and Quantum Fund** were born
- 4 From the end of the 1960s to the beginning of 1980s: difficult time for hedge funds
- 5 In 1986, the popularity of hedge funds was revived again by *Institutional Investor* written by Rohrer reporting the out-performance of Julian Robertson's Tiger Fund (**Global Macro strategy**)

## A little history of hedge funds

- 1 From the end of the 1980s to 1998, hedge funds were hurt by several crises but recovered better than financial markets as a whole
- 2 In 1998, **Long Term Capital Management (LTCM)** collapsed.
- 3 From the end of 1990s to 2007, hedge fund golden age
- 4 In 2008, hedge funds were hurt much by the subprime crisis. The fraud by Madoff Investment Securities LLC drove regulators to impose more constraints on registration and reporting
- 5 At the end of 2012, the asset under management of hedge funds reached USD 2.05 trillion

# A panorama of the hedge fund industry

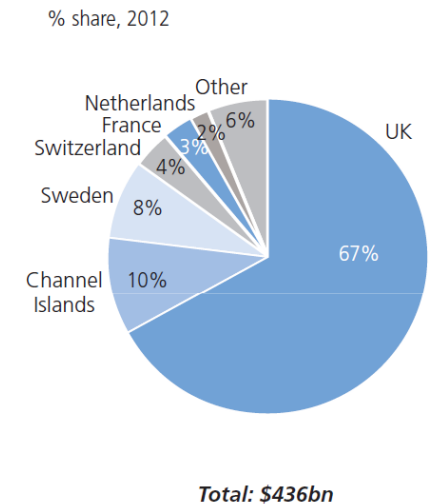
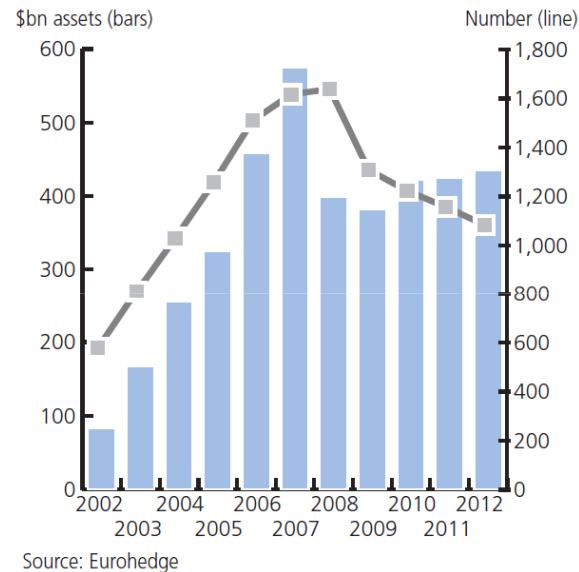
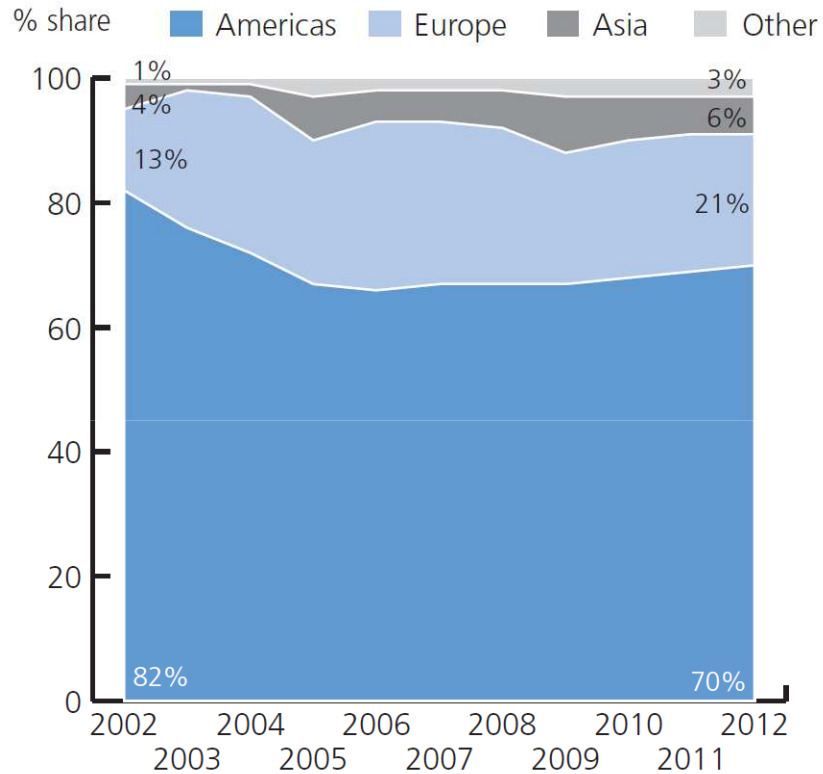
Figure: Traditional investment vs Alternative investment (left) and the hedge fund industry (right)





# A panorama of the hedge fund industry

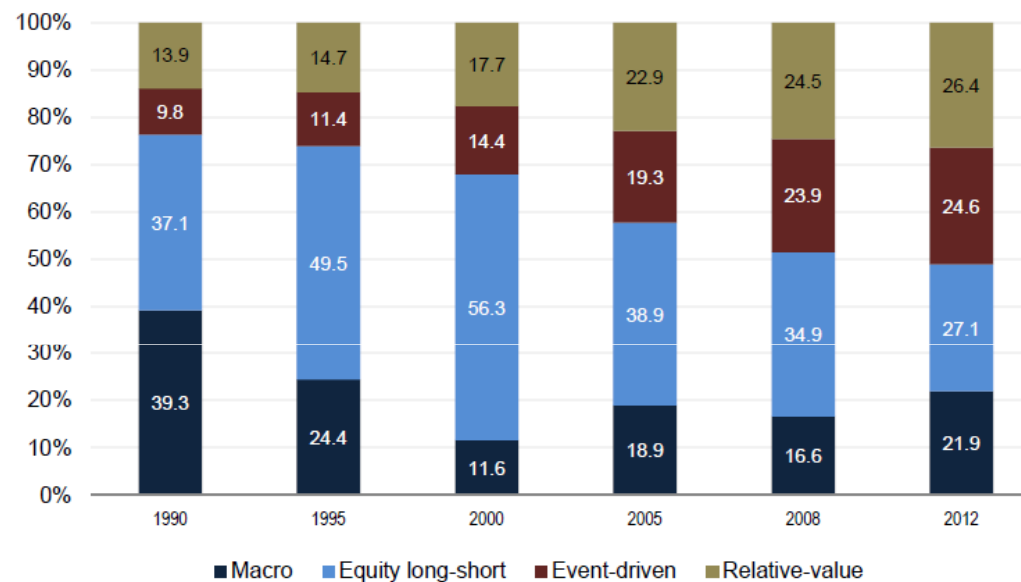
Figure: Geographic breakdown of the hedge fund industry



Source: TheCityUK estimates

# A panorama of the hedge fund industry

Figure: Distribution of AUM by strategy

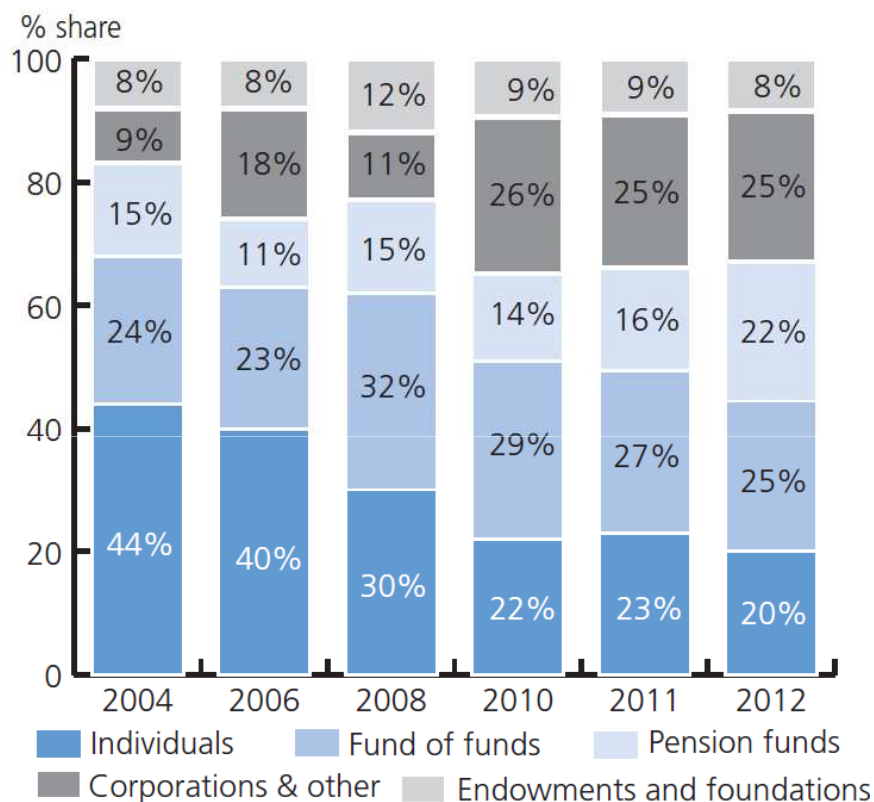


Source: IR&M, Hedge Fund Research

Note: Hedge Fund Research reclassified their HFRI indices in 2008. Previous versions of this sector breakdown show larger market share for Macro in the 1990s.

# A panorama of the hedge fund industry

Figure: Hedge fund investors (left) and the largest hedge funds (right)



Source: Hennessee Group LLC; FSA; TheCityUK estimates

Largest hedge funds, 2012, assets under management

	Location	\$bn
Bridgewater Associates	Westport CT, US	76.1
JP Morgan Asset Man.	New York NY, US	53.6
Man Group	London, UK	36.5
Brevan Howard Asset Man.	London, UK	34.2
Och-Ziff Capital Man. Group	London, UK	30.0
BlackRock Advisors	New York NY, US	28.8
BlueCrest Capital Management	New York NY, US	28.8
Baupost Group	London, UK	28.6
AQR Capital Management	Boston MA, US	25.2
Paulson & Co	Greenwich CT, US	23.2
Angelo, Gordon & Co.	New York NY, US	22.6
Renaissance Technologies Corp.	New York NY, US	22.1
DE Shaw & Co.	East Setauket NY, US	20.0
Ellion Management Corp.	New York NY, US	19.5

Source: Institutional Investor

# Private hedge fund databases

Main strategy	HFR	TASS	CISDM	Eureka Hedge
Equity Hedge	Equity Market Neutral Fundamental Quantitative Directional Sector Short Bias Multi-strategy	LongShort Equity Equity Market Neutral Dedicated Short Bias	LongShort Equity Long Only Equity	LongShort Equity Bottom-up Top-Down
Event-Driven	Activist Credit Arbitrage Distressed Restructuring Merger Arbitrage Private Issue Regulation D Special Situations Multi-strategy	Event-Driven	Distressed Securities Event-Driven	Event-Driven Distressed Debt
Macro	Active Trading Commodity Currency Discretionary Thematic Energy Systematic Diversified Multi-strategy	Global Macro Managed Futures	Global Macro	CTA Managed Futures Macro
Relative Value	Fixed Income Volatility Yield Alternatives Multi-strategy	Convertible Arbitrage Fixed Income Arbitrage Multi-strategy	Convertible Arbitrage Debt Arbitrage & Arbitrage Fixed Income	Fixed Income Value Relative Value Multi-strategy
Other	Emerging Market	Emerging Market	Emerging Market Other	Emerging Market Dual Approach Other

## Definition of hedge fund strategies in HFR

- 1 **Equity Hedge:** Equity Hedge strategies maintain positions both long and short in primarily equity and equity derivative securities.
- 2 **Event-Driven:** Investment Managers who maintain positions in companies currently or prospectively involved in corporate transactions of a wide variety including but not limited to mergers, restructurings, financial distress, tender offers, shareholder buybacks, debt exchanges, security issuance or other capital structure adjustments.
- 3 **Macro:** Investment Managers which trade a broad range of strategies in which the investment process is predicated on movements in underlying economic variables and the impact these have on equity, fixed income, hard currency and commodity markets.
- 4 **Relative Value:** Investment Managers who maintain positions in which the investment thesis is predicated on realization of a valuation discrepancy in the relationship between multiple securities.

## Biases in database construction

- 1 **Selection bias:** hedge funds decide for themselves what to communicate in prospectuses and voluntarily provide information about their performance
- 2 **Survivorship bias:** exclude “dead funds” from statistical study when their performance is no longer reported
- 3 **Backfill bias:** fund managers decide whether or not to report their returns over the incubation period prior to the date of submission
- 4 **Liquidity bias:** the smoothing of prices in the valuation process of illiquid assets

## Basic statistics of hedge fund indices

Table: Abbreviation of hedge fund strategies

Strategy	Abbreviation
HFRI Fund Weighted Composite Index	HFRI
Equity Hedge	EH
Event-Driven	ED
Macro	Macro
Relative Value	RV

## Basic statistics of hedge fund indices

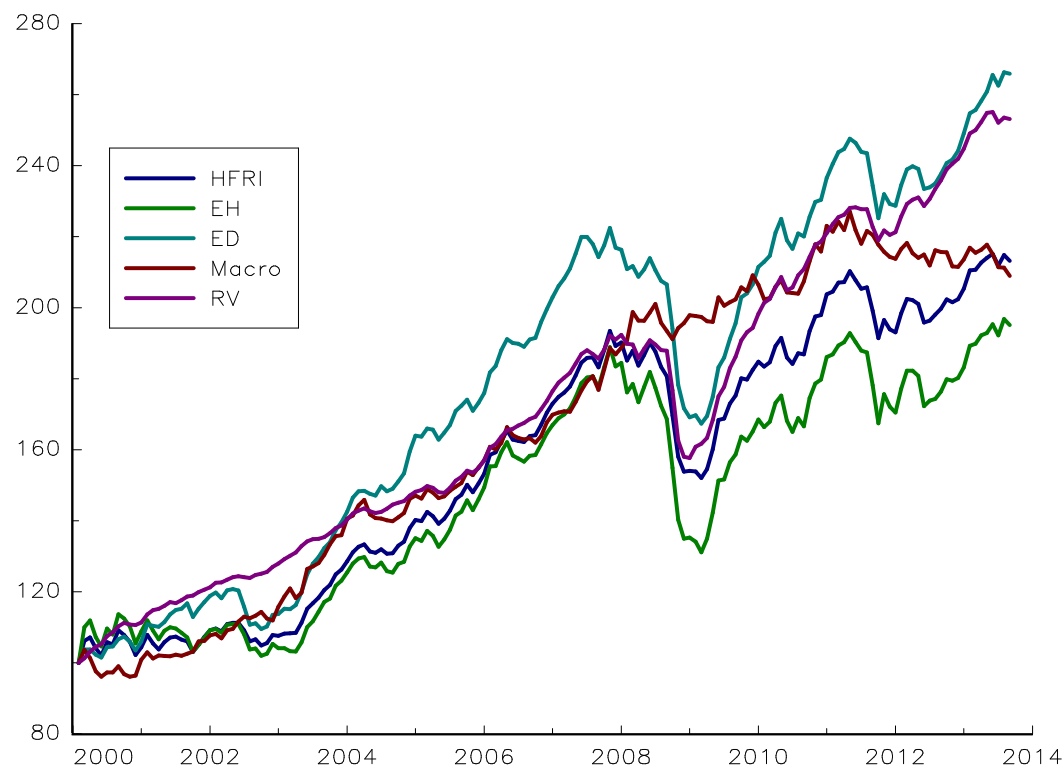
**Table:** Abbreviation of hedge fund strategies

Strategy	Abbreviation
Equity Hedge Equity Market Neutral	EH: EMN
Equity Hedge Quant. Directional	EH: QD
Equity Hedge Short Bias	EH: SB
Equity Hedge Sector Energy Basic Mat	EH: S-EB
Equity Hedge Sector Tech Health	EH: S-TH
Event Driven Merger Arbitrage	ED: MA
Event Driven Private Issue	ED: PI
Event Driven Distressed	ED: DIS
Macro Syst. Diversified	ED: SD
Relative Value Yield Alternative	RV: YA
Relative Value Fixed Income Asset Backed	RV: FI-AB
Relative Value Fixed Income Asset Convertible Arbitrage	RV: FI-CA
Relative Value Fixed Income Asset Corporate	RV: FI-C
Relative Value Multi Strategy	RV: MS



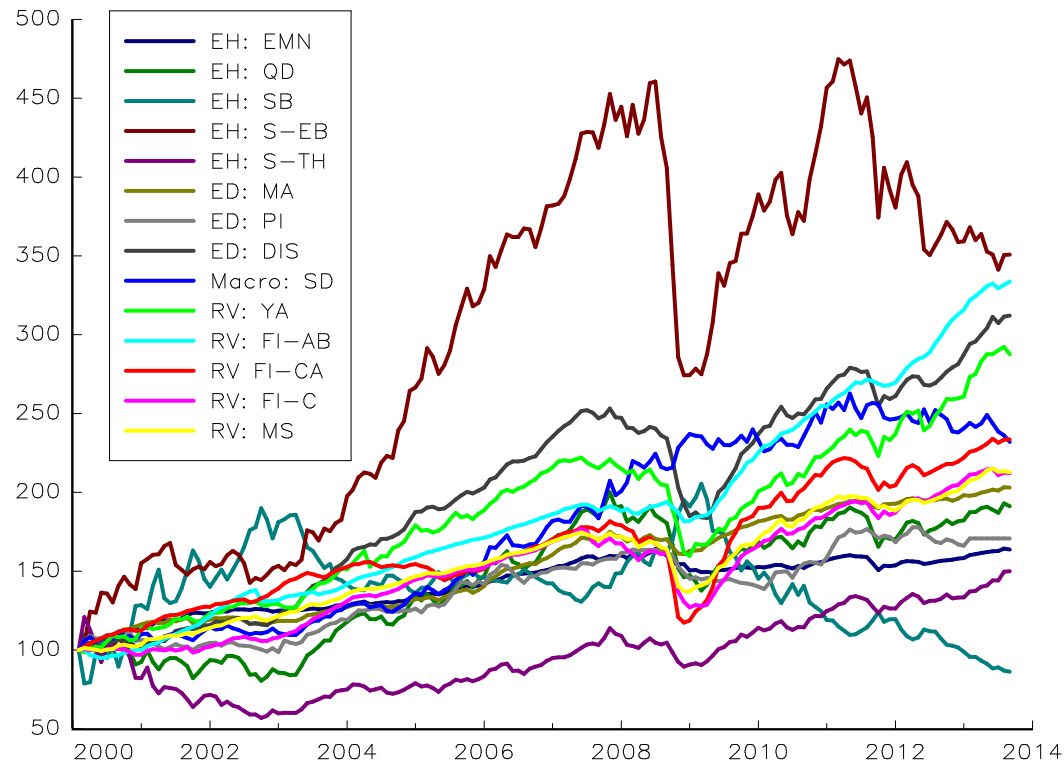
# Basic statistics of hedge fund indices

Figure: Evolution of HFRI strategies



# Basic statistics of hedge fund indices

Figure: Evolution of HFRI sub-strategies



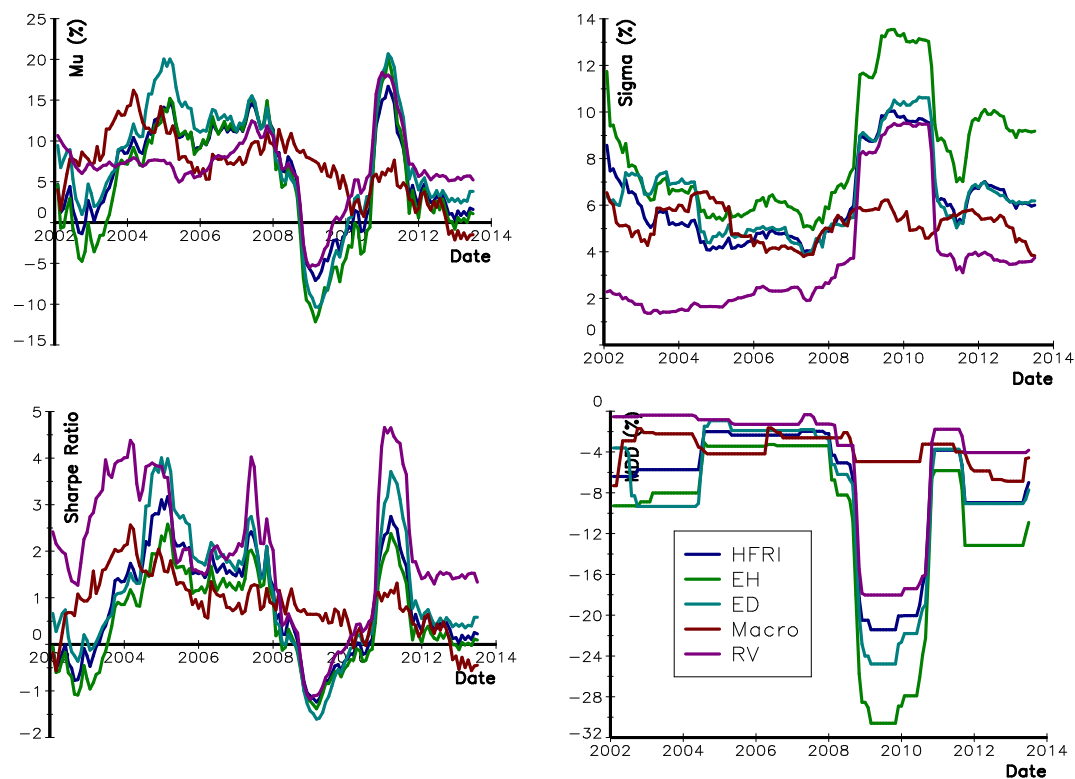
## Basic statistics of hedge fund indices

Table: Statistics of HFRI strategies (January 2000 - June 2013)

Strategy	$\mu$	$\sigma$	SR	$MDD$	$\gamma_1$	$\gamma_2$
HFRI	5.76	6.67	0.49	-21.42	-0.57	4.34
EH	4.98	9.03	0.28	-30.59	-0.40	4.89
ED	7.47	6.73	0.74	-24.79	-1.09	5.59
Macro	5.75	5.44	0.60	-7.32	0.27	3.23
RV	7.13	4.41	1.06	-18.04	-2.83	18.92

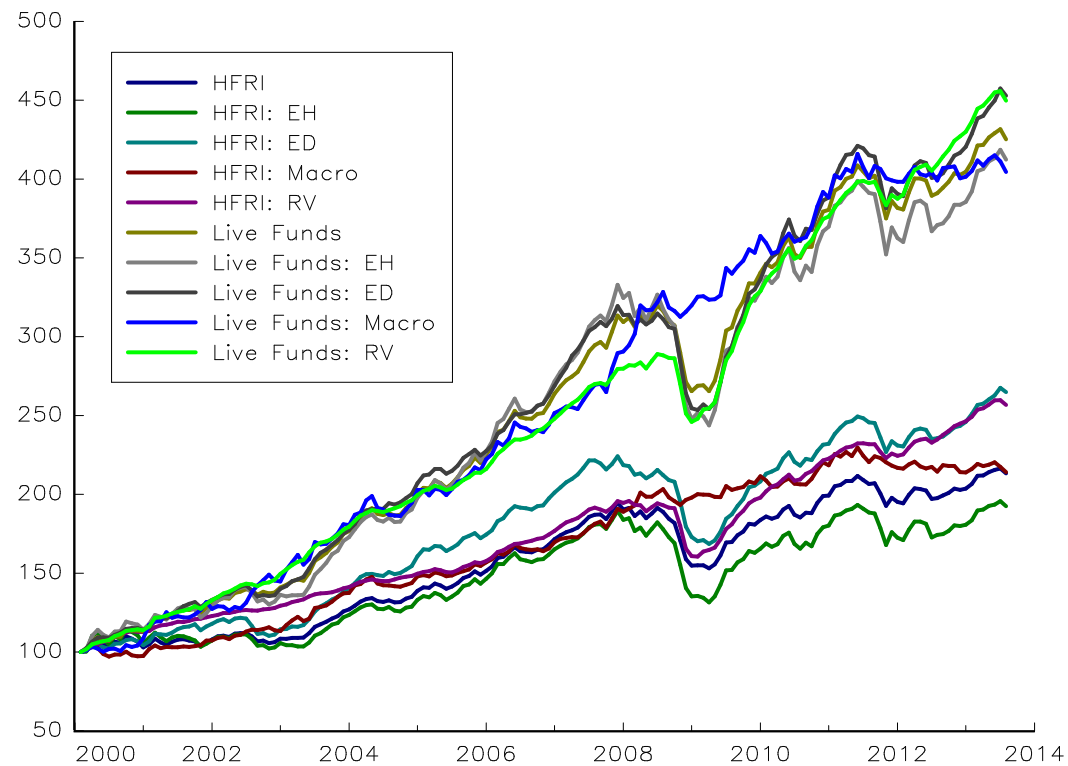
# Basic statistics of hedge fund indices

Figure: Evolution of statistics for each strategy



# Survivorship bias

Figure: Performance of live funds based indices versus HFRI



## Survivorship bias

**Table:** Statistics of HFRI versus live funds based indices (January 2000 - June 2013)

Asset	$\mu$	$\sigma$	SR	$MDD$	$\gamma_1$	$\gamma_2$
HFRI	5.76	6.67	0.49	-21.42	-0.57	4.34
EH	4.98	9.03	0.28	-30.59	-0.40	4.89
ED	7.47	6.73	0.74	-24.79	-1.09	5.59
Macro	5.75	5.44	0.60	-7.32	0.27	3.23
RV	7.13	4.41	1.06	-18.04	-2.83	18.92
Live Funds	11.26	6.69	1.32	-16.98	-0.43	4.35
Live Funds: EH	11.00	9.24	0.93	-26.79	-0.56	4.37
Live Funds: ED	11.70	6.48	1.43	-20.63	-1.15	6.31
Live Funds: Macro	10.88	7.22	1.17	-6.37	0.48	3.42
Live Funds: RV	11.72	4.81	1.93	-14.85	-1.55	12.08

## Abnormal distribution and fat tail risk

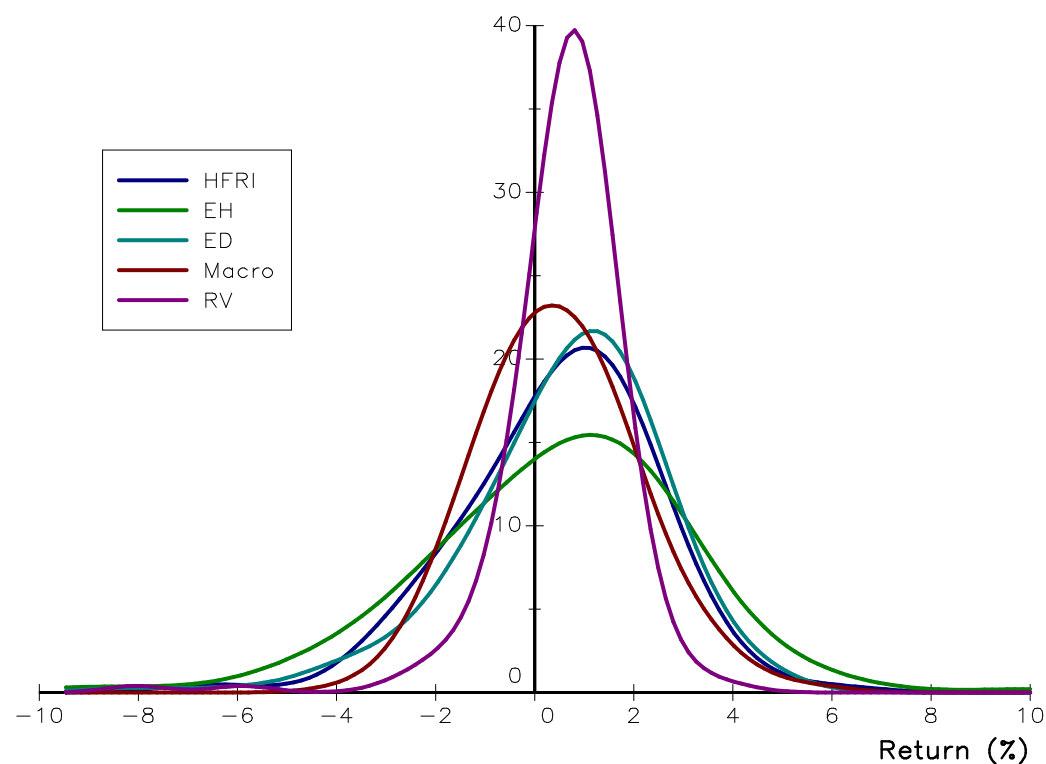
- ① Brooks and Kat (2002) show that any hedge fund strategy return distributions are not normal and exhibit negative skewness and positive excess kurtosis
- ② RV is the most leptokurtic strategy
- ③ ED and EH are characterized by very fat left-tails
- ④ The non-normal payoffs of hedge funds are due to various reasons such as the use of options or option-like dynamic trading strategies

Table: Statistics of HFRI strategies (January 2000 - June 2013)

Strategy	$\mu$	$\sigma$	SR	$\mathcal{MDD}$	$\gamma_1$	$\gamma_2$
HFRI	5.76	6.67	0.49	-21.42	-0.57	4.34
EH	4.98	9.03	0.28	-30.59	-0.40	4.89
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# Abnormal distribution and fat tail risk

Figure: Non-parametric distribution of HFRI strategies



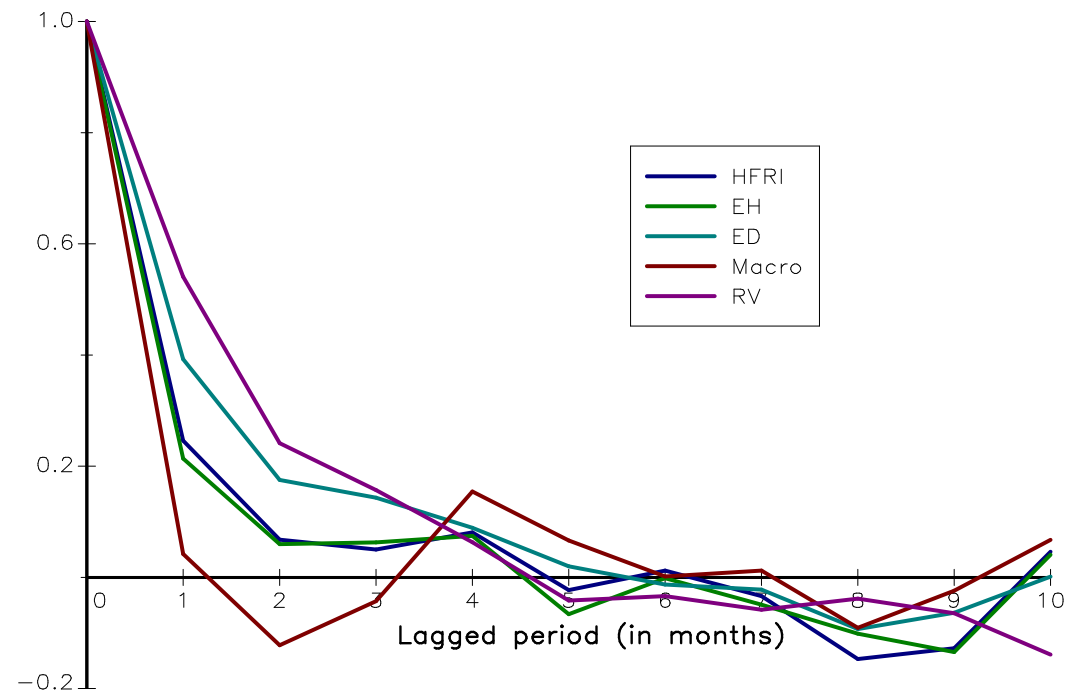


# Performance persistence

- 1 Performance persistence is defined by the fact that hedge funds which outperform (or underperform) their corresponding strategies continue to outperform (or underperform) over time
- 2 Performance persistence is higher for losers (hedge funds that underperform), see Agarwal and Naik (2000)
- 3 The abnormal performances are not only persistent in the short term but also in the case of annual horizons, see Kosowski *et al.* (2007) and Jagannathan *et al.* (2010)

# Auto-correlation

Figure: Correlograms of HFRI strategies



# Auto-correlation

Strategy	$ACF(1)$	$ACF(2)$	$ACF(3)$	$ACF(4)$	$ACF(5)$
HFRI	0.25***	0.06	0.06	0.08	-0.02
EH	0.22***	0.05	0.07	0.08	-0.07
ED	0.40***	0.17**	0.15*	0.09	0.02
Macro	0.04	-0.13	-0.05	0.16*	0.07
RV	0.55***	0.24***	0.16*	0.07	-0.04

## Cross-correlation with traditional assets

- 1 The cross-correlation between hedge funds and traditional assets is weak, see Lhabitant (2006)

The traditional assets used by Fung and Hsieh (1997):

Asset class	Asset name	Abbreviation
Equity	MSCI USA	EQ US
Equity	MSCI WORLD Ex USA	EQ WLD
Equity	MSCI EM	EQ EM
Bond	JPM US GOV BOND	BD US
Bond	JPM GLOBAL BOND Ex US	BD WLD
Bond	BOFA US HIGH YIELD	HY
Currency	US TRADE WEIGHTED	USD
Commodity	GSCI Gold	GOLD
Cash	US EUROUSD 1M	EUR 1M

## Cross-correlation with traditional assets

Table: Statistics on the database January 2000 - June 2013

Asset	$\mu$	$\sigma$	SR	$MDD$	$\gamma_1$	$\gamma_2$
HFRI	5.76	6.67	0.49	-21.42	-0.57	4.34
EH	4.98	9.03	0.28	-30.59	-0.40	4.89
ED	7.47	6.73	0.74	-24.79	-1.09	5.59
Macro	5.75	5.44	0.60	-7.32	0.27	3.23
RV	7.13	4.41	1.06	-18.04	-2.83	18.92
EQ US	2.77	15.83	0.02	-50.65	-0.52	3.84
EQ WLD	3.17	17.99	0.04	-56.34	-0.67	4.36
EQ EM	7.77	23.89	0.22	-61.44	-0.53	4.08
BD US	5.83	5.02	0.67	-5.34	-0.22	4.18
BD WLD	5.58	8.51	0.37	-10.24	0.10	3.18
HY	7.57	10.41	0.49	-33.28	-1.18	10.21
USD	-1.51	7.06	-0.56	-39.29	0.14	3.09
GOLD	10.79	17.92	0.46	-34.04	-0.24	3.78
EUR 1M	2.47	0.61	0.00	0.00	0.61	1.93

## Cross-correlation with traditional assets

Table: Correlations of HFRI indices versus traditional assets

	HFRI	EH	ED	Macro	RV
EQ US	0.76	0.78	0.75	0.17	0.60
EQ WLD	0.85	0.86	0.81	0.38	0.69
EQ EM	0.88	0.86	0.81	0.44	0.69
BD US	-0.27	-0.29	-0.33	0.12	-0.22
BD WLD	0.15	0.11	0.07	0.40	0.07
HY	0.70	0.68	0.77	0.17	0.78
USD	-0.45	-0.43	-0.37	-0.46	-0.34
GOLD	0.29	0.26	0.18	0.46	0.21
EUR 1M	-0.06	-0.06	-0.10	0.07	-0.08

## Significant different investment style than mutual funds

Let us denote the fund's return at time  $t$  by  $R_t$  and the  $k^{th}$  factor's return at time  $t$  by  $F_{kt}$ , Sharpe's (1992) style regression is described by:

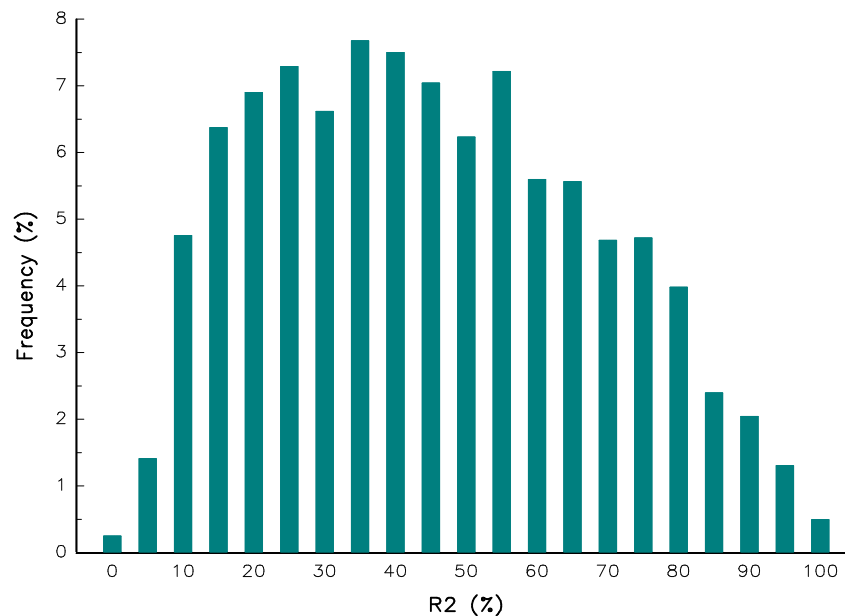
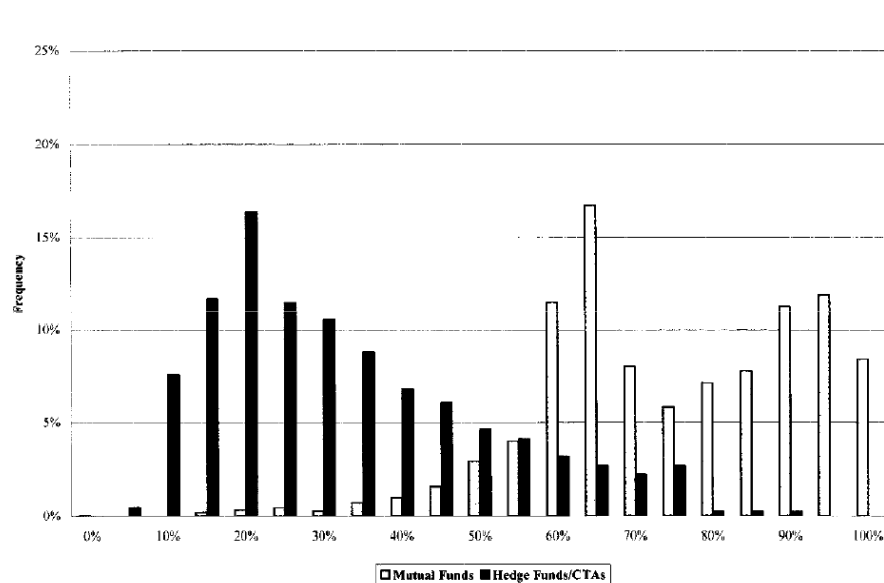
$$R_t = \alpha + \sum_k b_k F_{kt} + \varepsilon_t$$

Fung and Hsieh (1997) state that:

- 1 There is a high correlation between mutual funds and traditional assets, meanwhile, the correlation between hedge funds and traditional assets is low
- 2 The investment style of mutual funds is buy-and-hold whereas hedge funds exhibit five main investment styles

# Significant different investment style than mutual funds

The comparison of  $R^2$  values between mutual funds and hedge funds (see Fung and Hsieh, 1997) is shown in the following figure on the left. The distribution of  $R^2$  values of hedge funds using the HFR database from 2000 to 2013 is presented in the following figure on the right.





# Principal Component Analysis (PCA)

- 1 PCA is a statistical tool to reduce a complex data set to a lower dimension to reveal the hidden and simplified dynamics
- 2 PCA uses orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables

Let us consider a co-variance matrix  $\Sigma$ , the diagonalization of  $\Sigma$  is described by:

$$P^T \Sigma P = D$$

where  $P$  is the eigenvector matrix and  $D$  is a diagonal matrix.

# Quantitative classification of sub-strategies

**Table:** Eigenvalues and percentage of explained inertia by each component

Component	Eigenvalue	Percent of inertia (%)	Cumulated percentage (%)
$k = 1$	7.07	50.53	50.53
$k = 2$	2.00	14.31	64.84
$k = 3$	1.32	9.45	74.29
$k = 4$	0.74	5.32	79.61
$k = 5$	0.62	4.41	84.02
$k = 6$	0.53	3.78	87.80
$k = 7$	0.45	3.19	90.99
$k = 8$	0.40	2.89	93.88

# Quantitative classification of sub-strategies

Table: Representation quality (in %)

Strategy	$k = 1$	$k = 2$	$k = 3$	$k = 4$	$k = 5$	$k = 6$	$k = 7$	$k = 8$
EH: EMN	25.73	2.95	35.46	8.84	12.56	5.40	0.83	7.28
EH: QD	71.46	18.38	1.56	0.61	0.79	1.03	0.01	0.01
EH: SB	47.28	23.31	15.43	0.48	0.43	6.21	1.58	0.09
EH: S-EB	53.05	0.03	20.62	0.01	3.92	0.07	11.03	3.54
EH: S-TH	50.56	28.88	9.98	0.02	0.04	1.52	0.08	2.39
ED: MA	52.63	0.20	11.89	0.53	6.48	1.38	17.96	6.02
ED: PI	28.03	13.90	0.79	30.84	22.52	2.35	0.00	0.29
ED: DIS	79.87	2.71	0.22	0.25	1.32	0.06	0.43	0.20
Macro: SD	10.92	44.37	6.99	14.08	0.00	18.76	0.01	2.27
RV: YA	55.78	4.48	0.73	1.21	1.07	7.60	10.24	17.95
RV: FI-AB	21.80	21.38	24.93	12.76	6.77	5.69	0.05	0.15
RV: FI-CA	60.61	16.81	0.09	3.76	5.17	0.78	1.56	0.23
RV: FI-C	72.09	11.84	2.34	1.04	0.16	0.75	0.07	0.02
RV: MS	77.54	11.15	1.29	0.01	0.47	1.39	0.77	0.00

# Quantitative classification of sub-strategies

Table: Contribution (in %)

Strategy	$k = 1$	$k = 2$	$k = 3$	$k = 4$	$k = 5$	$k = 6$	$k = 7$	$k = 8$
EH: EMN	3.64	1.47	26.80	11.88	20.36	10.20	1.86	18.01
EH: QD	10.10	9.17	1.18	0.81	1.28	1.95	0.02	0.02
EH: SB	6.68	11.63	11.66	0.65	0.69	11.71	3.55	0.21
EH: S-EB	7.50	0.02	15.58	0.02	6.35	0.14	24.71	8.75
EH: S-TH	7.15	14.41	7.54	0.02	0.06	2.88	0.17	5.92
ED: MA	7.44	0.10	8.99	0.71	10.50	2.61	40.25	14.88
ED: PI	3.96	6.94	0.60	41.43	36.50	4.43	0.01	0.72
ED: DIS	11.29	1.35	0.17	0.34	2.13	0.11	0.96	0.49
Macro: SD	1.54	22.14	5.28	18.92	0.00	35.41	0.02	5.60
RV: YA	7.89	2.23	0.55	1.62	1.74	14.34	22.96	44.39
RV: FI-AB	3.08	10.67	18.84	17.15	10.98	10.73	0.11	0.38
RV: FI-CA	8.57	8.39	0.07	5.05	8.38	1.46	3.50	0.56
RV: FI-C	10.19	5.91	1.77	1.40	0.25	1.42	0.15	0.05
RV: MS	10.96	5.56	0.97	0.01	0.77	2.62	1.73	0.01

# Quantitative classification of sub-strategies

Table: Principal strategies in the three main components

1 <sup>st</sup> component	2 <sup>nd</sup> component	3 <sup>rd</sup> component
ED: DIS	Macro	EH: EMN
RV: MS	EH: S-TH	RV: FI-AB
RV: FI-C	EH: SB	EH: S-EB
EH: QD	RV: FI-AB	ED: MA
RV: FI-CA	EH: QD	EH: S-TH

## Single hedge funds

The main characteristics of **single hedge funds** are:

- 1 They manage a portfolio of public and private securities or derivative instruments
- 2 They use unconventional strategies
- 3 They generate alpha using long positions, short positions and leverage
- 4 Hedge fund manager determines its governance structure, the level of transparency towards investors and selects the fund's service providers

Cost for investors:

- 1 Management fee: proportional to the amount of assets under management
- 2 Incentive fee: proportional to fund performance (if it is positive)

## Managed Account Platforms

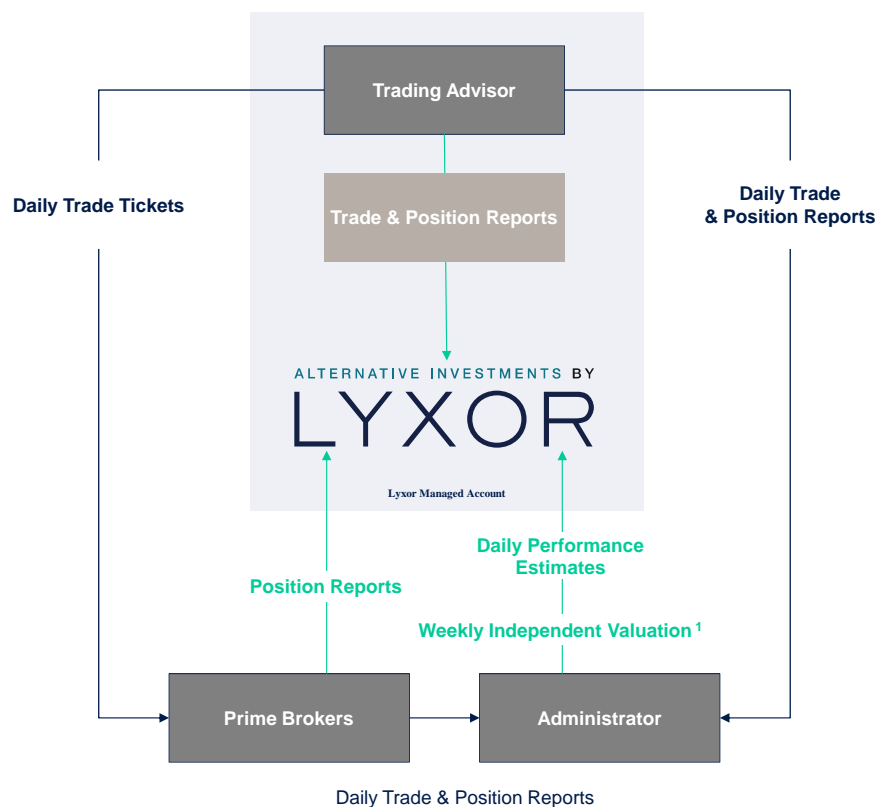
Managed Account Platforms are an investment structure run by the sponsor including investor, managed account provider and independent board of directors etc. They allow investors to benefit the hedge fund performance with limited risks, more transparency and higher liquidity.

Their main characteristics are:

- 1 Managers are restricted to managing the investor's assets with the selected hedge funds (trading advisors)
- 2 Independent third-party providers carry out certain operational tasks such as valuation or accounting services
- 3 Reinforced risk control and more transparency
- 4 Higher liquidity

# Managed Account Platforms

Figure: Lyxor Managed Account Platform





## Funds of hedge funds

**Funds of hedge funds** invest in several different hedge funds. Their main characteristics are:

- 1 Selection of single hedge funds by experienced managers
- 2 Better risk diversification than single hedge funds
- 3 Additional cost compared to direct investment in single hedge funds

**Investable hedge fund index fund:** a specific fund of hedge funds expected to deliver the performance of the reference hedge fund index by investing in an universe of hedge funds.

# Multi-strategy funds

There are two kinds of **multi-strategy funds**:

- 1 Multi-manager hedge fund
- 2 Fund of hedge funds investing in multiples strategies

## Hedge fund indices replicators

Hedge fund indices replicators use the statistical approach to replicate hedge fund indices using various investable financial assets. They are built on the research of Hasanhodzic and Lo (2007).

Their main characteristics are:

- 1 Passive index-tracking management
- 2 Replication with liquid exchange-traded instruments
- 3 Compared to hedge fund investment, hedge fund indices replicators have similar risk exposures but lower cost and greater transparency

## Significant risk-adjusted return

Period	Asset	$\mu$	$\sigma$	SR	$\mathcal{MDD}$	$\gamma_1$	$\gamma_2$
01/31/2000-05/31/2007	HFRI	8.71	5.95	0.89	-6.39	-0.09	3.37
	EH	8.24	7.88	0.61	-10.30	0.44	5.11
	ED	11.34	5.75	1.38	-9.34	-0.64	3.93
	Macro	8.07	5.48	0.85	-7.32	0.15	3.81
	RV	8.91	2.09	2.63	-1.29	-0.03	3.10
	EQ US	2.45	14.15	-0.07	-46.15	-0.31	3.39
	EQ WLD	7.38	14.17	0.28	-46.77	-0.59	3.19
	EQ EM	13.30	20.49	0.48	-47.76	-0.50	2.75
	BD US	6.14	5.02	0.54	-5.34	-0.73	4.07
	BD WLD	5.90	8.22	0.30	-10.16	0.31	2.78
	HY	7.24	7.66	0.50	-12.00	-0.82	6.12
	USD	-2.24	6.40	-0.88	-28.92	0.04	2.80
	GOLD	11.82	14.05	0.60	-12.10	0.26	2.84
	EUR 1M	3.41	0.56	0.00	0.00	0.27	1.57

## Significant risk-adjusted return

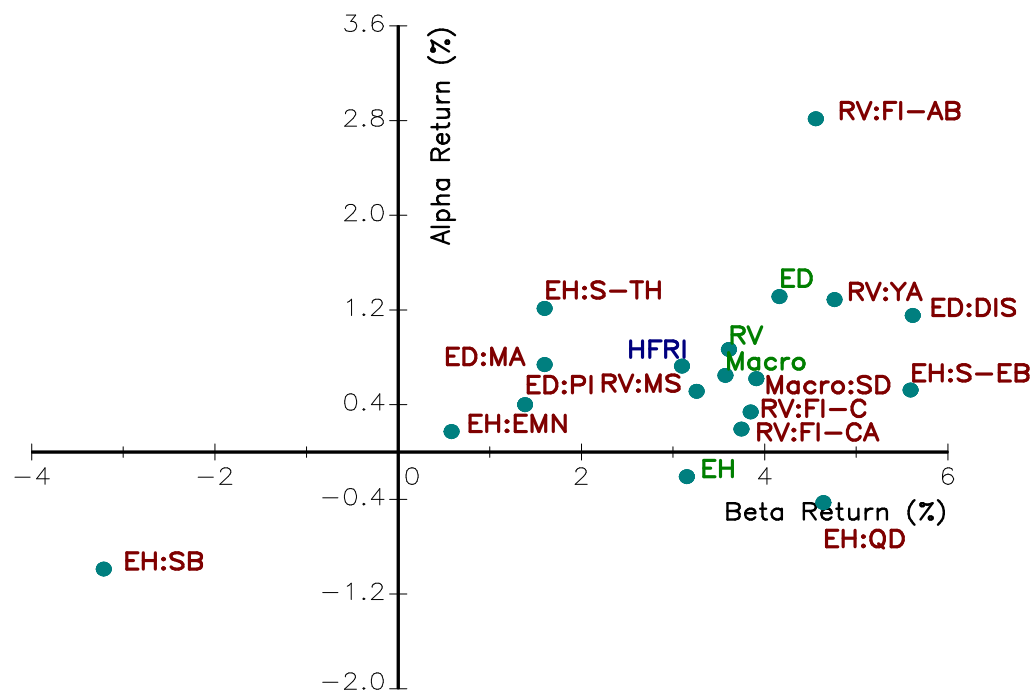
Period	Asset	$\mu$	$\sigma$	SR	$\mathcal{MDD}$	$\gamma_1$	$\gamma_2$
06/30/2007-04/30/2009	HFRI	-7.80	9.33	-1.21	-21.42	-0.57	2.99
	EH	-12.09	12.71	-1.23	-30.59	-0.48	2.97
	ED	-11.72	9.10	-1.67	-24.79	-0.96	4.10
	Macro	4.97	5.95	0.25	-4.94	0.41	2.82
	RV	-5.83	8.80	-1.06	-18.04	-1.51	5.35
	EQ US	-23.59	22.31	-1.21	-50.65	-0.28	2.84
	EQ WLD	-26.73	26.94	-1.12	-56.34	-0.35	3.05
	EQ EM	-20.56	37.83	-0.64	-61.44	-0.33	2.77
	BD US	10.15	6.84	0.98	-3.67	0.26	3.31
	BD WLD	9.71	10.77	0.58	-10.24	0.17	2.71
	HY	-8.20	19.98	-0.58	-32.76	-0.57	4.36
	USD	-0.26	8.53	-0.44	-12.24	0.55	2.79
	GOLD	16.99	25.40	0.53	-27.07	-0.82	3.77
	EUR 1M	3.48	0.51	0.00	0.00	0.15	2.16

## Significant risk-adjusted return

Period	Asset	$\mu$	$\sigma$	SR	$\mathcal{MDD}$	$\gamma_1$	$\gamma_2$
05/31/2009-06/30/2013	HFRI	5.80	5.71	0.96	-8.97	-0.55	3.15
	EH	6.00	8.18	0.69	-13.17	-0.65	3.56
	ED	9.25	5.81	1.53	-9.06	-0.87	3.71
	Macro	1.03	4.83	0.15	-6.87	0.36	2.20
	RV	9.35	3.65	2.47	-4.06	-0.84	3.83
	EQ US	17.16	14.24	1.18	-16.41	-0.24	2.98
	EQ WLD	8.87	17.78	0.48	-22.39	-0.36	2.93
	EQ EM	7.81	20.42	0.37	-25.59	-0.09	3.12
	BD US	3.91	4.00	0.89	-3.30	-0.26	2.83
	BD WLD	2.55	7.89	0.28	-10.10	-0.63	3.71
	HY	15.03	7.52	1.95	-7.44	-0.21	3.78
	USD	0.68	7.15	0.05	-13.67	0.23	2.72
	GOLD	4.86	20.11	0.23	-34.04	-0.09	2.81
EUR 1M	0.33	0.03	0.00	0.00	2.04	8.20	

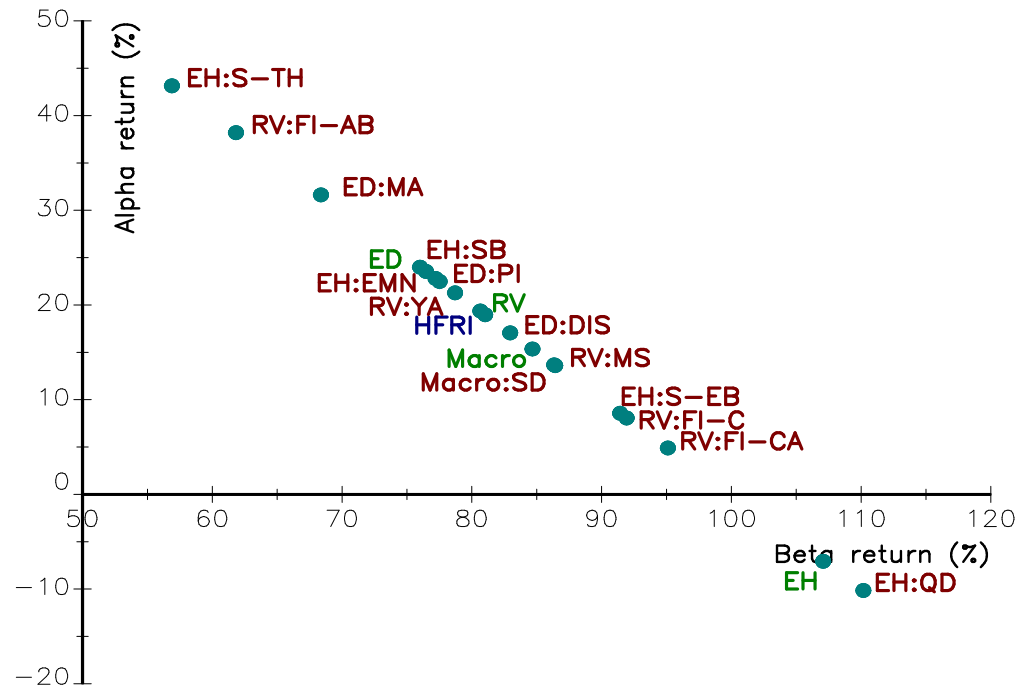
# Significant risk-adjusted return

Figure: Absolute alpha versus beta return for hedge fund strategies



# Significant risk-adjusted return

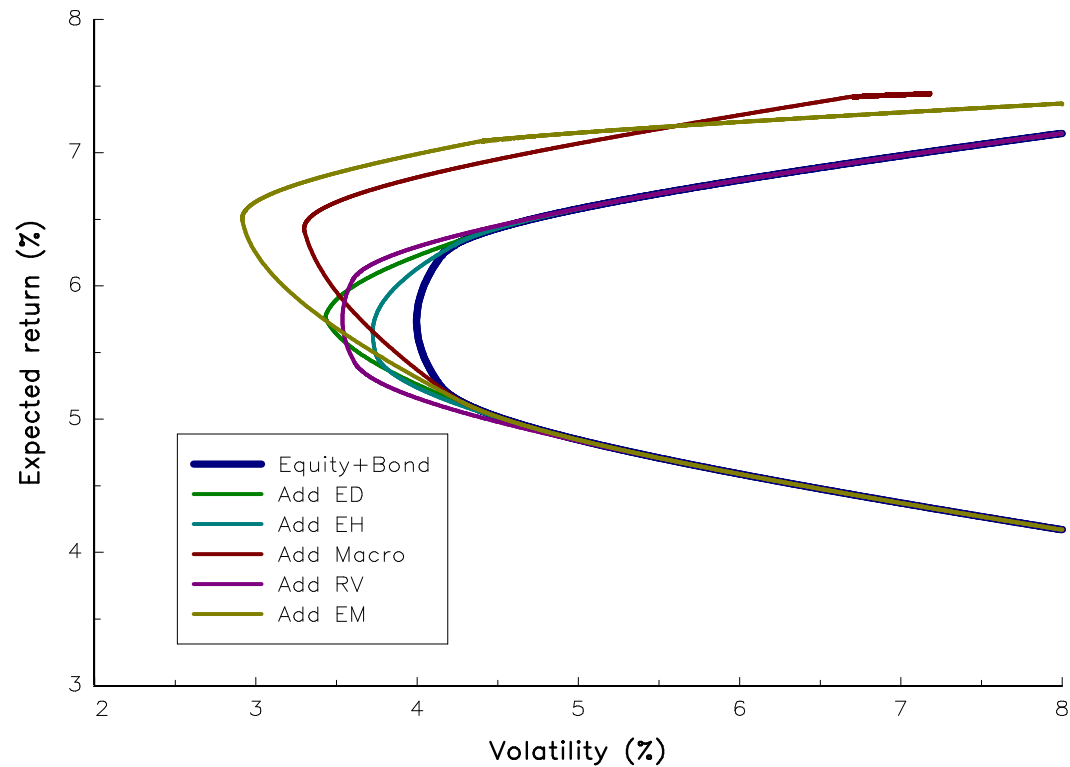
Figure: Relative alpha versus beta return for hedge funds strategies





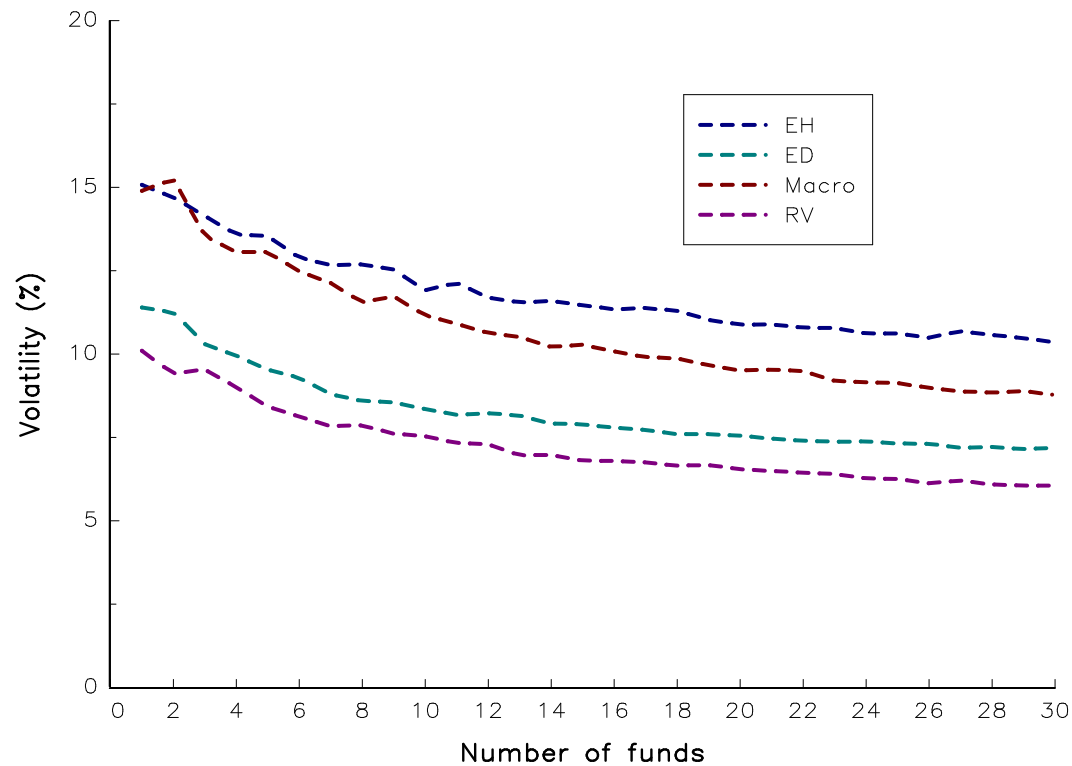
## Efficient diversification of risks

Figure: Efficient frontier of portfolio diversified in each hedge fund strategy



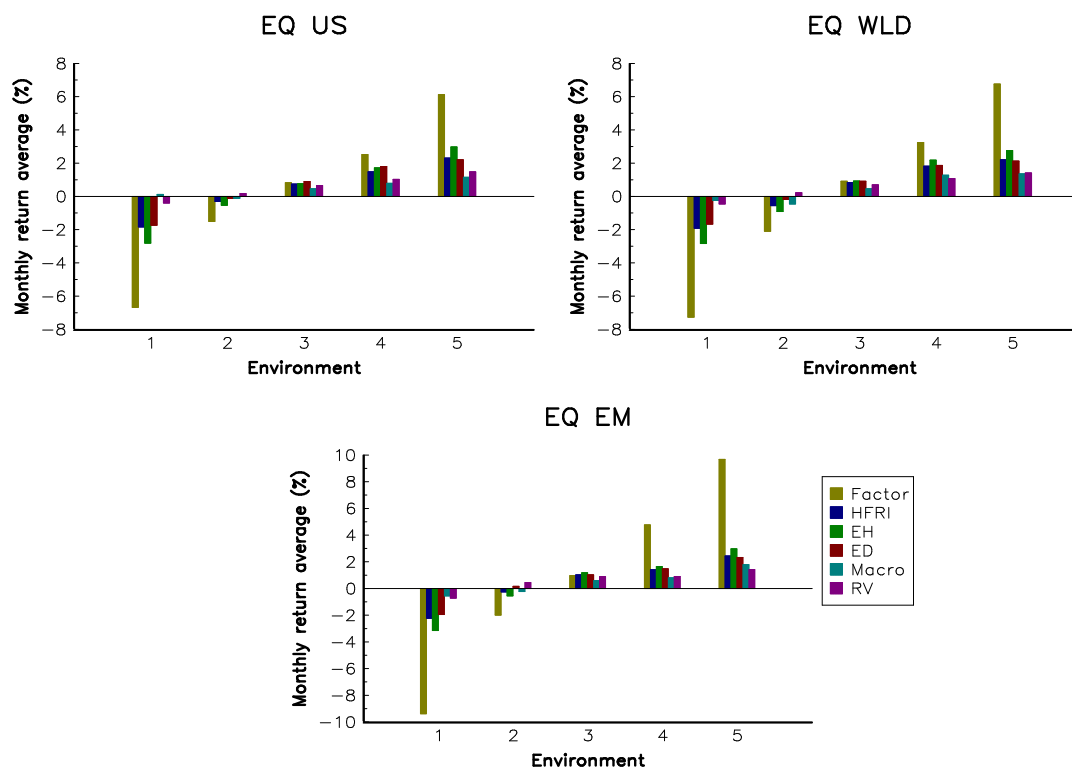
# Efficient diversification of risks

Figure: Impact of diversification on volatility



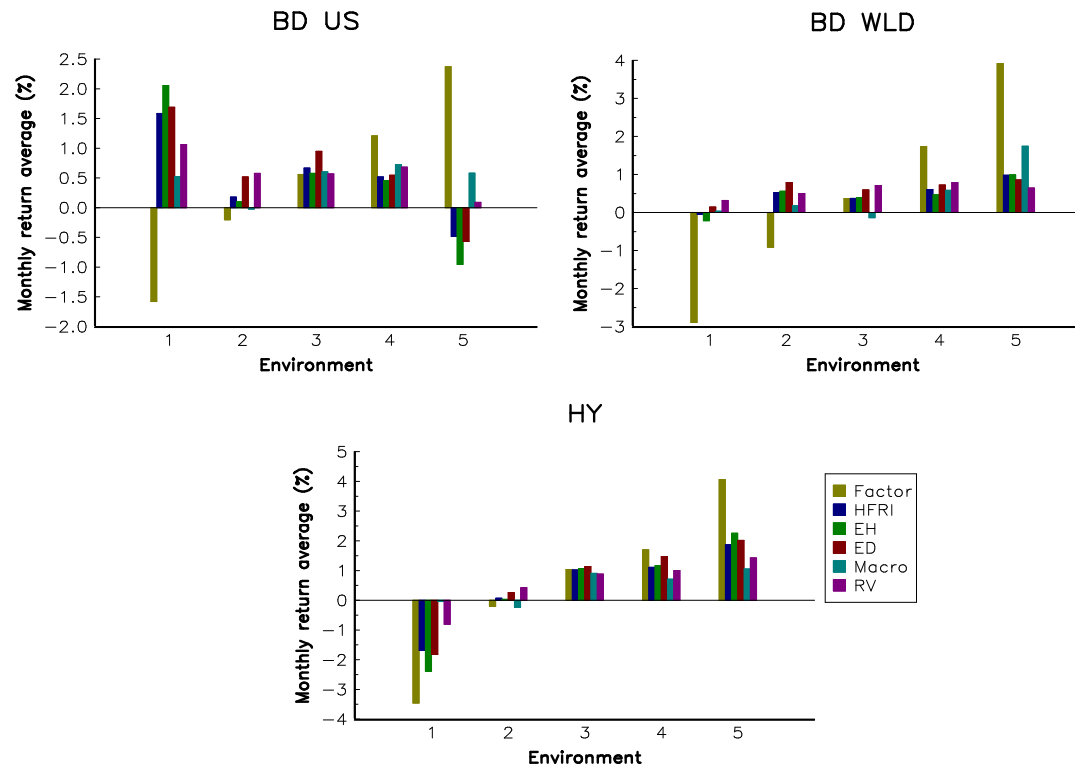
# Resistance to market environments

Figure: Average monthly return with respect to the environment factor (Equities)



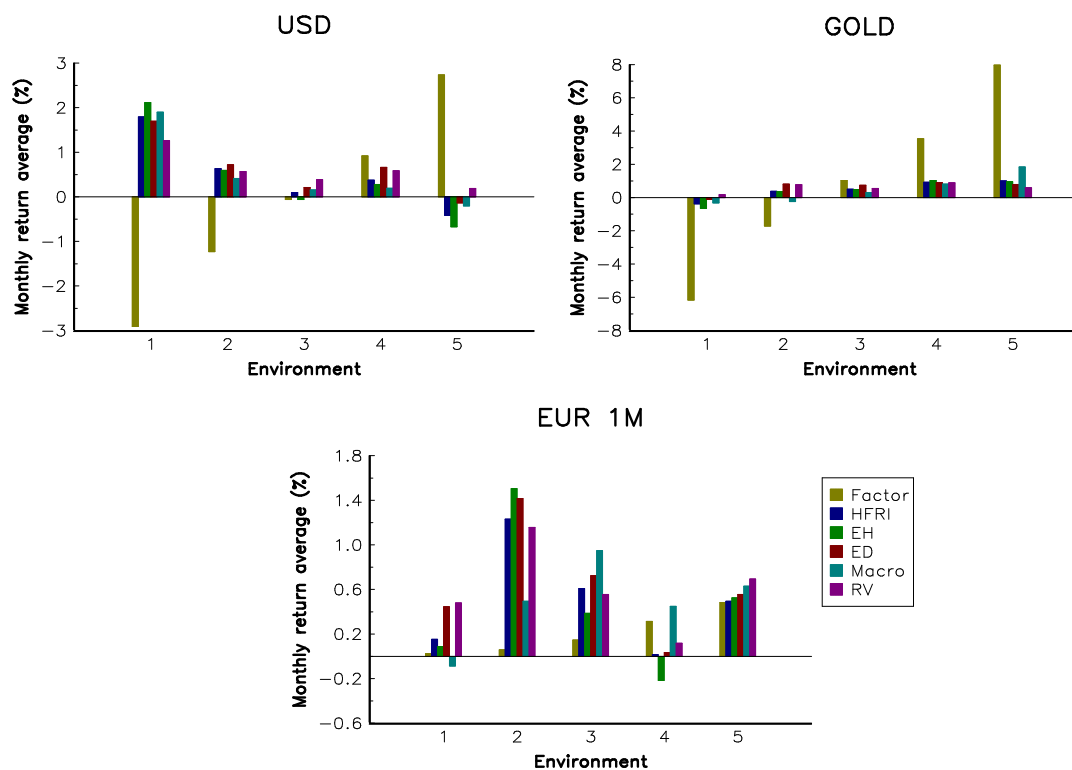
# Resistance to market environments

Figure: Average monthly return with respect to the environment factor (Bonds)



# Resistance to market environments

Figure: Average monthly return with respect to the environment factor (Other)



## Risk classification

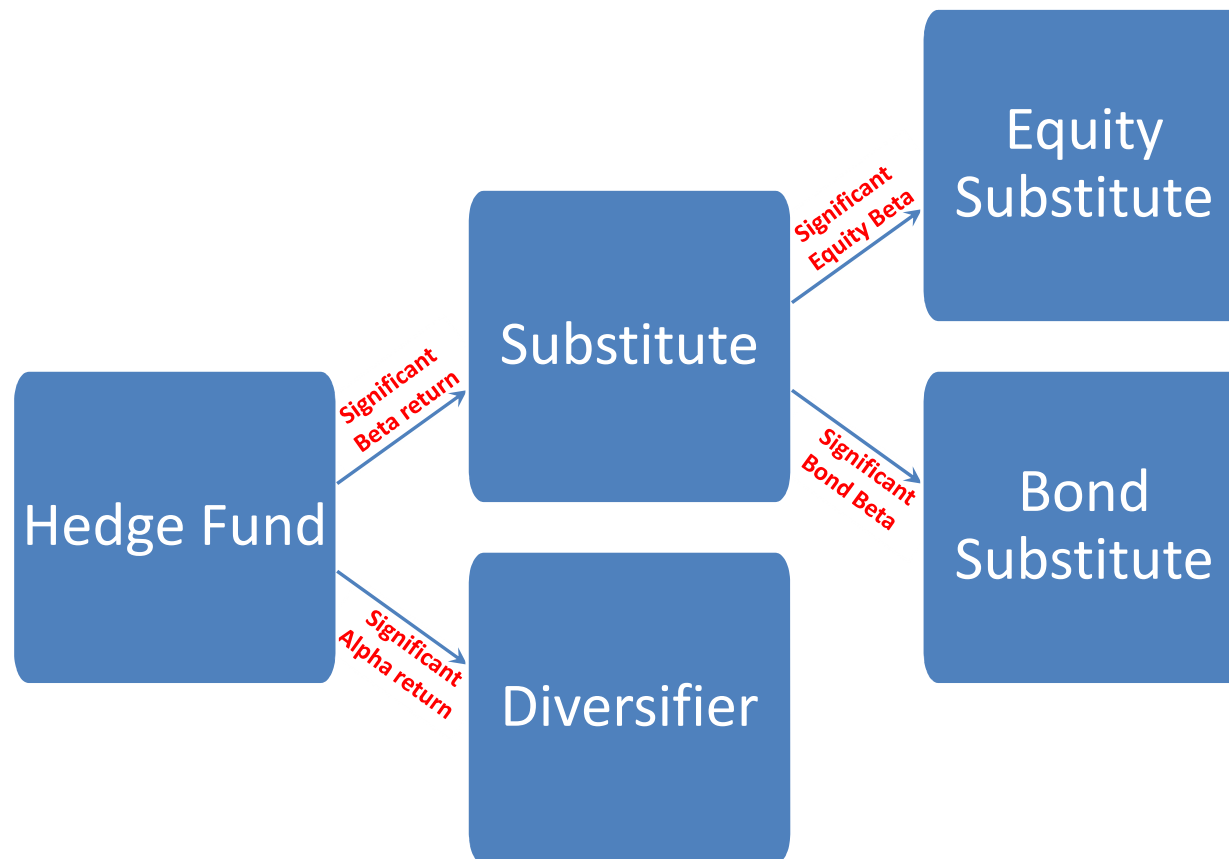
- **Market risk:** risks related to market movements
  - Tail risk
  - Credit risk
  - Liquidity risk
- **Management risk:** risks related to internal management of hedge funds
  - Transparency risk
  - Operational risk
  - Risk management risk

## Hedge funds and SAA

Including hedge funds in SAA can be interpreted as a way to benefit from the management expertise of hedge funds with principally traditional exposures.

- Hedge funds resist better than traditional assets during crisis periods
- After 2008, it is no longer possible to consider hedge funds as a single asset class
- In order to take into account the heterogeneity, it is better to evaluate hedge funds by their exposure to common risk factors and their capacity of generating absolute uncorrelated return resulting from manager's skill

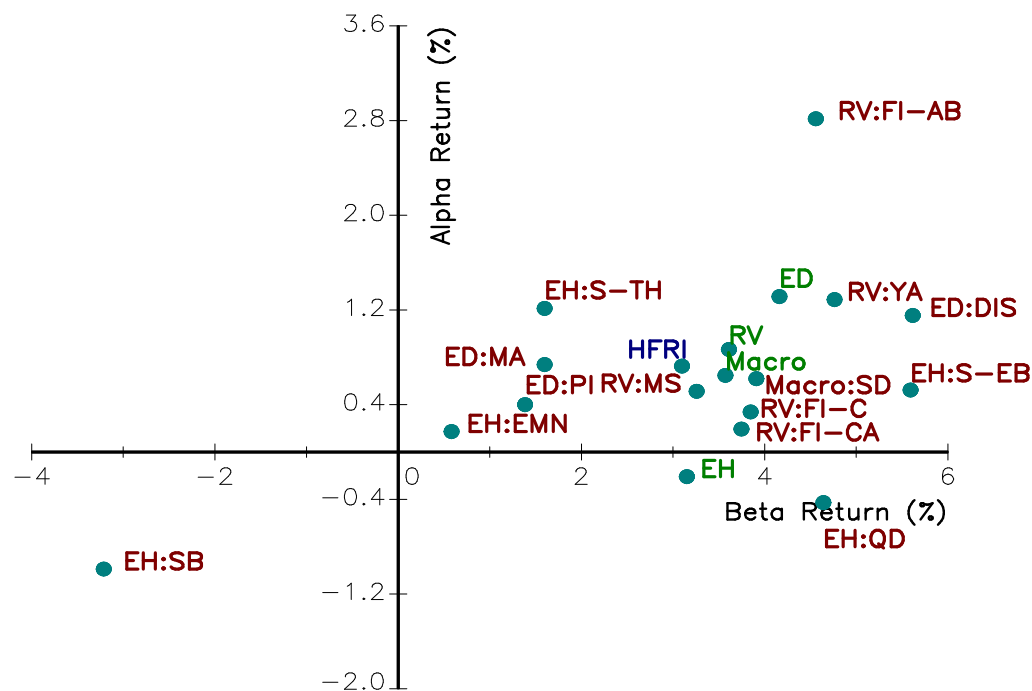
# Hedge fund classification





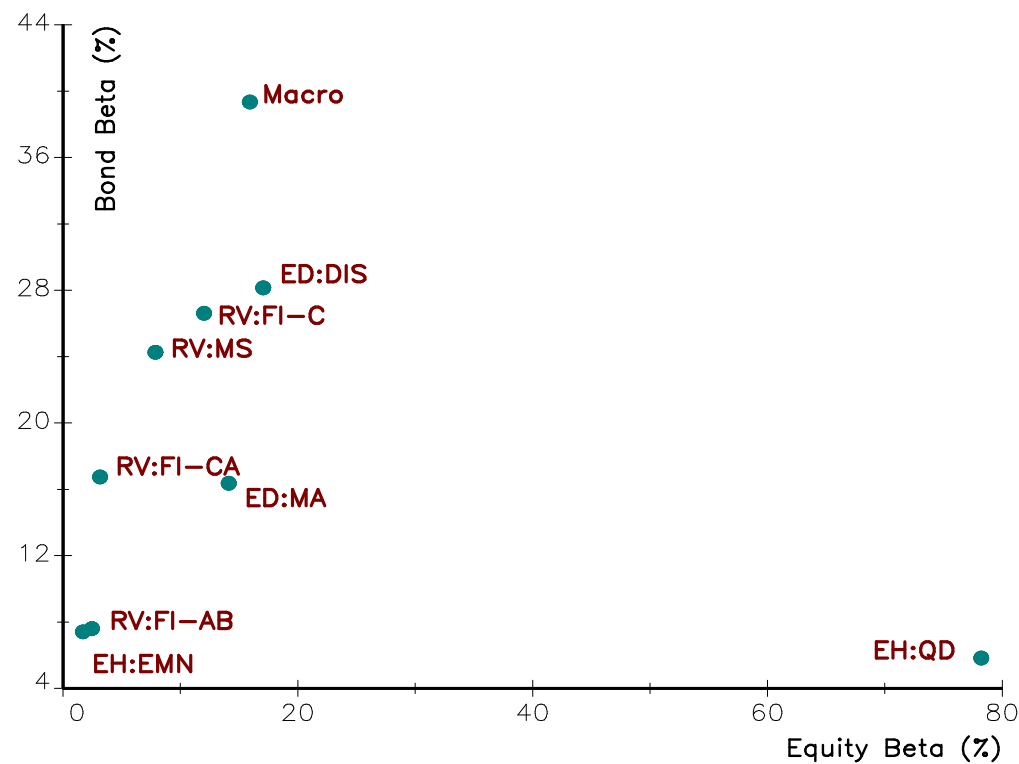
# Hedge fund classification

Figure: Absolute alpha versus beta return for hedge fund strategies



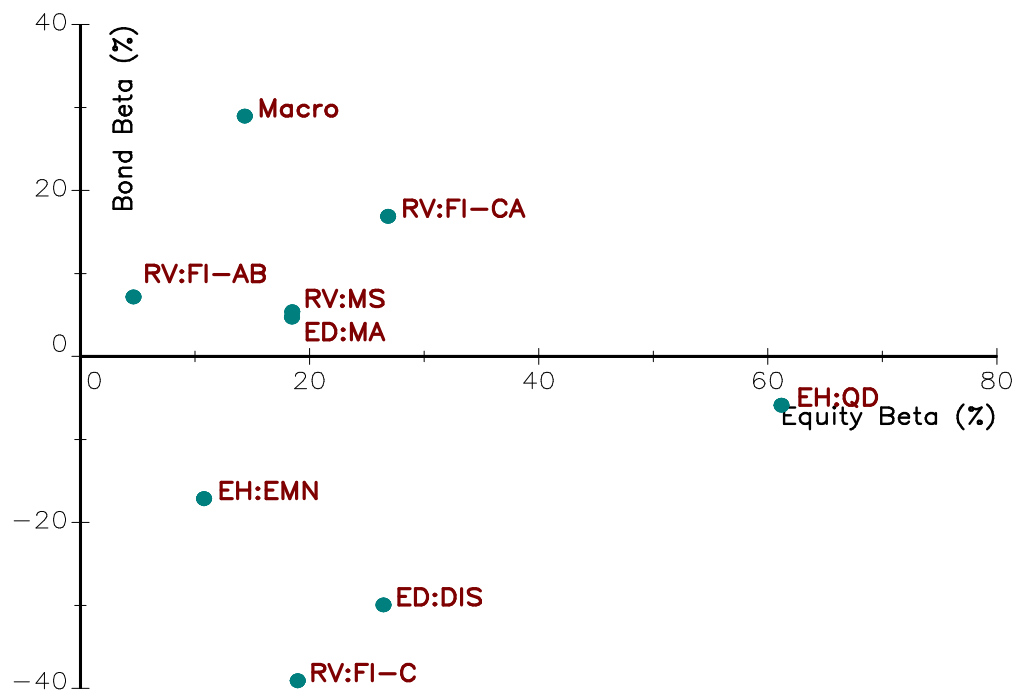
# Hedge fund classification

Figure: Equity Beta versus Bond Beta (01/31/2000 - 05/31/2007)



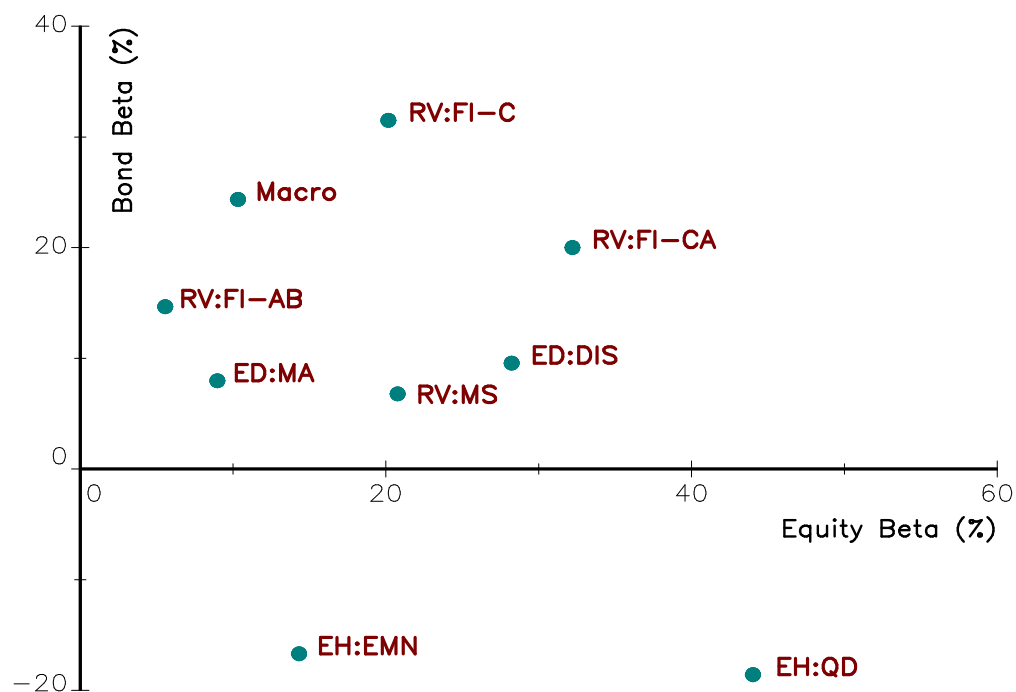
# Hedge fund classification

Figure: Equity Beta versus Bond Beta (06/30/2007 - 04/30/2009)



# Hedge fund classification

Figure: Equity Beta versus Bond Beta (05/31/2009 - 06/30/2013)



## Hedge fund classification

Using the above hedge fund classification process, we get the following classification:

	<b>Equity substitutes</b>	EH: Quantitative Directional
<b>Substitutes</b>	<b>Bond substitutes</b>	ED: Distressed Macro
		RV: Fixed Income Asset Convertible Arbitrage RV: Fixed Income Asset Corporate RV: Multi Strategy
<b>Diversifiers</b>		EH: Equity Market Neutral ED: Merger Arbitrage RV: Fixed Income Asset Backed

**Remark:** The diversifiers are the main contributors of the third component in principal component analysis. The substitutes are the main contributors of the first and second components in principal component analysis.

# Markowitz mean variance model with regime switching

Our main investment philosophy is:

- Strengthen risk diversification in each asset class (equity and bond) by adding substitutes
- Generate uncorrelated absolute return by adding diversifiers
- Regarding the economic cycles, it is more appropriate to introduce a hidden economic state variable which determines the assets' performance

# Markowitz mean variance model with regime switching

## Smart strategic asset allocation with hedge funds vs Current solution

### Current solution

Equity	$\frac{1}{3}(1-x)$
Bond	$\frac{2}{3}(1-x)$
Hedge fund	$x$



### Smart strategic asset allocation with hedge funds

			Extreme regime	Normal regime
Beta	Equity	Long-Only	$\frac{1}{3}(1-x_0) - y_0$	$\frac{1}{3}(1-x_1) - y_1$
		Hedge Fund	$y_0$	$y_1$
	Bond	Long-Only	$\frac{2}{3}(1-x_0) - z_0$	$\frac{2}{3}(1-x_1) - z_1$
		Hedge Fund	$z_0$	$z_1$
Diversifier		Hedge Fund	$x_0$	$x_1$

## Markowitz mean variance model with regime switching

Let us denote the economic state of the year  $t$  by  $s_t$ :

$$s_t = \begin{cases} 0 & \text{if the economy of the year } t \text{ is in crisis} \\ 1 & \text{otherwise} \end{cases}$$

The transition matrix is defined as follows:

$$Q = \begin{pmatrix} p & 1-p \\ 1-q & q \end{pmatrix}$$

The distribution of the  $i^{\text{th}}$  asset's return in the year  $t$  depends on the state  $s_t$ :

$$\begin{cases} r_t^i(s_t) \sim \mathcal{N}(\mu_i(s_t), \Sigma_{ii}(s_t)) \\ \mathbb{P}[s_t = j | s_{t-1} = j] = Q_{i,j} \end{cases}$$



## Markowitz mean variance model with regime switching

With the allocation vectors  $w_0$  and  $w_1$ , if denote  $w = \begin{pmatrix} w_0 \\ w_1 \end{pmatrix}$ , the portfolio return  $r_t(w)$  becomes:

$$\begin{aligned} r_t(w) &= w_0^\top r_t(0)(1 - s_t) + w_1^\top r_t(1)s_t \\ &= \left( w_1^\top r_t(1) - w_0^\top r_t(0) \right) s_t + w_0^\top r_t(0) \end{aligned}$$

where  $r_t(0)$  and  $r_t(1)$  are vectors of asset returns.

Under the long term stationary distribution, the expected return of the portfolio is:

$$\mu(w) = (w_1^\top \mu_1 - w_0^\top \mu_0) \mathbb{E}(s_t) + w_0^\top \mu_0$$

the standard deviation of the portfolio  $\sigma(w)$  is:

$$\sigma^2(w) = \left[ (w_1^\top \mu_1 - w_0^\top \mu_0)^2 + \sum_{i=0}^1 w_i^\top \Sigma(i) w_i \right] \mathbb{E}(s_t) + [1 - 2\mathbb{E}(s_t)] w_0^\top \Sigma(0) w_0$$

## Markowitz mean variance model with regime switching

Then we introduce a Markowitz-like optimization program which consists in maximizing the expected performance of the portfolio  $\mu(w)$  under a constraint on the variance  $\sigma(w)$ :

$$\begin{aligned} \{w_0^*, w_1^*\} &= \arg \max \mu(w) & (1) \\ \text{u.c.} &\begin{cases} \sigma(w) \leq \sigma^* \\ 0 \leq w_0, w_1 \leq 1 \\ \sum_i w_0^i = 1 \text{ and } \sum_i w_1^i = 1 \end{cases} \end{aligned}$$

## Markowitz mean variance model with regime switching

Using the following notations:

$$A = \begin{pmatrix} -\mu_0 \\ \mu_1 \end{pmatrix}, B = \begin{pmatrix} \mu_0 \\ 0 \end{pmatrix},$$

$$C = \begin{pmatrix} \Sigma(0) & 0 \\ 0 & \Sigma(1) \end{pmatrix}, D = \begin{pmatrix} \Sigma(0) & 0 \\ 0 & 0 \end{pmatrix} \text{ and } E = \begin{pmatrix} \mathbf{1} & 0 \\ 0 & \mathbf{1} \end{pmatrix}$$

the optimization program (1) becomes:

$$\hat{w} = \arg \min w^\top \left[ \mathbb{E}(s_t)(AA^\top + C) - (2\mathbb{E}(s_t) - 1)D \right] w - \lambda w^\top (\mathbb{E}(s_t)A + B)$$

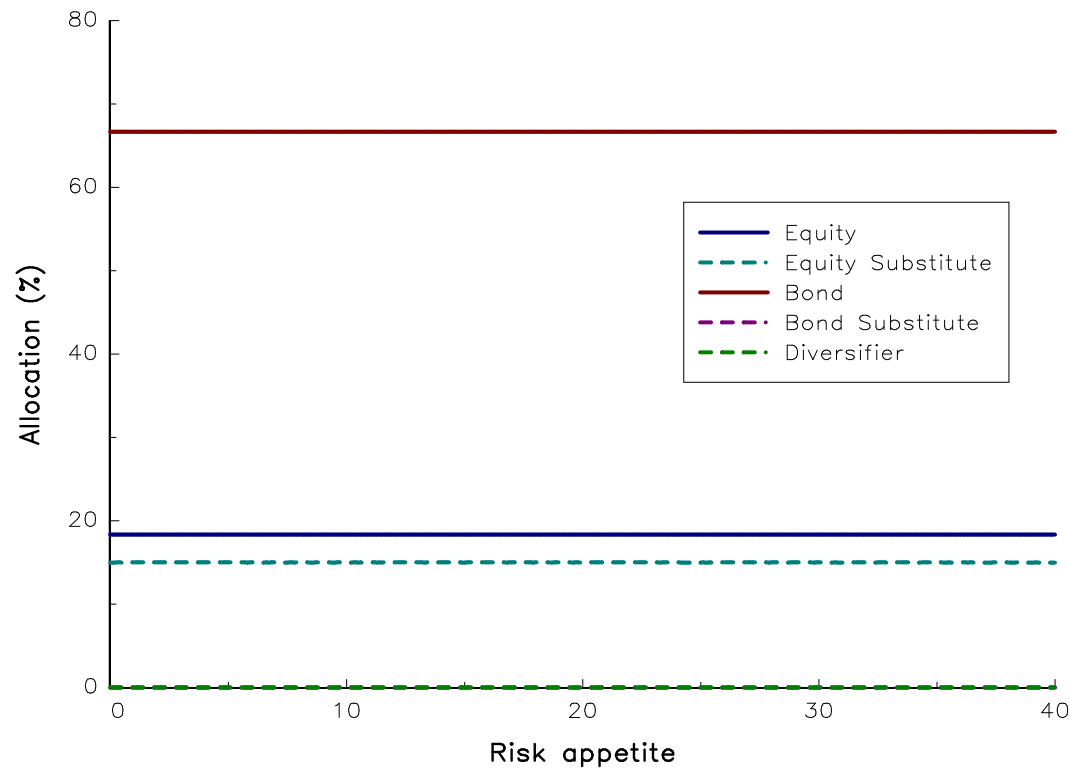
$$\text{u.c. } \begin{cases} 0 \leq w \leq 1 \\ w^\top E = \mathbf{1} \end{cases}$$

where  $\lambda$  is a risk appetite parameter of the investor.

In order to invest reasonably in hedge funds, we limit the hedge fund allocation by 15%, saying  $x_{s_t} + y_{s_t} + z_{s_t} \leq 15\%$ .

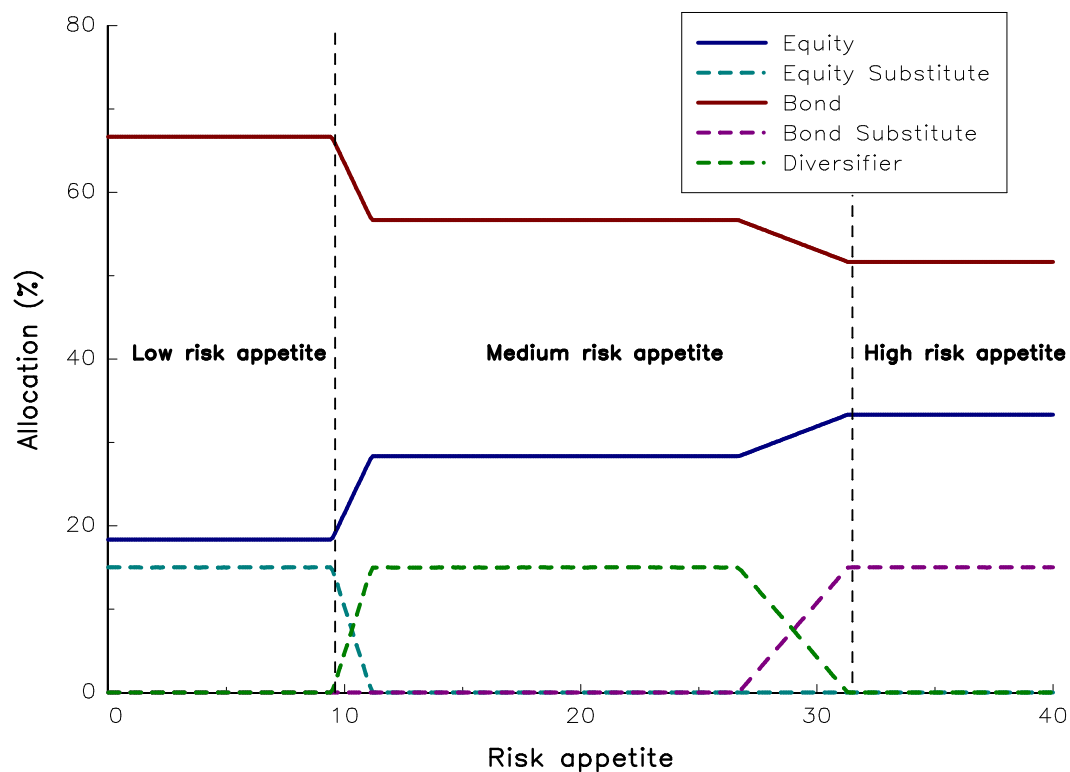
## Numerical results

Figure: Allocation strategy with respect to risk appetite - Extreme Regime



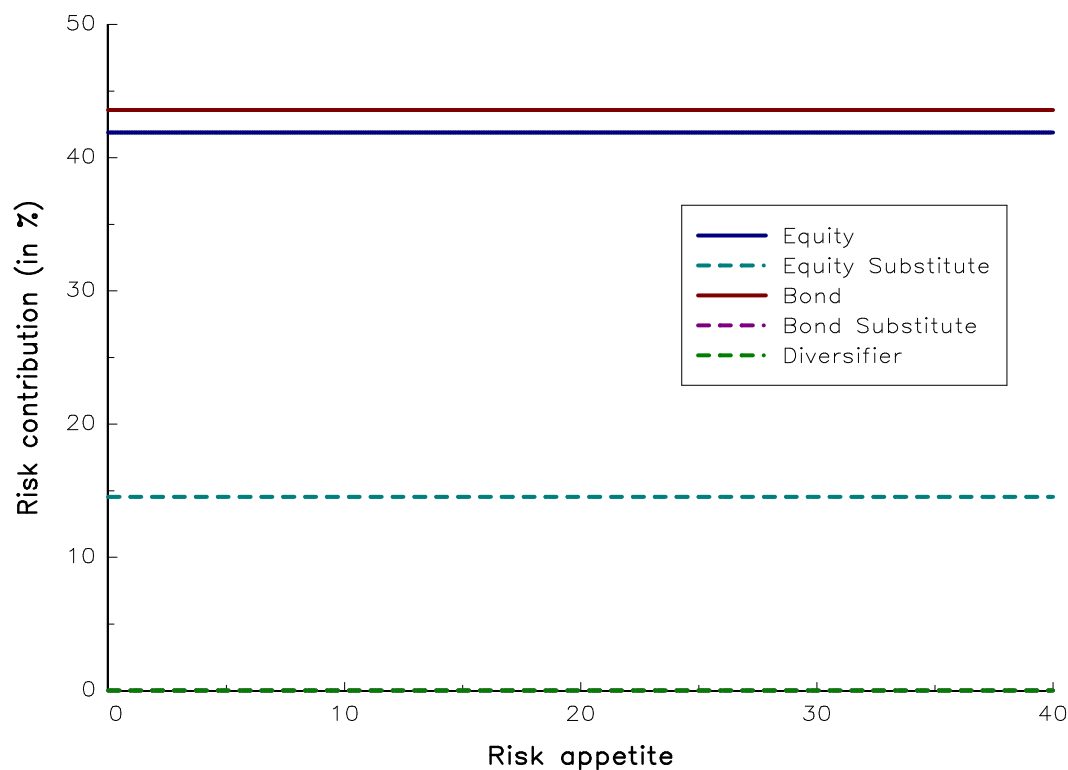
# Numerical results

Figure: Allocation strategy with respect to risk appetite - Normal Regime



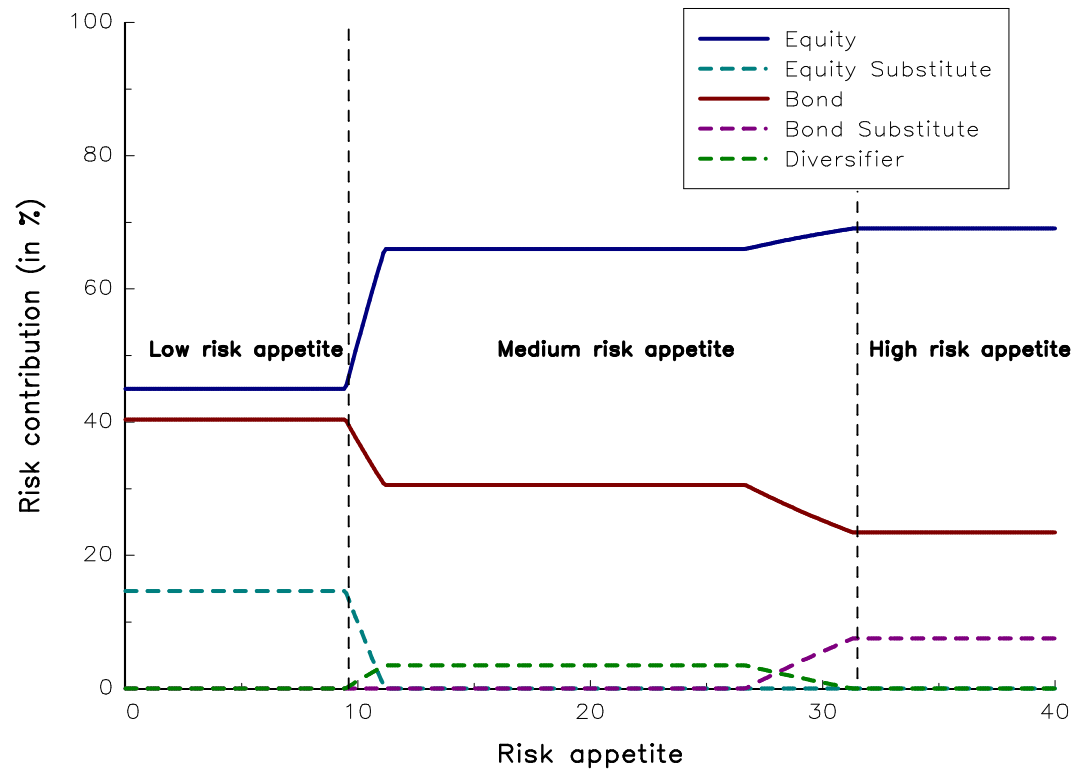
## Numerical results

Figure: Risk contributions with respect to risk appetite - Extreme Regime



# Numerical results

Figure: Risk contributions with respect to the risk appetite - Normal Regime



## Conclusion

- Hedge funds resist better than traditional assets during crisis periods
- After 2008, it is no longer possible to consider hedge funds as a single asset class
- Hedge funds can be grouped in terms of their exposures to traditional assets and their capacities to generate uncorrelated absolute return
  - **Substitutes** which have the vocation to improve the return/risk profile of equities and bonds
  - **Diversifiers** which have the vocation to generate absolute performance and diversification








## Conclusion






Following our model, we show that

- In **extreme regime**, investors use equity substitutes for some equities
- In **normal regime**, it is possible to give priority to different families of hedge funds according to the portfolio target volatility
  - **Low risk appetite**: investors with a low target volatility prefer **equity substitutes**
  - **Medium risk appetite**: investors with a medium target volatility invest in **diversifiers**
  - **High risk appetite**: investors with a high target volatility prefer **bond substitutes**



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