Alternative Risk Premia: What Do We know?[1]

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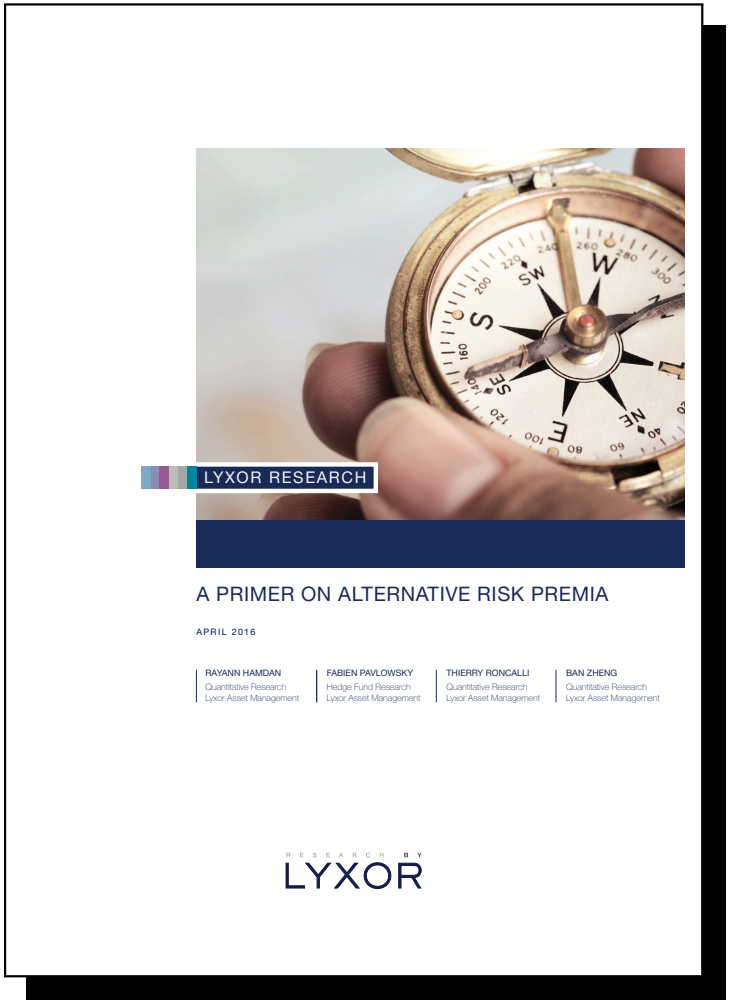
[1] The materials used in these slides are taken from Hamdan R., Pavlowsky F., Roncalli T. and Zheng B. (2016), A Primer on Alternative Risk Premia, Lyxor Research Paper, 123 pages.

[2] The opinions expressed in this presentation are those of the authors and are not meant to represent the opinions or official positions of Lyxor Asset Management.

Lyxor Research Paper



Outline

Summary I

- Alternative risk premia = extension of equity factor investing to other asset classes (in a long/short format)
- Alternative risk premia encompasses two different types of risk factor:
  - Skewness risk premia (= pure risk premia)
  - Market anomalies ($\neq$ risk premia)
- There are few skewness risk premia, but a lot of market anomalies
- Contrary to a traditional risk premium, it is extremely difficult to estimate an alternative risk premium
- The two most important ARP are carry and momentum
- Some ARP strategies are not relevant:
  - Value premium in rates and commodities
  - Alternative risk premia in credit
  - Dividend futures premium
  - Liquidity premium in equities, rates and currencies
  - Correlation premium
  - Reversal premium using variance swaps

Summary II

Risk Factor	Equities	Rates	Credit	Currencies	Commodities
Carry	~~Dividend Futures~~ High Dividend Yield	FRB TSS ~~CTS~~	~~FRB~~	FRB	FRB TSS ~~CTS~~
Liquidity	~~Amihud liquidity~~	~~Turn-of-the-month~~	~~Turn-of-the-month~~		Turn-of-the-month
Momentum	Cross-section Time-series	~~Cross-section~~ Time-series	~~Time-Series~~	~~Cross-section~~ Time-series	Cross-section Time-series
Reversal	Time-series ~~Variance~~	~~Time-series~~		~~Time-series~~	~~Time-series~~
Value	Value	~~Value~~	~~Value~~	PPP Economic model	~~Value~~
Volatility	Carry Term structure	Carry ~~Term structure~~		~~Carry~~	~~Carry~~
Event	~~Buyback~~ Merger arbitrage				
Growth	Growth				
Low volatility	Low volatility				
Quality	Quality				
Size	Size				

Summary III

- ARP (in particular skewness risk premia) are not all-weather strategies:
  - Extreme risks of ARP are high and may be correlated
  - Aggregation of skewness is not straightforward
- It is more difficult to manage a portfolio of ARP than a portfolio of TRP:
  - Volatility diversification $\neq$ risk diversification
  - ARP exhibit non-linear payoffs wrt TRP
- ARP help to understand the performance of hedge fund strategies:
  - The main risk factors are: Long equity + Long credit + some ARP
  - Importance of short volatility, carry and momentum
  - The 2008 break (TRP $\Rightarrow$ ARP)
- A portfolio of ARP is not a portfolio of HFs
  - Low correlation (40% on average)
  - A diversification asset
  - A new performance asset?

Risk premia, risk factors and market anomalies

- A risk premium is a compensation for being exposed to a non-diversifiable risk (e.g. equity risk premium vs bond risk premium)
- Risk factors are the systematic components that explain the return variation of diversified portfolios (e.g. the Fama-French-Carhart risk factors)
- A market anomaly is a strategy that exhibits a positive excess return, which is not explained by a risk premium (e.g. the trend-following strategy)

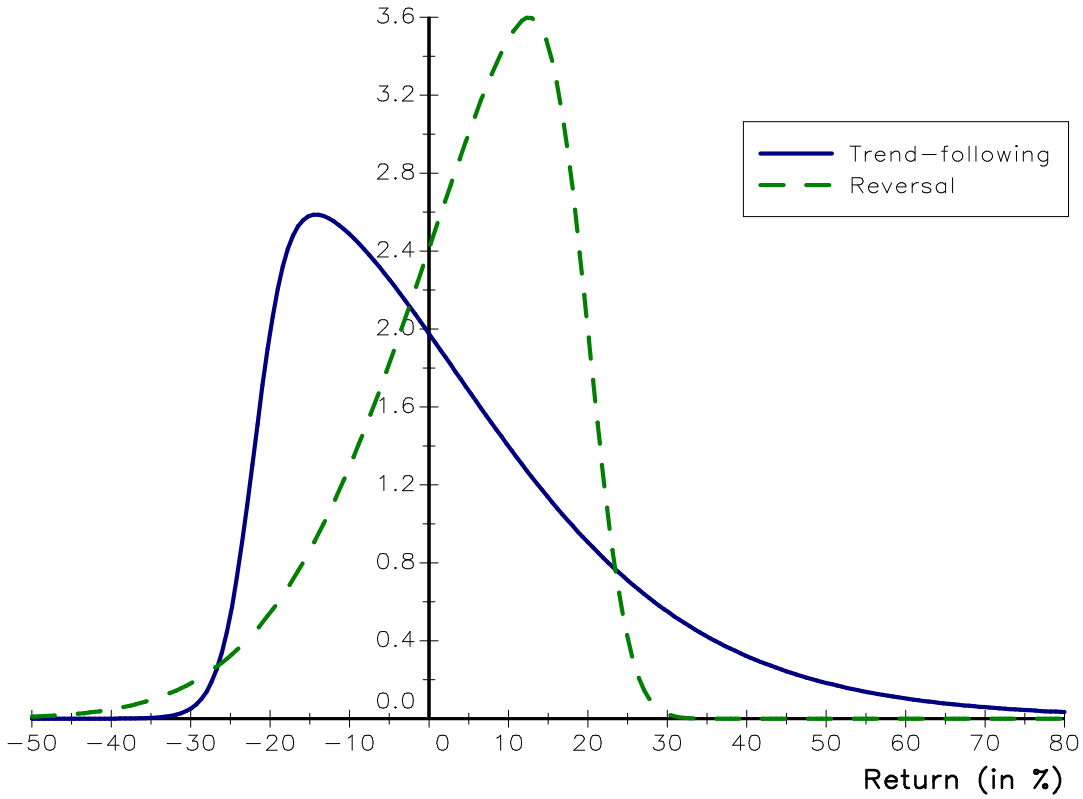
Risk premia and market anomalies are generally risk factors
The converse is not true

$\Rightarrow$ The cat bond premium is a risk premium, but it is not a risk factor
$\Rightarrow$ A risk factor may have a positive or negative excess return

Alternative risk premia

Consumption-based model

A risk premium is a compensation for accepting risk in bad times.



- The equity premium puzzle (1900-2000)
- The bond premium puzzle (2000-2015)
- Are size, value and momentum factors risk premia?
- The cat bond risk premium

Alternative risk premia

Characterization of alternative risk premia

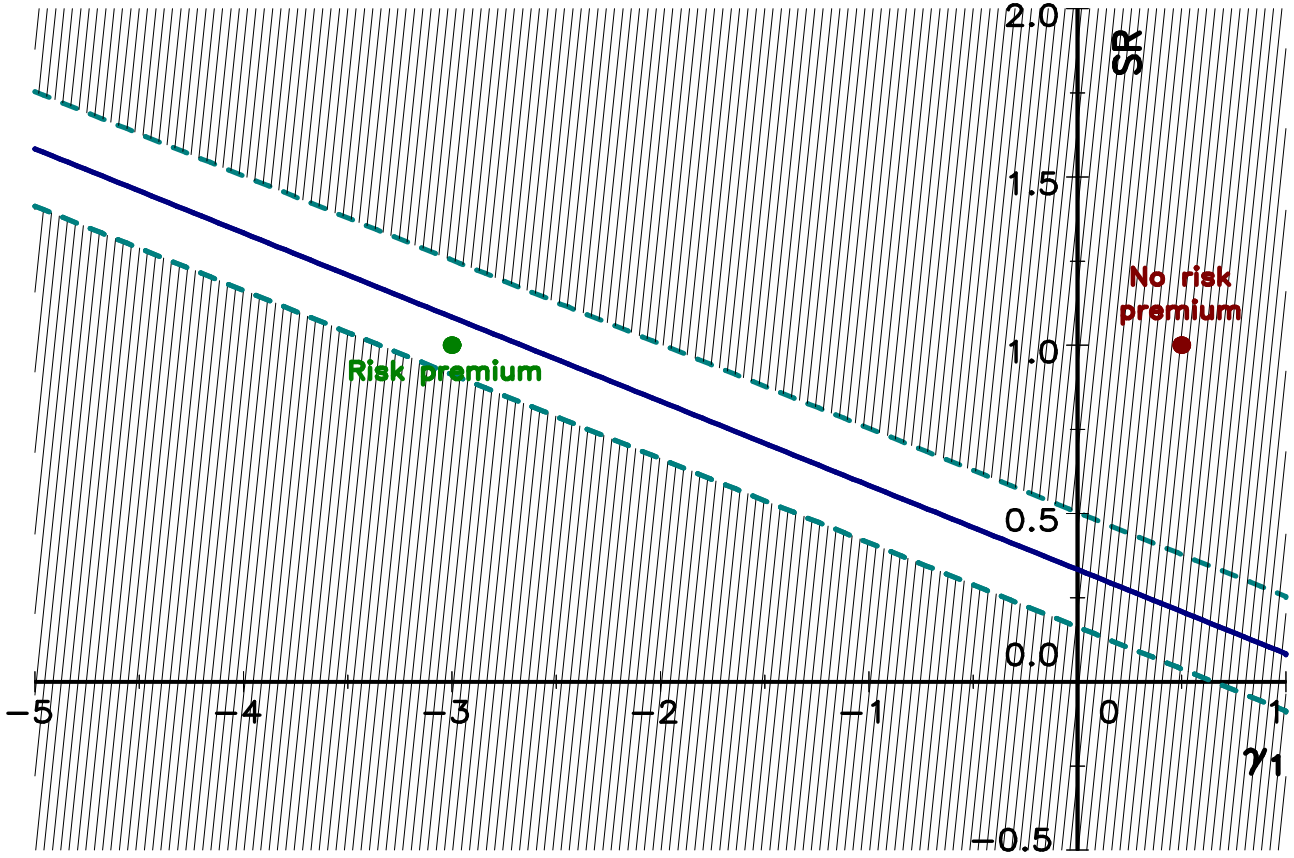
- An alternative risk premium (ARP) is a risk premium, which is not traditional
  - Traditional risk premia (TRP): equities, sovereign/corporate bonds
  - Currencies and commodities are not TRP
- The drawdown of an ARP must be positively correlated to bad times
  - Risk premia $\neq$ insurance against bad times
  - (SMB, HML) $\neq$ WML
- Risk premia are an increasing function of the volatility and a decreasing function of the skewness

In the market practice, alternative risk premia recovers:

1. Skewness risk premia (or pure risk premia), which present high negative skewness and potential large drawdown
2. Markets anomalies

The skewness premium assumption

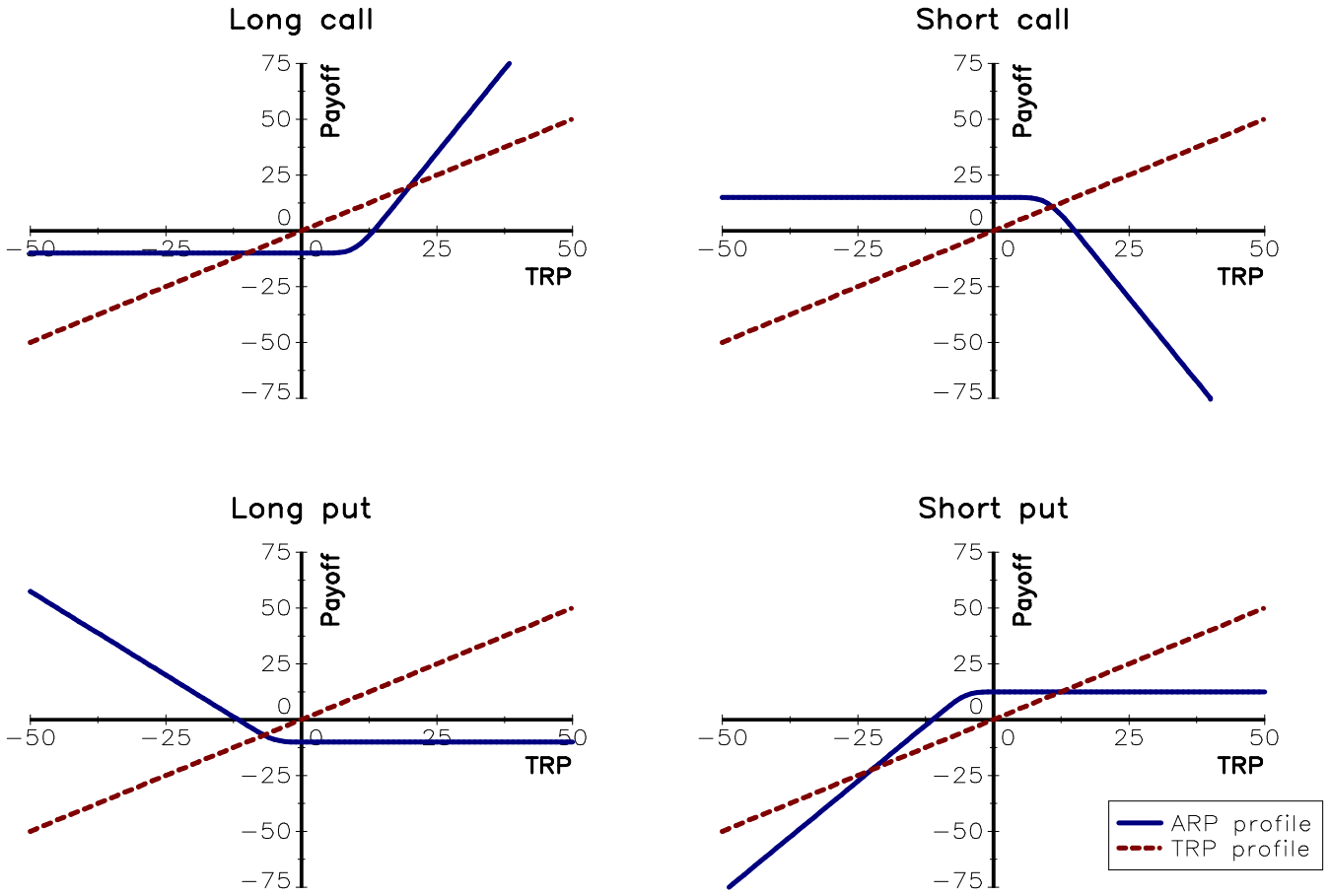
Empirical model of Lempérière *et al.* (2014)



Some issues:

- Linearity
- Stability
- Correlation with bad times

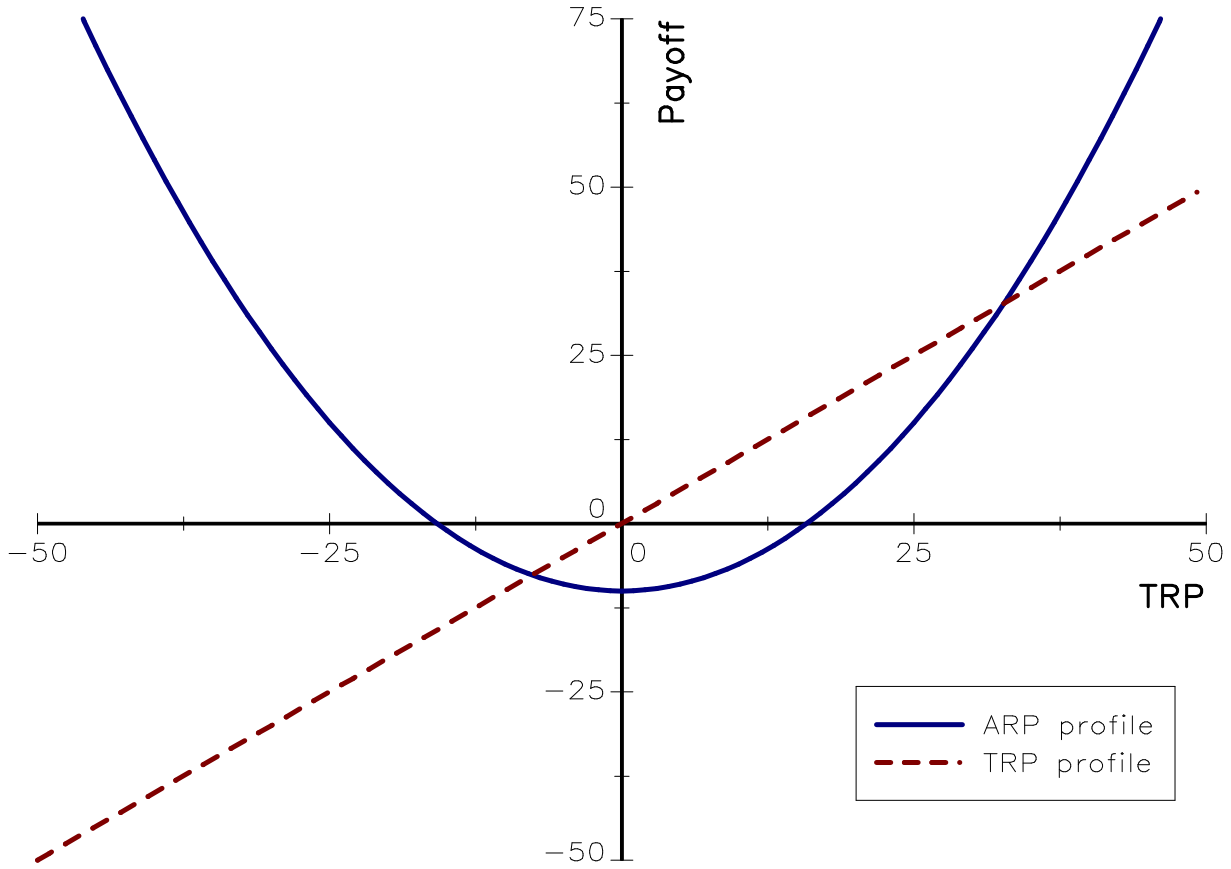
Which option profile may be considered as a risk premium?



- ~~Long call~~ (risk adverse)
- ~~Short call~~ (market anomaly)
- ~~Long put~~ (insurance)
- Short put

$\Rightarrow$ SMB, HML, ~~WML~~, ~~BAB~~, ~~QMJ~~

The example of CTA strategies



- Fung and Hsieh (2001)
- What is the motivation of investing in CTA?
- Diversification versus risk premium

A long straddle option profile that has a positive excess return is a market anomaly

Universe of potential candidates

Mapping of ARP candidates (Level 1)

Strategy	Equities	Rates	Credit	Currencies	Commodities
Market			✓		✓
Carry	✔	✔	✔	✔	✔
Liquidity	✔	✔	✔	✔	✔
Momentum	✔	✔	✔	✔	✔
Reversal	✔	✔		✔	✔
Value	✔	✔	✔	✔	✔
Volatility	✔	✔	✔	✔	✔
Event	✔				
Growth	✔				
Low volatility	✔				
Quality	✔				
Size	✔				

✓ Some asset managers include long-only credit and commodities in their ARP portfolios.

Universe of potential candidates

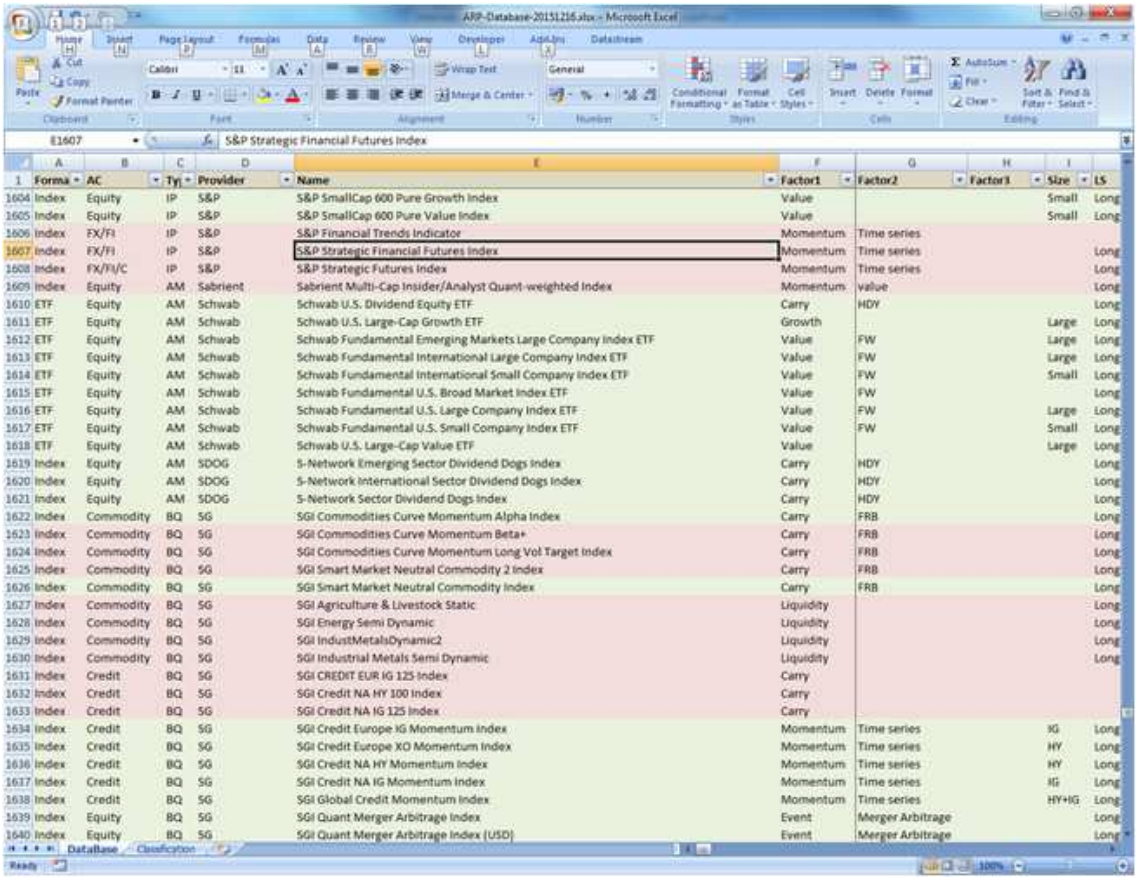
Mapping of ARP candidates (Level 2)

Risk Factor	Equities	Rates	Credit	Currencies	Commodities
Carry	Dividend Futures High Dividend Yield	FRB TSS CTS	FRB	FRB	FRB TSS CTS
Liquidity	Amihud liquidity	Turn-of-the-month	Turn-of-the-month		Turn-of-the-month
Momentum	Cross-section Time-series	Cross-section Time-series	Time-Series	Cross-section Time-series	Cross-section Time-series
Reversal	Time-series Variance	Time-series		Time-series	Time-series
Value	Value	Value	Value	PPP Economic model	Value
Volatility	Carry Term structure	Carry Term structure		Carry	Carry
Event	Buyback Merger arbitrage				
Growth	Growth				
Low volatility	Low volatility				
Quality	Quality				
Size	Size				

Facts and fantasies about alternative risk premia

- Value and momentum everywhere?
- Relevance of some ARP candidates?
- Hierarchy of ARP?
- Performance of ARP?
- Skewness risk premia or market anomalies?
- What means carry?

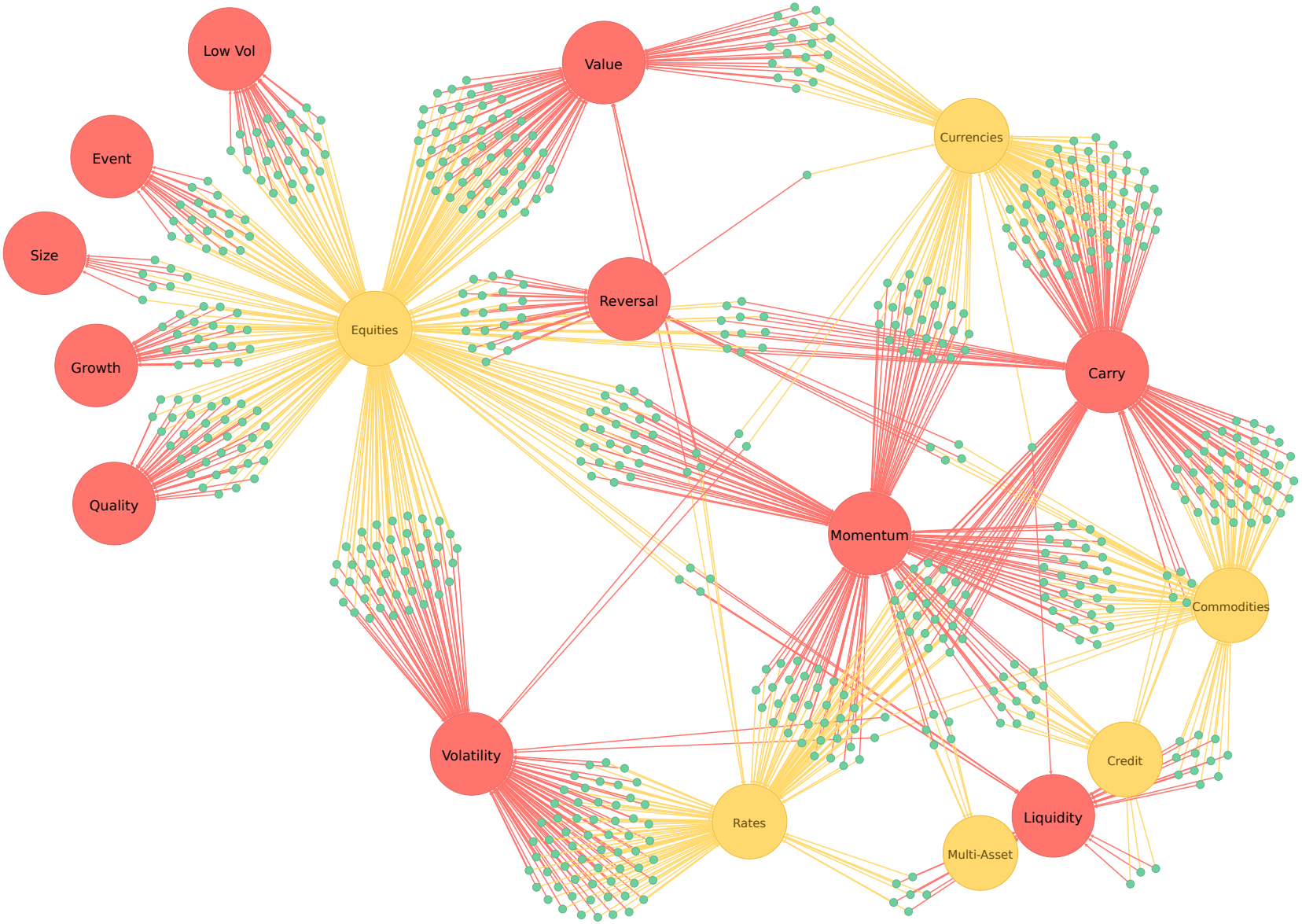
The Lyxor ARP database



	Forma	AC	Ty	Provider	Name	Factor1	Factor2	Factor3	Size	LS
1604	Index	Equity	IP	S&P	S&P SmallCap 600 Pure Growth Index	Value			Small	Long
1605	Index	Equity	IP	S&P	S&P SmallCap 600 Pure Value Index	Value			Small	Long
1606	Index	FX/FI	IP	S&P	S&P Financial Trends Indicator	Momentum	Time series			
1607	Index	FX/FI	IP	S&P	S&P Strategic Financial Futures Index	Momentum	Time series			Long
1608	Index	FX/FI/C	IP	S&P	S&P Strategic Futures Index	Momentum	Time series			Long
1609	Index	Equity	AM	Sabrient	Sabrient Multi-Cap Insider/Analyst Quant-weighted Index	Momentum	value			Long
1610	ETF	Equity	AM	Schwab	Schwab U.S. Dividend Equity ETF	Carry	HDY			Long
1611	ETF	Equity	AM	Schwab	Schwab U.S. Large-Cap Growth ETF	Growth			Large	Long
1612	ETF	Equity	AM	Schwab	Schwab Fundamental Emerging Markets Large Company Index ETF	Value	FW		Large	Long
1613	ETF	Equity	AM	Schwab	Schwab Fundamental International Large Company Index ETF	Value	FW		Large	Long
1614	ETF	Equity	AM	Schwab	Schwab Fundamental International Small Company Index ETF	Value	FW		Small	Long
1615	ETF	Equity	AM	Schwab	Schwab Fundamental U.S. Broad Market Index ETF	Value	FW			Long
1616	ETF	Equity	AM	Schwab	Schwab Fundamental U.S. Large Company Index ETF	Value	FW		Large	Long
1617	ETF	Equity	AM	Schwab	Schwab Fundamental U.S. Small Company Index ETF	Value	FW		Small	Long
1618	ETF	Equity	AM	Schwab	Schwab U.S. Large-Cap Value ETF	Value			Large	Long
1619	Index	Equity	AM	SDOG	S-Network Emerging Sector Dividend Dogs Index	Carry	HDY			Long
1620	Index	Equity	AM	SDOG	S-Network International Sector Dividend Dogs Index	Carry	HDY			Long
1621	Index	Equity	AM	SDOG	S-Network Sector Dividend Dogs Index	Carry	HDY			Long
1622	Index	Commodity	BQ	SG	SGI Commodities Curve Momentum Alpha Index	Carry	FRB			Long
1623	Index	Commodity	BQ	SG	SGI Commodities Curve Momentum Beta+	Carry	FRB			Long
1624	Index	Commodity	BQ	SG	SGI Commodities Curve Momentum Long Vol Target Index	Carry	FRB			Long
1625	Index	Commodity	BQ	SG	SGI Smart Market Neutral Commodity 2 Index	Carry	FRB			Long
1626	Index	Commodity	BQ	SG	SGI Smart Market Neutral Commodity Index	Carry	FRB			Long
1627	Index	Commodity	BQ	SG	SGI Agriculture & Livestock Static	Liquidity				Long
1628	Index	Commodity	BQ	SG	SGI Energy Semi Dynamic	Liquidity				Long
1629	Index	Commodity	BQ	SG	SGI IndustMetalsDynamic2	Liquidity				Long
1630	Index	Commodity	BQ	SG	SGI Industrial Metals Semi Dynamic	Liquidity				Long
1631	Index	Credit	BQ	SG	SGI CREDIT EUR IG 125 Index	Carry				
1632	Index	Credit	BQ	SG	SGI Credit NA HY 100 Index	Carry				
1633	Index	Credit	BQ	SG	SGI Credit NA IG 125 Index	Carry				
1634	Index	Credit	BQ	SG	SGI Credit Europe IG Momentum Index	Momentum	Time series		IG	Long
1635	Index	Credit	BQ	SG	SGI Credit Europe XO Momentum Index	Momentum	Time series		HY	Long
1636	Index	Credit	BQ	SG	SGI Credit NA HY Momentum Index	Momentum	Time series		HY	Long
1637	Index	Credit	BQ	SG	SGI Credit NA IG Momentum Index	Momentum	Time series		IG	Long
1638	Index	Credit	BQ	SG	SGI Global Credit Momentum Index	Momentum	Time series		HY+IG	Long
1639	Index	Equity	BQ	SG	SGI Quant Merger Arbitrage Index	Event	Merger Arbitrage			Long
1640	Index	Equity	BQ	SG	SGI Quant Merger Arbitrage Index (USD)	Event	Merger Arbitrage			Long

- 1960 products (ETFs & indices)
- 1382 candidates (262 ETFs & 1120 indices)
  - 45 AM proprietary indices
  - 624 bank's proprietary indices
  - 451 indices from independent index providers (e.g. FTSE, MSCI, S&P, Stoxx, etc.)

Graph database of bank's proprietary indices



Building a generic ARP index

What is the problem?

- For traditional risk premia, the cross-correlation between several indices replicating the TRP is higher than 90%
- For alternative risk premia, the cross-correlation between several indices replicating the ARP is between -80% and 100%

Examples (2000-2015)

- In the case of the equities/US traditional risk premium, the cross-correlation between S&P 500, FTSE USA, MSCI USA, Russell 1000 and Russell 3000 indices is between 99.65% and 99.92%
- In the case of the equities/volatility/carry/US risk premium, the cross-correlation between the 14 short volatility indices is between -34.9% and 98.6% (mean $= 43.0\%$, $Q_3 - Q_1 > 35\%$)

The identification protocol

Step 1 Define the set of relevant indices (qualitative due diligence).

Step 2 Given an initial set of indices, the underlying idea is to find the subset, whose elements present very similar patterns. For that, we use the deletion algorithm using the $\mathbf{R}^2$ statistic:

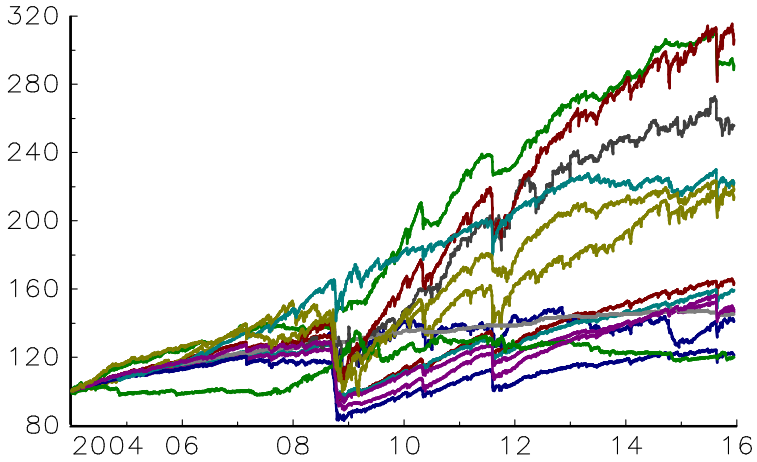
$$R_{k,t} = \alpha_k + \beta_k R_t^{(-k)} + \varepsilon_{k,t} \quad \Rightarrow \quad \mathbf{R}_k^2$$

Step 3 The algorithm stops when the similarity is larger than a given threshold for all the elements of the subset (e.g. $\mathbf{R}_k^2 > \mathbf{R}_{\min}^2 = 70\%$).

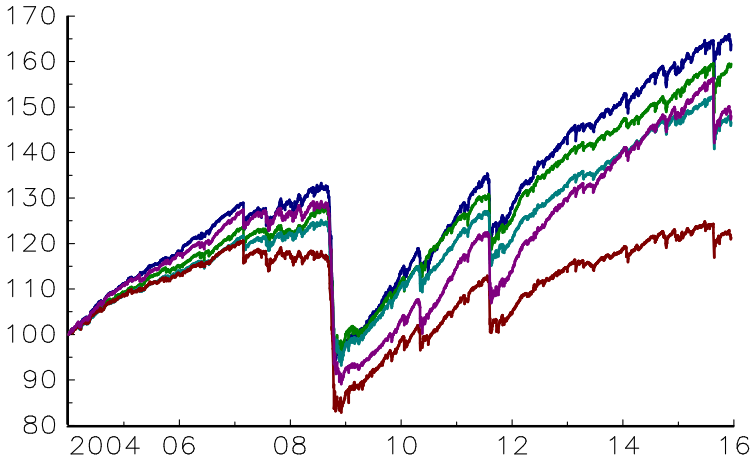
Step 4 The generic backtest of the ARP is the weighted average of the performance of the subset elements

Illustration with the equities/volatility/carry/US risk premium

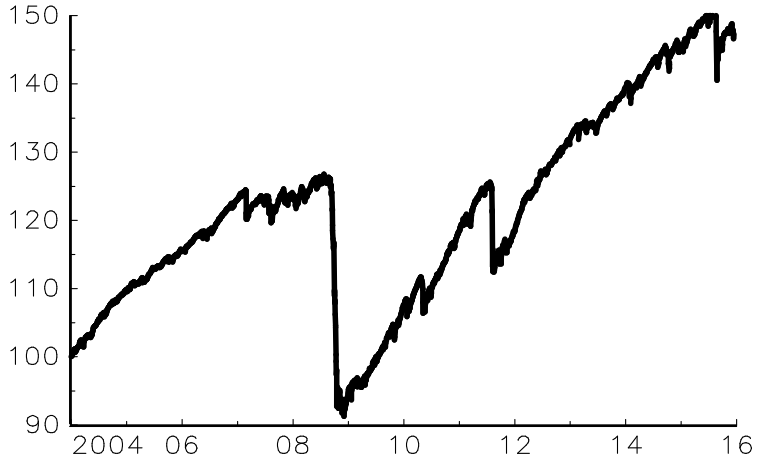
Indices after the 1st step



Selected indices after the 3rd step

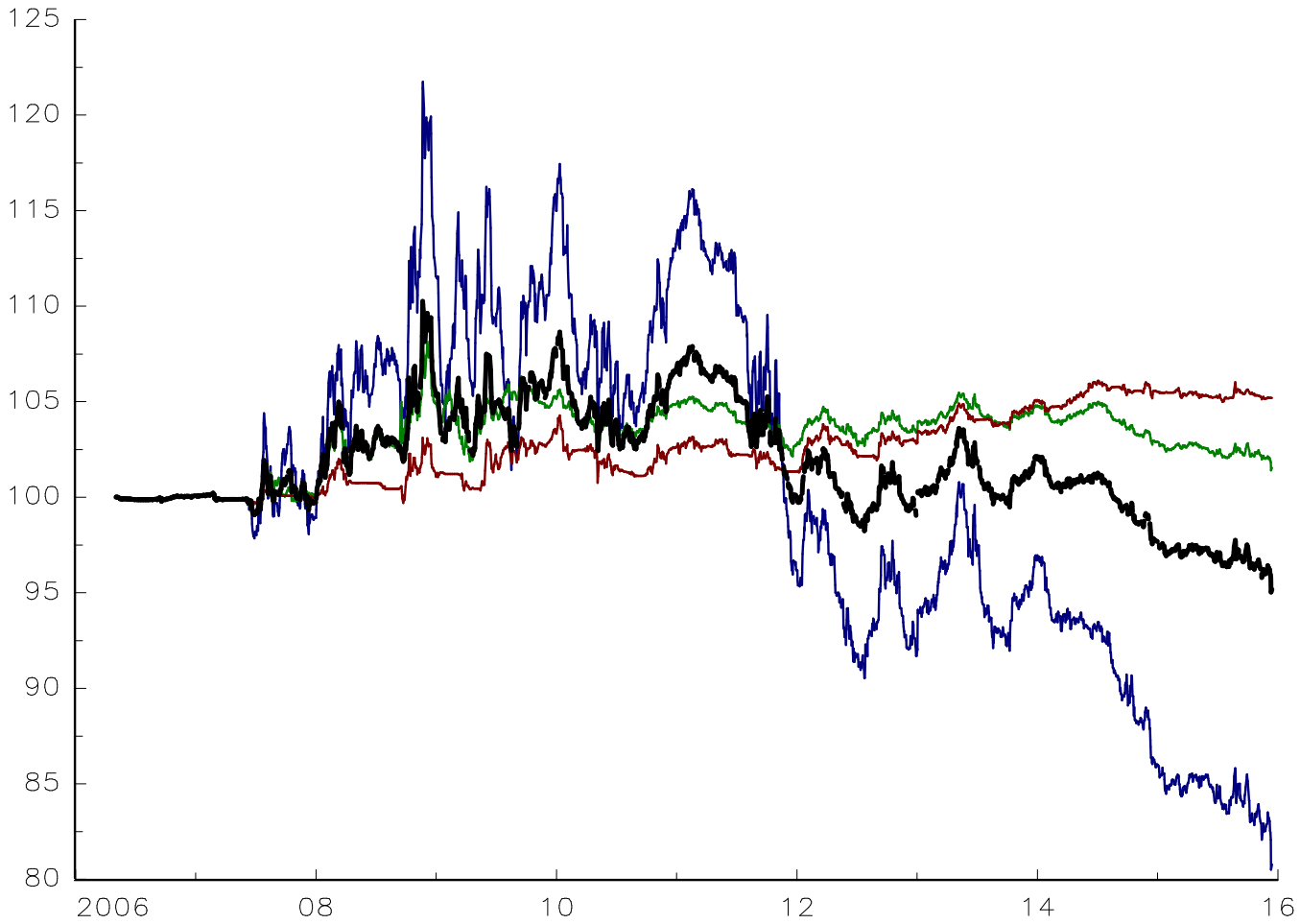


Generic cumulative return



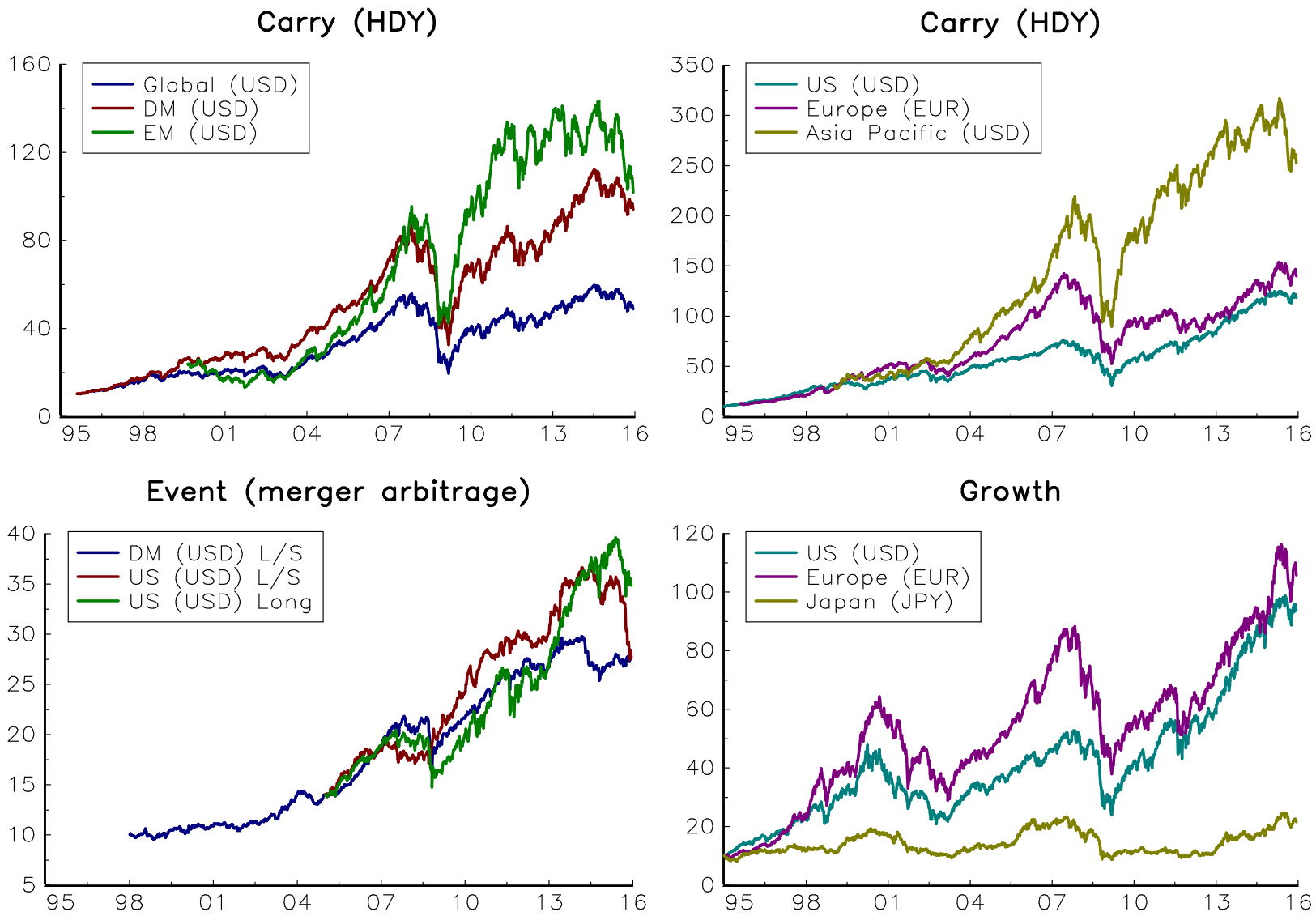
- Barclays (BXIISVUE) 90.2%
- Citi (CIISEVCU) 92.4%
- Citi (CIISEVWU) 97.0%
- JP Morgan (AIJPSV1U) 93.4%
- SG (SGIXVPUX) 94.9%

Illustration with the credit/momentum/US risk premium

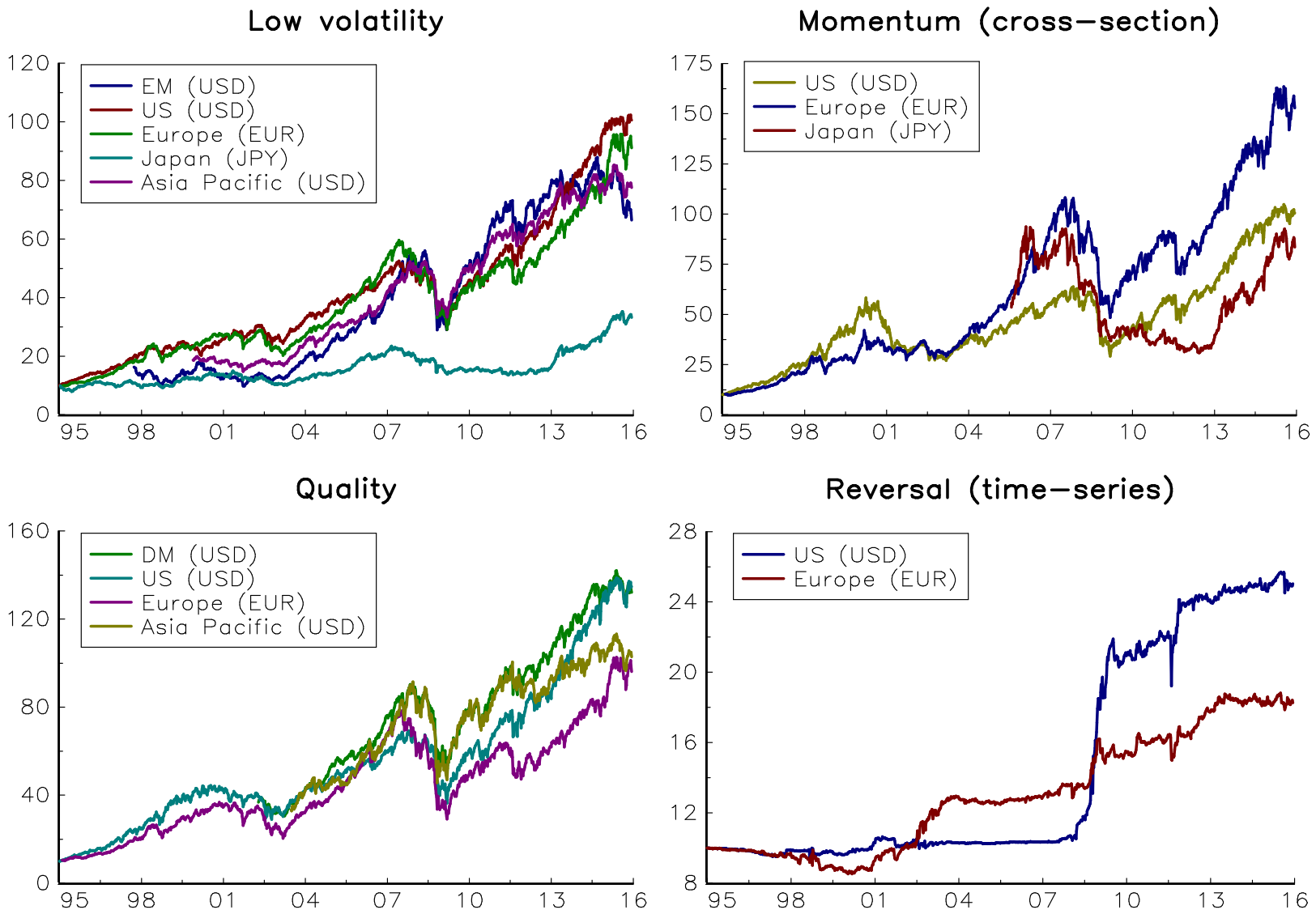


The existence of this risk premium is a major issue!

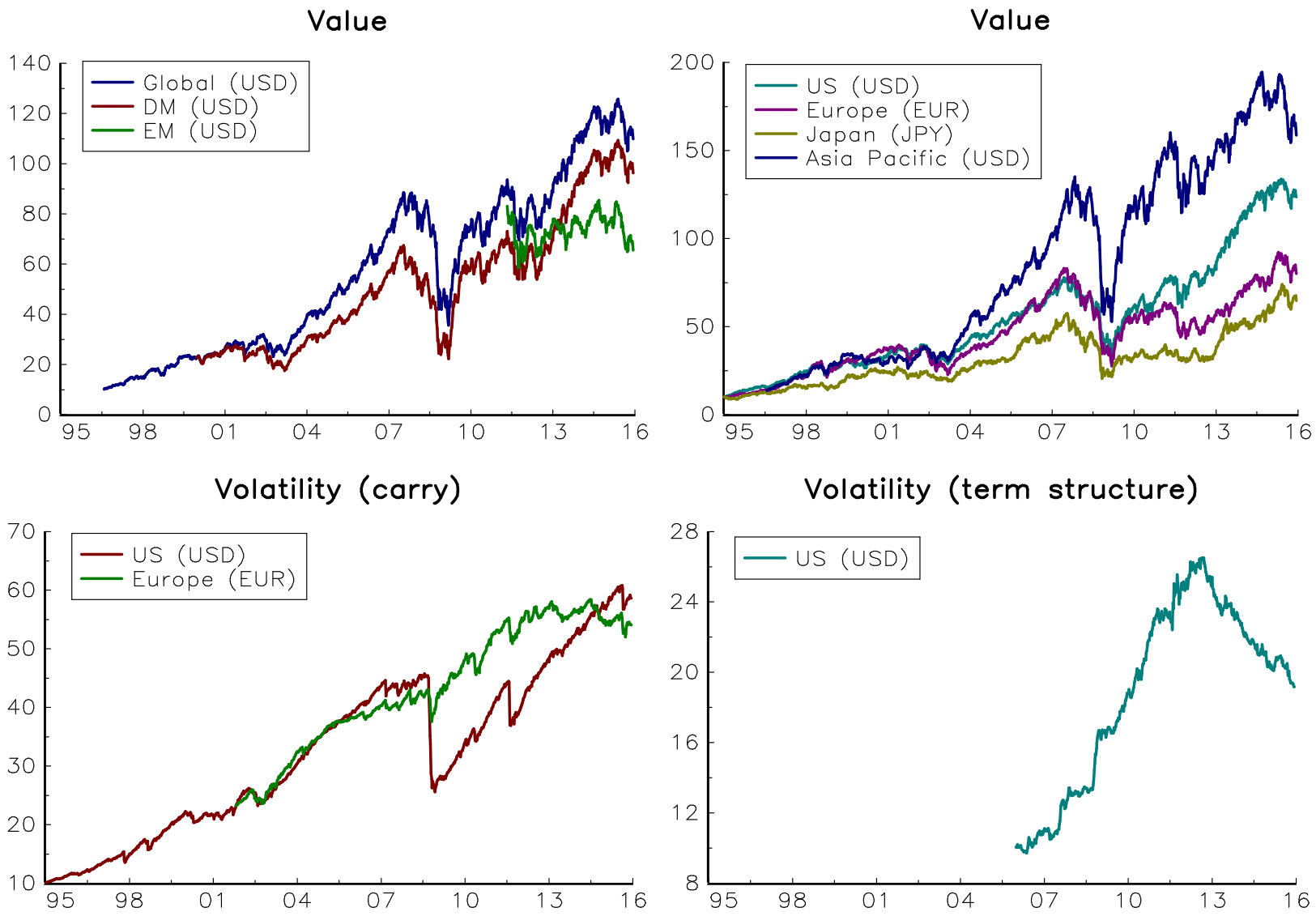
Generic Performance of ARP (equities)



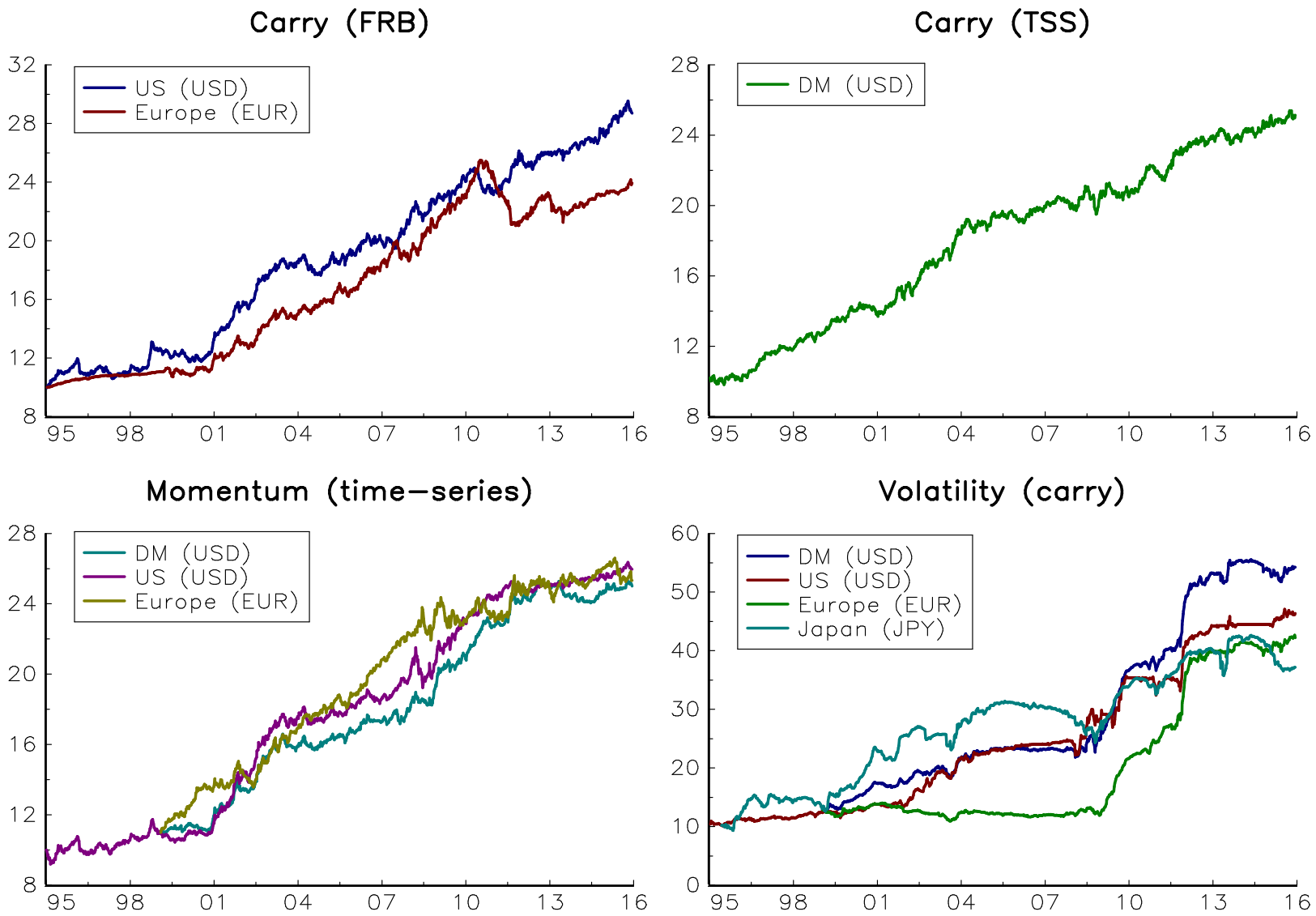
Generic Performance of ARP (equities)



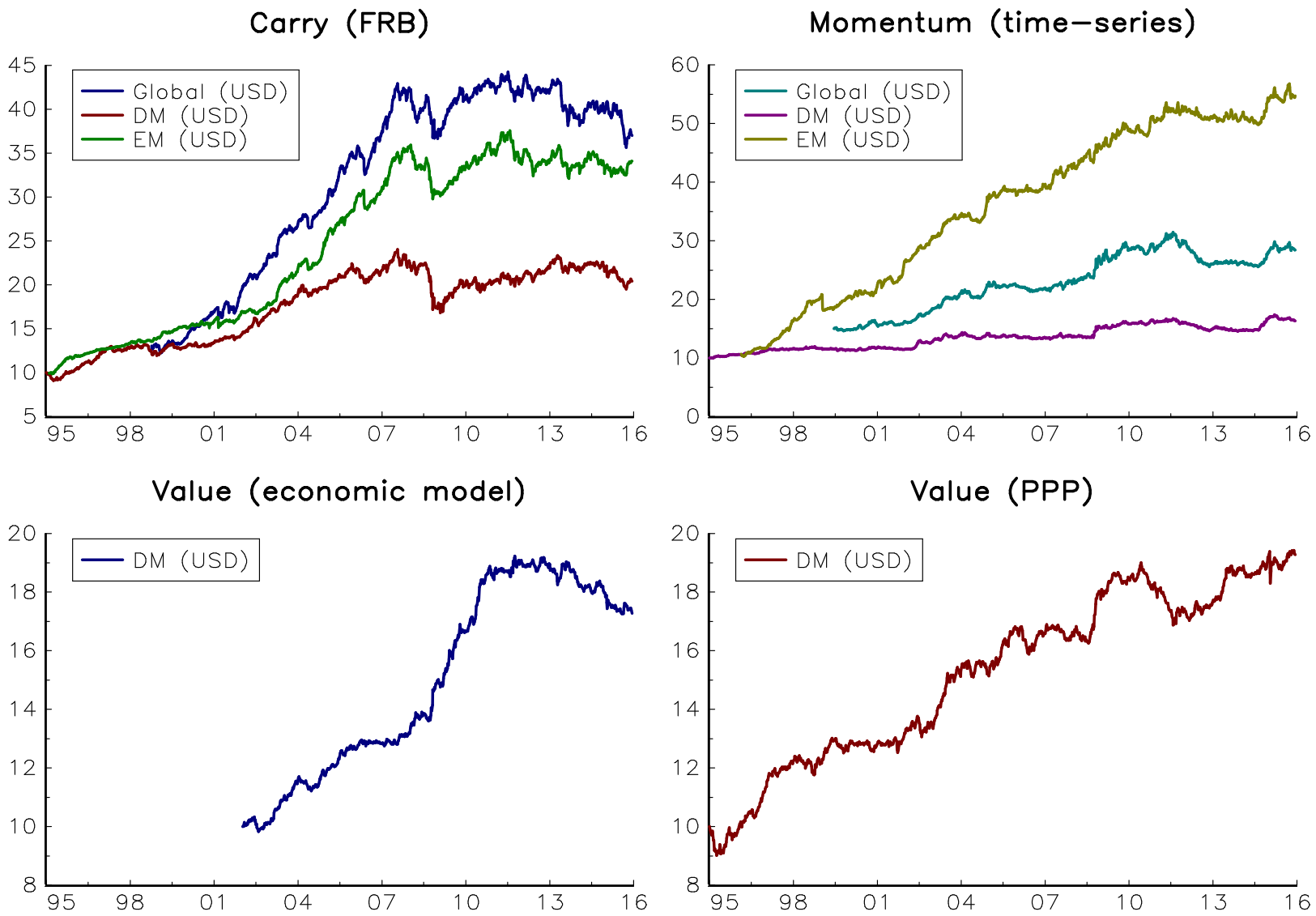
Generic Performance of ARP (equities)



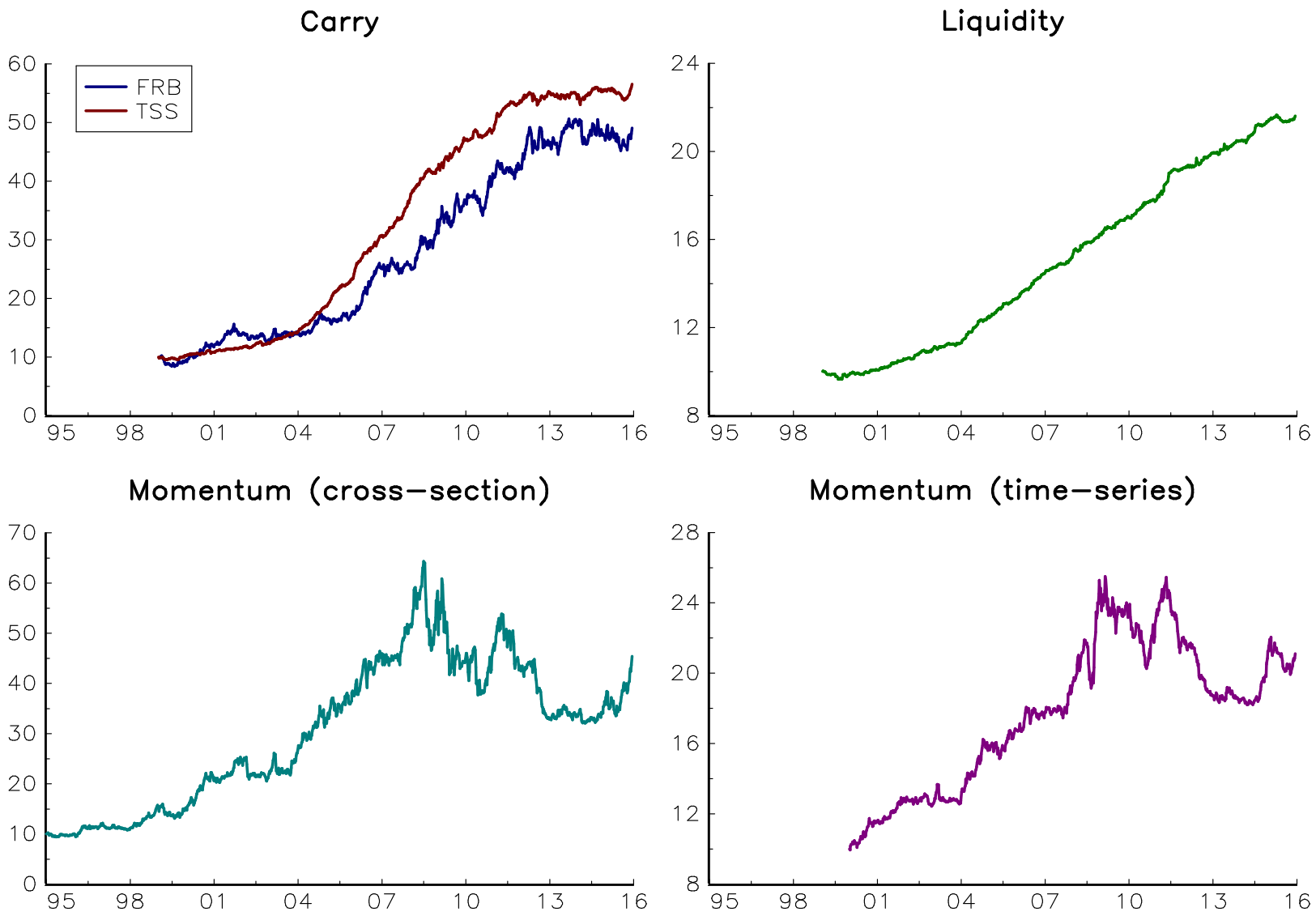
Generic Performance of ARP (rates)



Generic Performance of ARP (currencies)



Generic Performance of ARP (commodities)



Summary of the results

Mapping of **relevant** ARP

Risk Factor	Equities	Rates	Credit	Currencies	Commodities
Carry	~~Dividend Futures~~ High Dividend Yield	FRB TSS ~~CTS~~	~~FRB~~	FRB	FRB TSS ~~CTS~~
Liquidity	~~Amihud liquidity~~	~~Turn-of-the-month~~	~~Turn-of-the-month~~		Turn-of-the-month
Momentum	Cross-section Time-series	~~Cross-section~~ Time-series	~~Time-Series~~	~~Cross-section~~ Time-series	Cross-section Time-series
Reversal	Time-series ~~Variance~~	~~Time-series~~		~~Time-series~~	~~Time-series~~
Value	Value	~~Value~~	~~Value~~	PPP Economic model	~~Value~~
Volatility	Carry Term structure	Carry ~~Term structure~~		~~Carry~~	~~Carry~~
Event	~~Buyback~~ Merger arbitrage				
Growth	Growth				
Low volatility	Low volatility				
Quality	Quality				
Size	Size				

Summary of the results

- ~~Value~~ Carry and momentum everywhere
- Some ARP candidates are not relevant (e.g. liquidity premium in equities, rates and currencies; reversal premium using variance swaps; value premium in rates and commodities; dividend premium; volatility premium in currencies and commodities; correlation premium; seasonality premium.)
- Hierarchy of ARPs

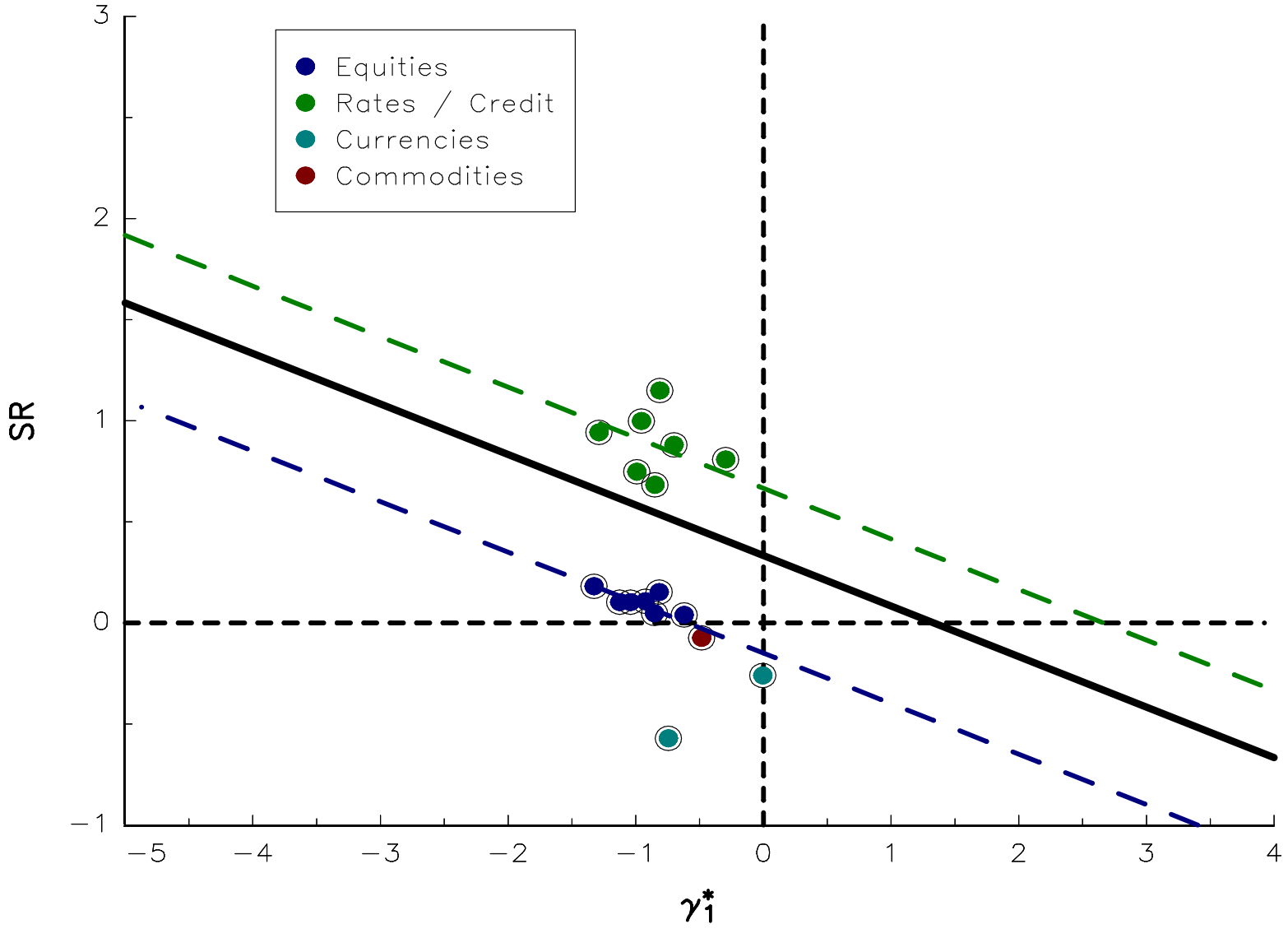
Equities	value, carry, low volatility, volatility/carry, momentum, quality, growth, size, event, reversal
Rates	volatility/carry, momentum, carry
Currencies	carry, momentum, value
Commodities	carry, momentum, liquidity

- Carry recovers different notions: FRB, TSS and CTS

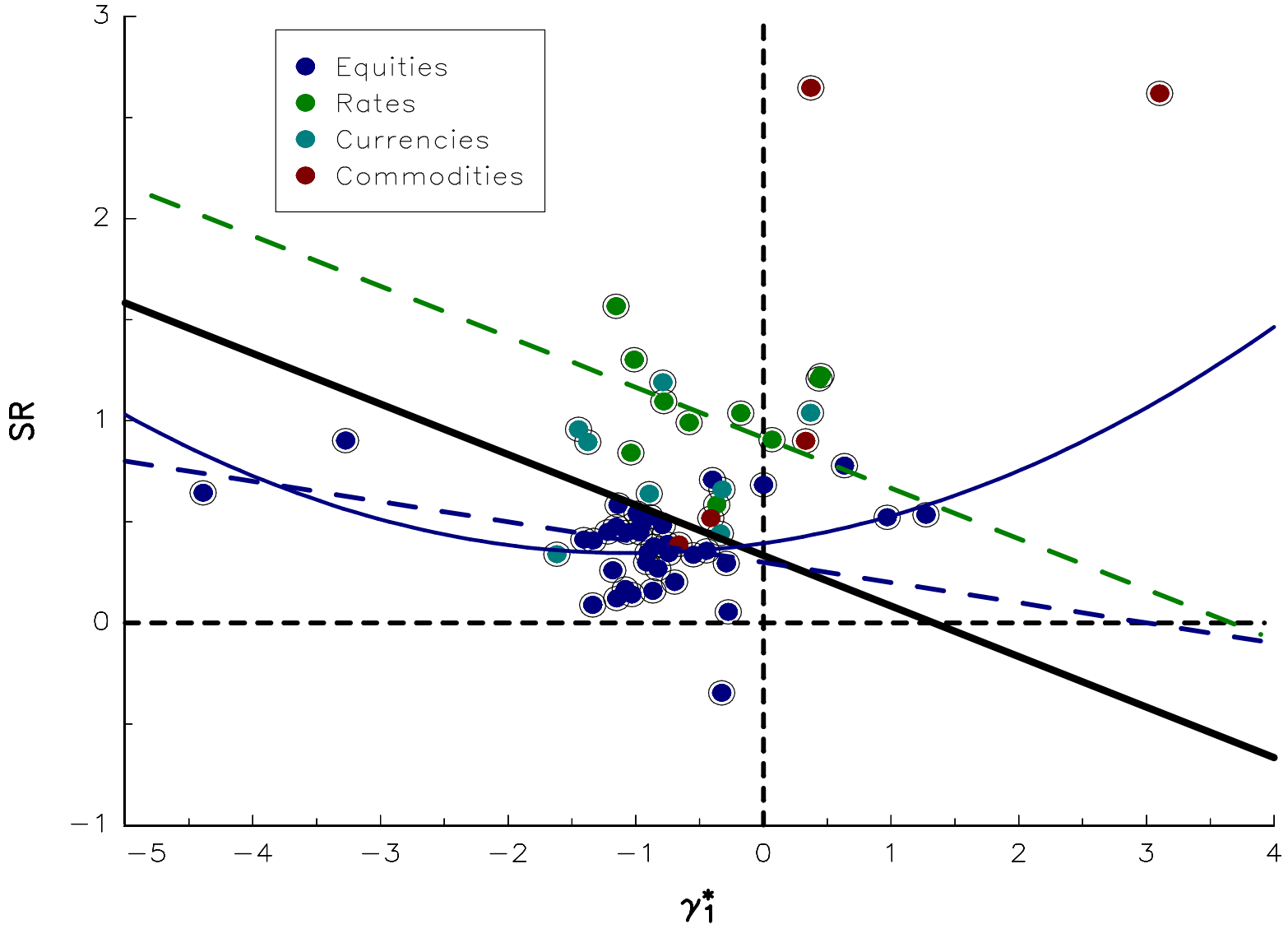
Some results

- ARP Sharpe ratios are generally better than TRP Sharpe ratios (in-sample backtest versus real performance)
- ARP present higher skewness risks than TRP
- Some ARP have very large drawdown with respect to their "normal" volatilities
- There are more volatility diversification within ARP investment universe than within TRP investment universe
  - Pure correlation effects
  - Number of systematic risk factors
- Extreme risks remain highly correlated
- The Sharpe ratio is not the right risk/return measure

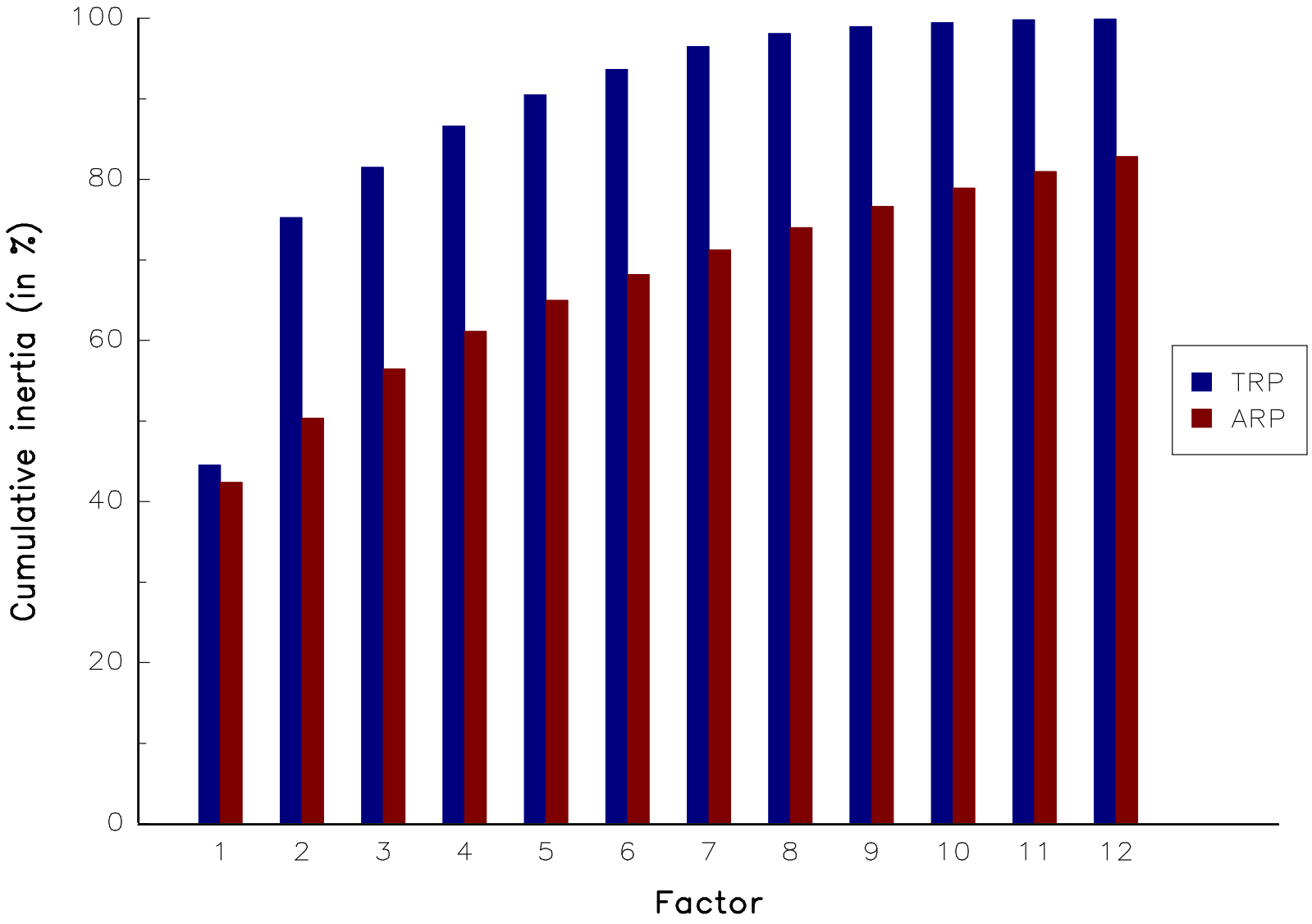
Relationship between $\gamma_1^\star$ and SR for traditional risk premia



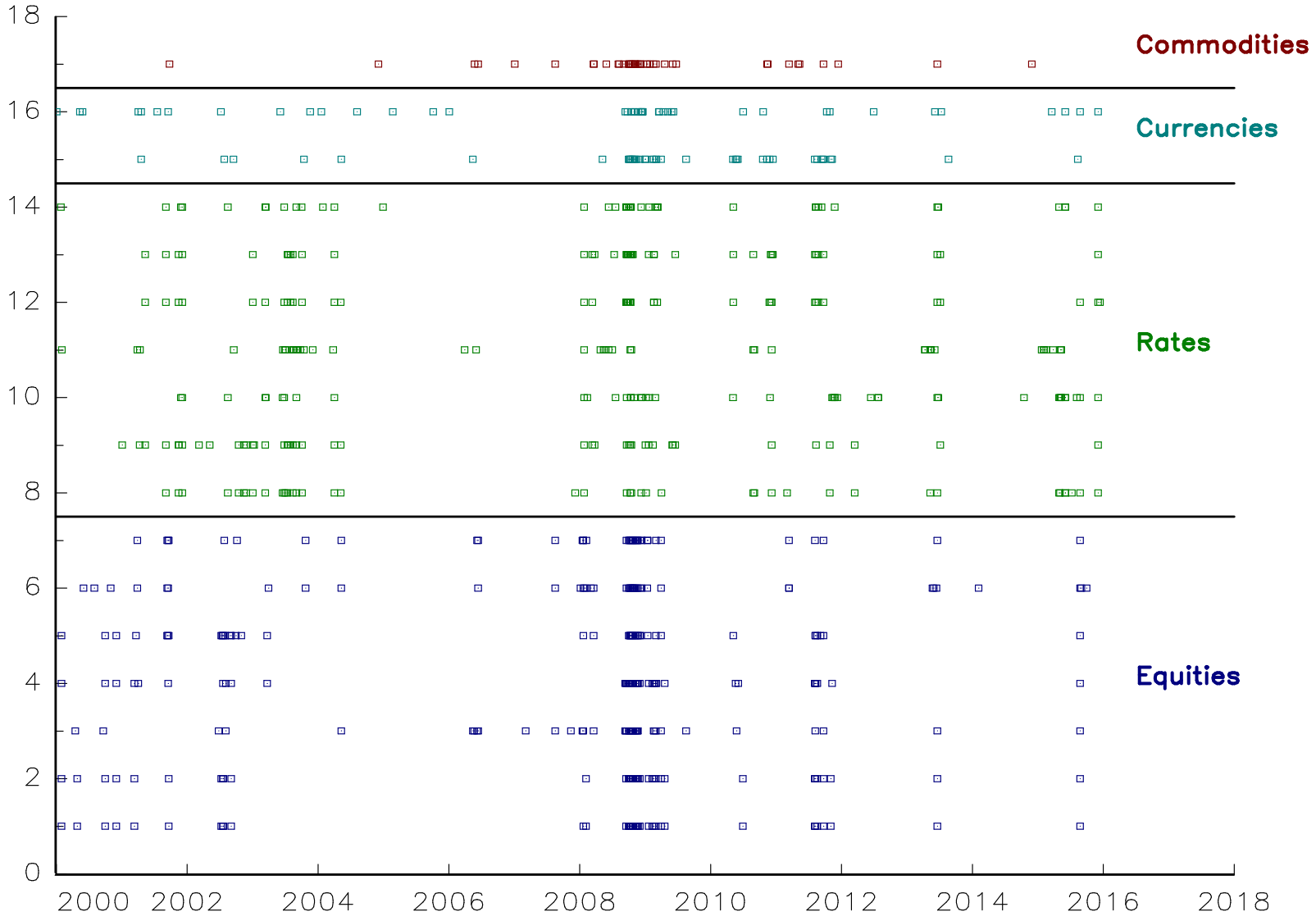
Relationship between $\gamma_1^\star$ and SR for alternative risk premia



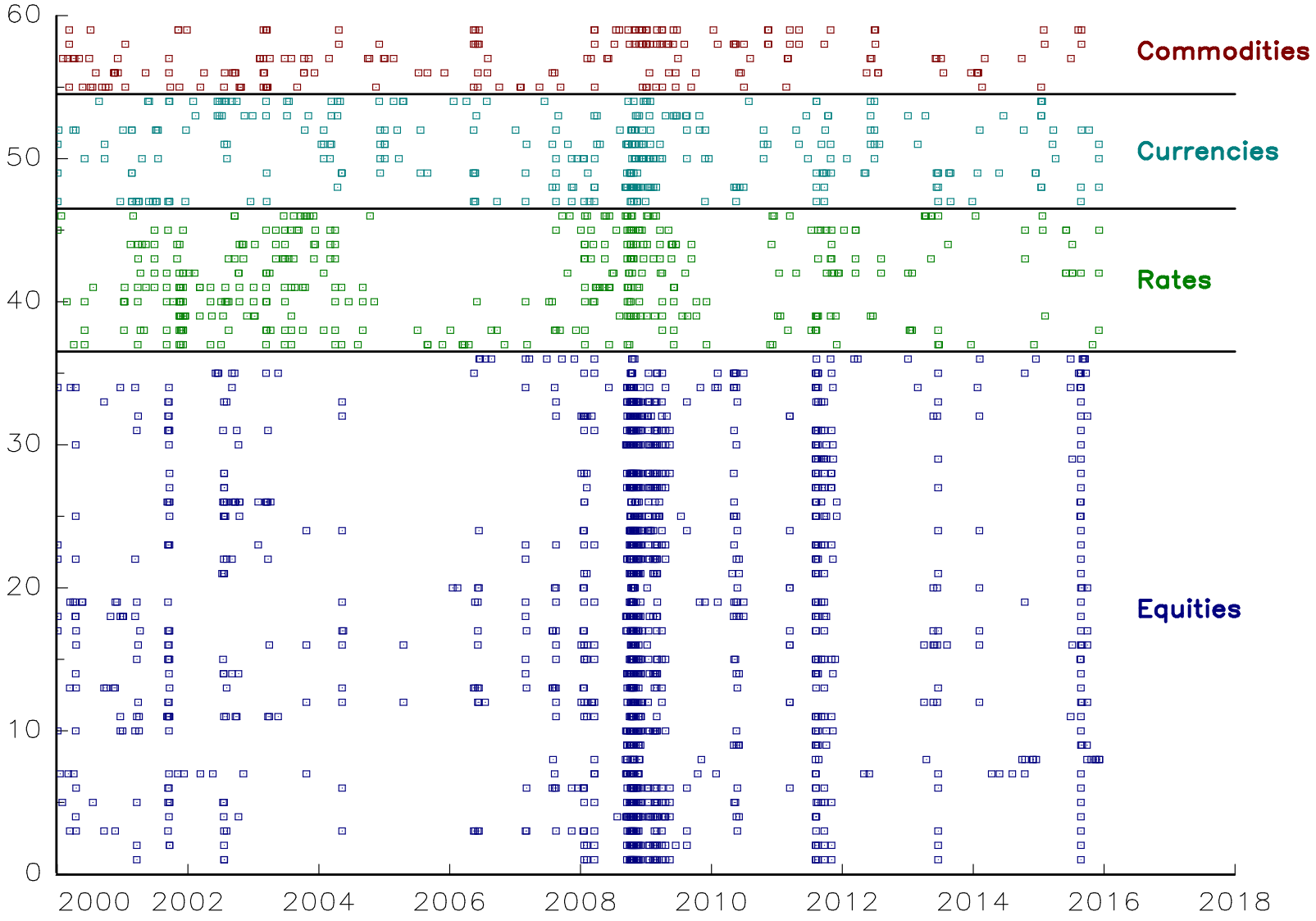
Volatility diversification



Dependence of extreme risks (the case of TRP)



Dependence of extreme risks (the case of ARP)



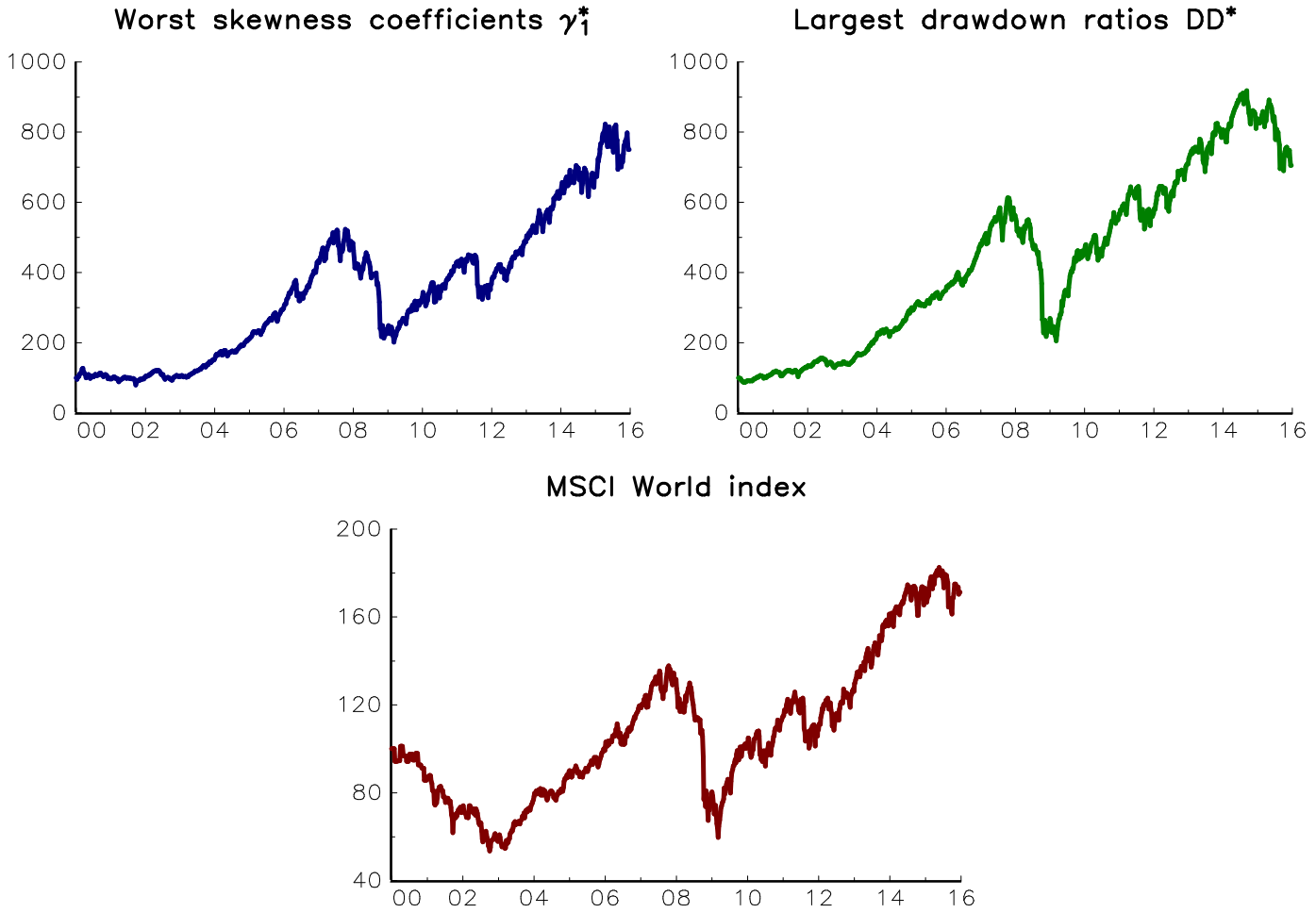
The diversification issue

- What means diversification?
  - Volatility hedging $\Rightarrow$ volatility reduction
  - Less skewness/drawdown risk *neq* extreme risk reduction
- Correlation is not the right tool to measure the extreme risk diversification
- Traditional portfolio allocation models are not adequate to manage a portfolio of skewness risk premia
  - Reduce dramatically the volatility risk (perception of low risk)
  - Does not reduce the skewness risk (the magnitude of extreme risk increases)
- ARP exhibit non-linear payoff functions with respect to TRP

Volatility diversification $\neq$ Risk diversification

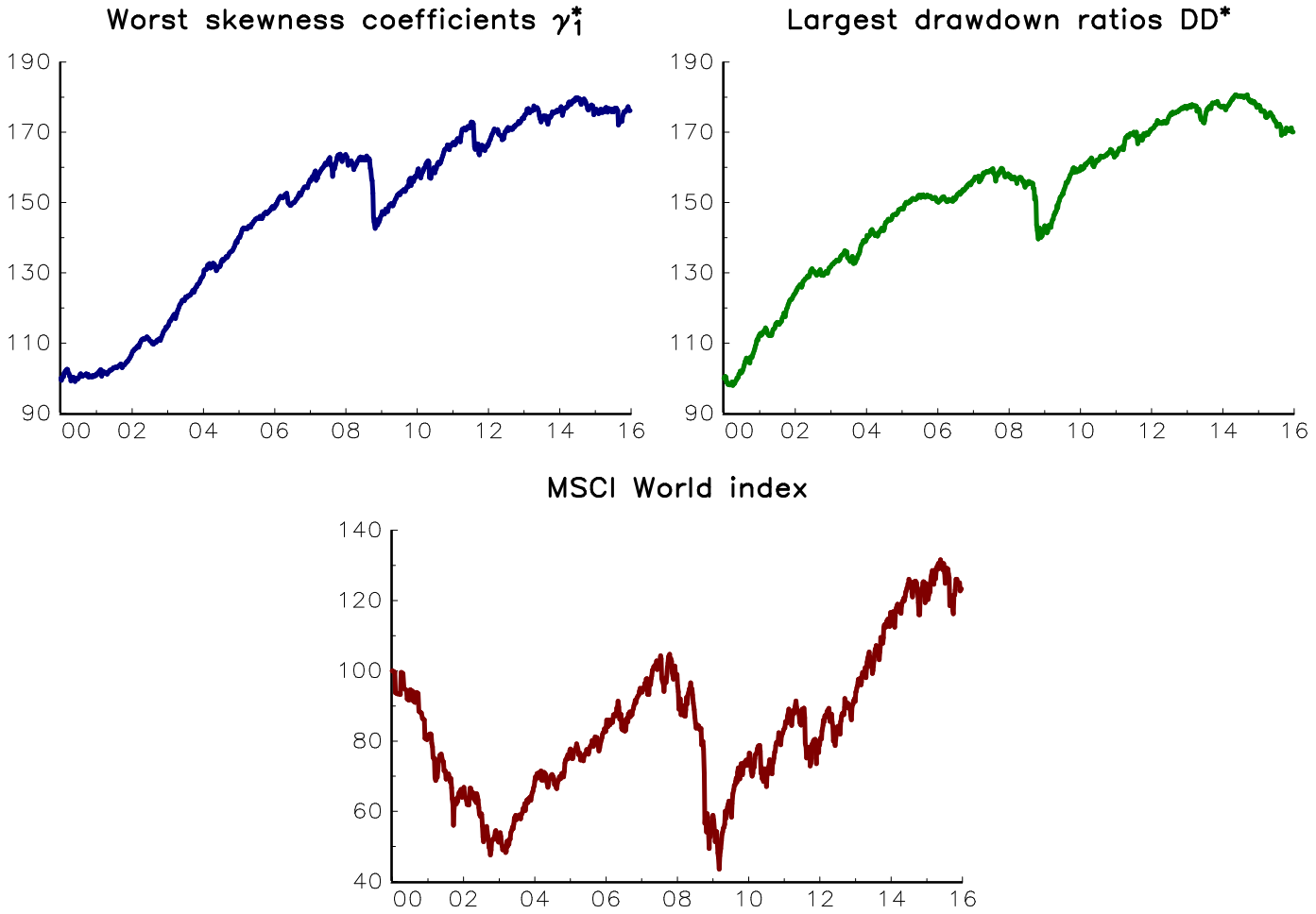
Skewness aggregation $\neq$ volatility aggregation

Cumulative returns of the ARP-EW-LO portfolio



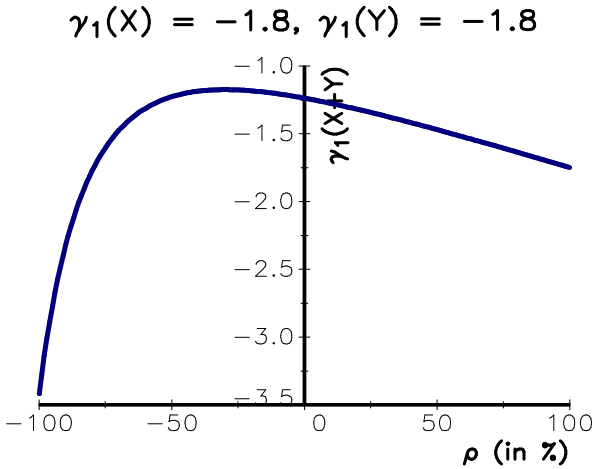
Skewness aggregation $\neq$ volatility aggregation

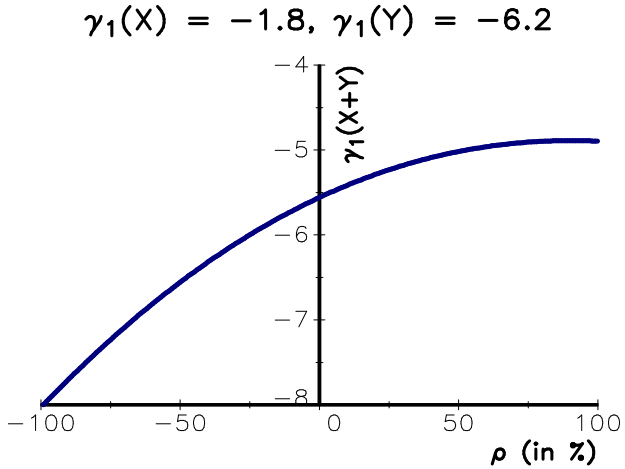
Cumulative returns of the ARP-EW-LS portfolio

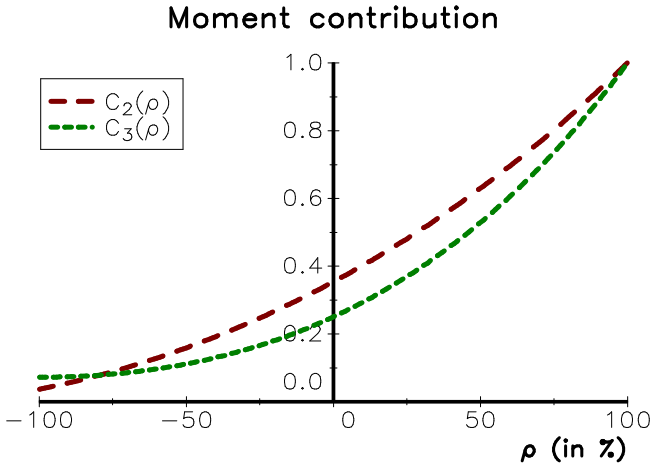


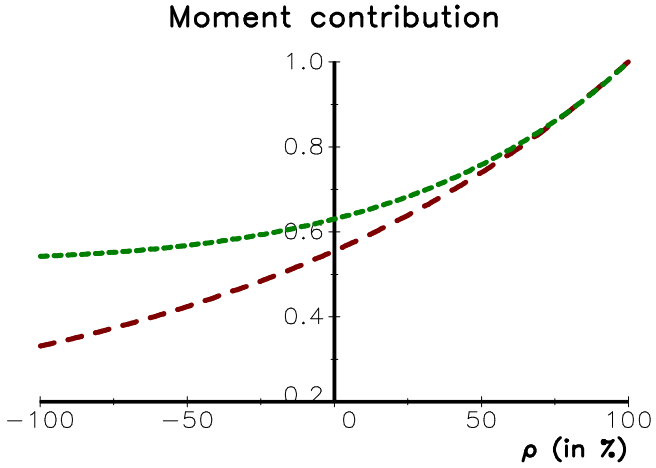
Skewness aggregation $\neq$ volatility aggregation

Illustration with log-normal random variables









Payoff of alternative risk premia

Let $R_t(x)$ and $R_t(b)$ be the returns of the ARP x and the benchmark b. If the dependence function between $R_t(x)$ and $R_t(b)$ is $\mathbf{C}^-$ ($\mathbf{C}^+$), we obtain:

$$R_t(x) = f(R_t(b))$$

where f is a decreasing (increasing) function. We also have:

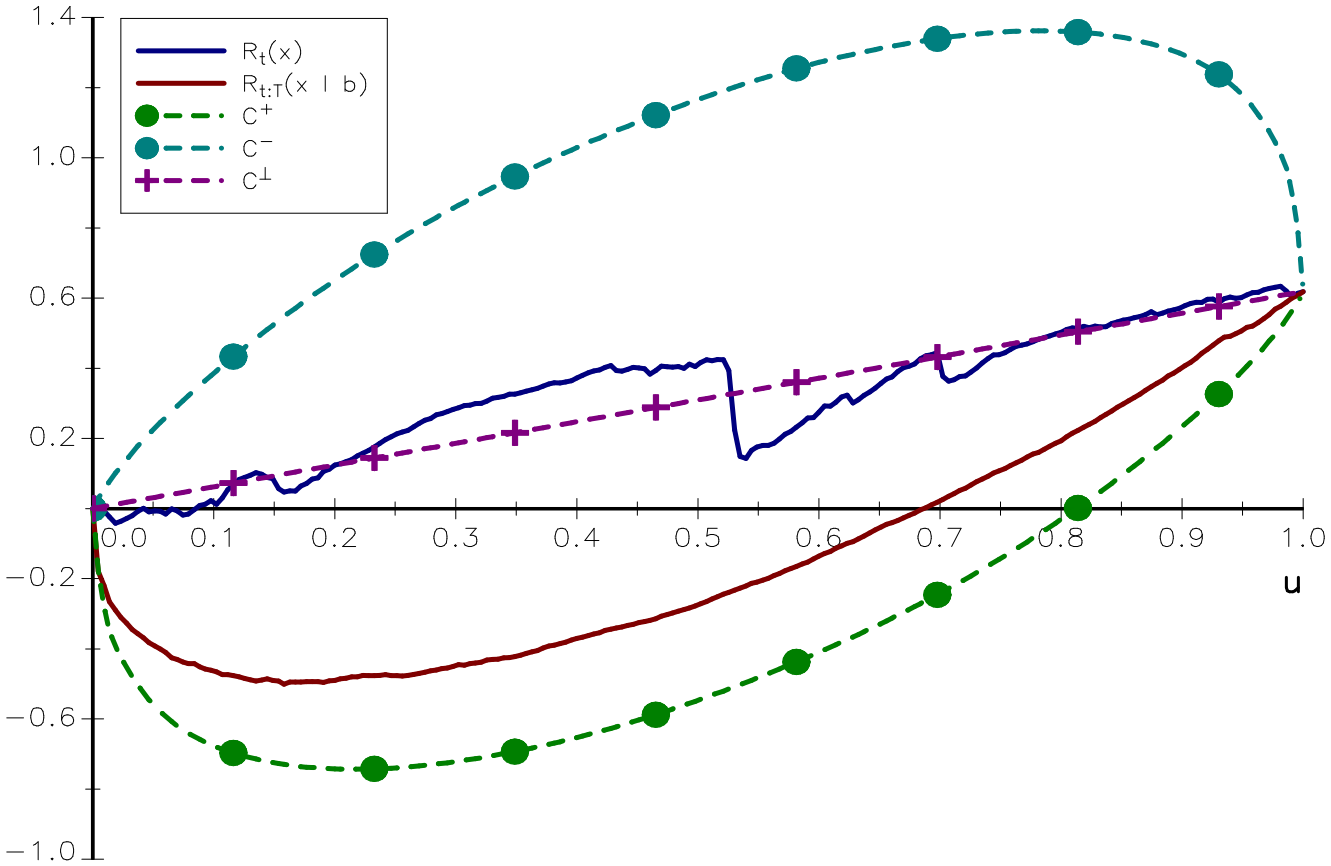
$$h\left(\frac{t}{T}\right) = \sum_{i=1}^{t} R_{t:T}(x \mid b)$$

where $R_{t:T}(x \mid b)$ is the conditional order statistic.

$\Rightarrow$ The payoff function between $R_{t:T}(b)$ and $R_{t:T}(x \mid b)$ is estimated using a non-parametric quantile regression with a spline kernel and monthly returns.

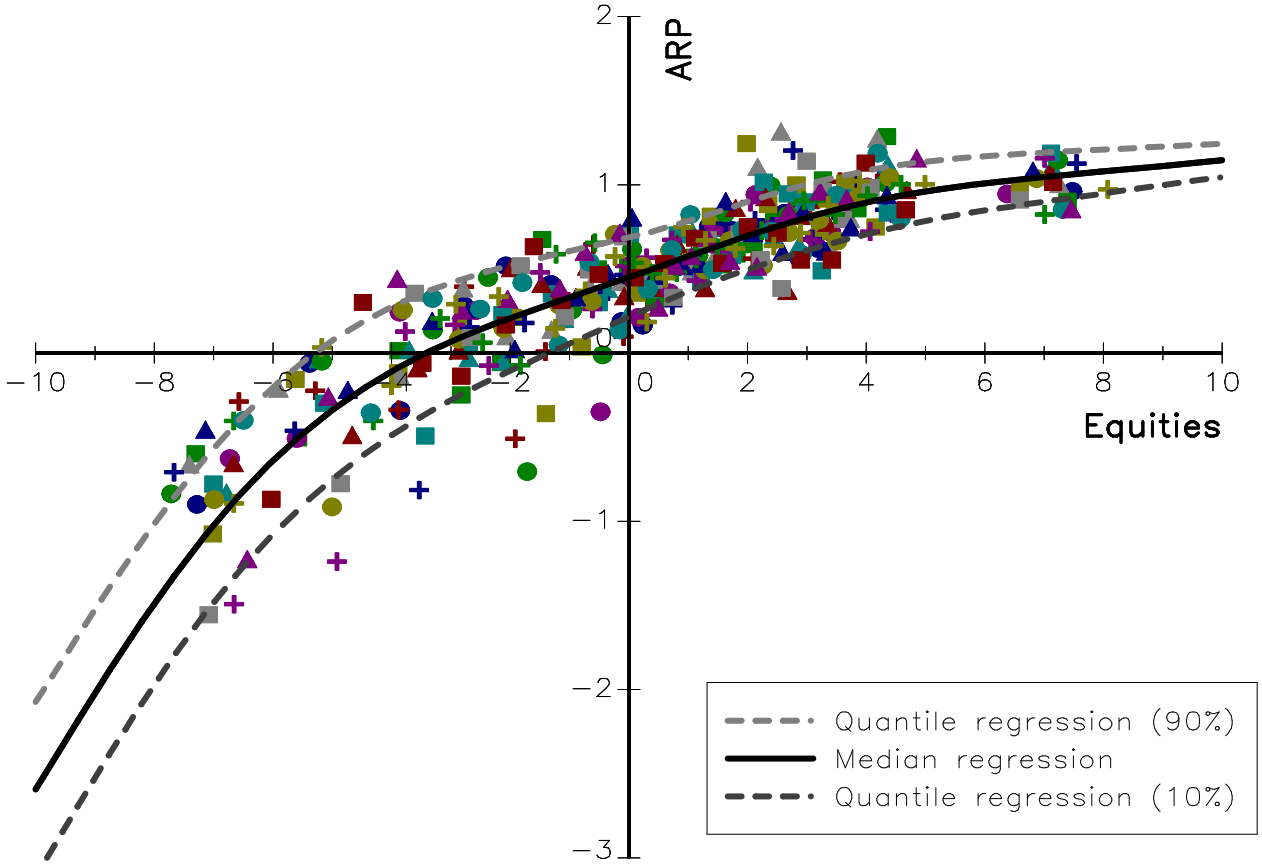
Payoff of alternative risk premia

Conditional dependence $h(u)$ for the equities/volatility/carry/US strategy



Payoff of alternative risk premia

Payoff function estimation for the equities/volatility/carry/US strategy



Payoff of alternative risk premia

Asset class	ARP	Payoff function	
		Equities	Rates
Equities	Carry	long-only	short-call
	Event (long)	short-put	short-call
	Event (long/short)	$\perp$	$\perp$
	Growth	long-only	short-call
	Low volatility	long-only	short-call
	Momentum	long-only	short-call
	Quality	long-only	short-call
	Reversal	short-put*	long-call*
	Value	leveraged	short-call
	Volatility (carry)	short-put	short-call*
	Volatility (term structure)	long-put	long-call
Rates	Carry	long-put	long-only
	Momentum	long-straddle*	long-only
	Volatility	long-call	short-straddle
Currencies	Carry	long-only	short-call
	Momentum	long-strangle	$\perp$
	Value	long-strangle*	$\perp$
Commodities	Carry	$\perp$	short-put*
	Liquidity	$\perp$	short-put*
	Momentum (cross-section)	short-straddle*	long-only*
	Momentum (time-series)	short-risk-reversal*	long-put*

The framework

- The linear factor model:

$$R_{i,t} = R_{f,t} + \sum_{j=1}^{n_{\mathcal{F}}} \beta_{i,t}^{j} \mathcal{F}_{j,t} + \varepsilon_{i,t}$$

- Set of risk factors:
  - 12 TRP (traditional risk factors of TREX)
  - 59 ARP
- Statistical estimation based on the Lasso regression

$$\sum_{j=1}^{n_{\mathcal{F}}} \left| \tilde{\beta}_{i,t}^{j} \right| \leq \tau$$

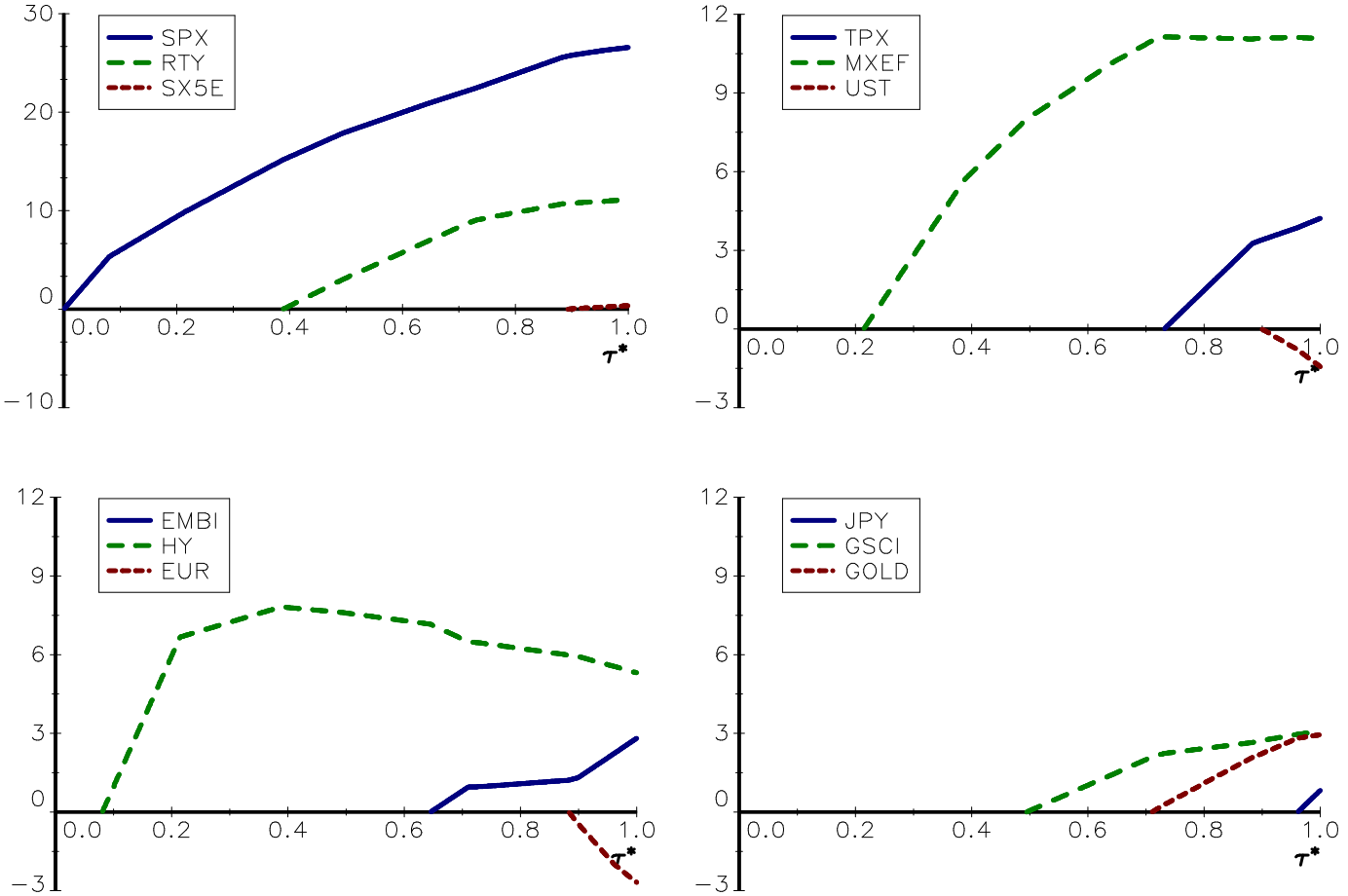
  - Manage the degrees of freedom and over-fitting

$$\tau^{\star} = \frac{\sum_{j=1}^{n_{\mathcal{F}}} \left| \hat{\beta}_{i,t}^{j}(\tau) \right|}{\sum_{j=1}^{n_{\mathcal{F}}} \left| \hat{\beta}_{i,t}^{j}(\infty) \right|}$$

  - Risk premia selection

The Lasso approach

Selection procedure of TRP for the HFRI index (in-sample, static, 2000-2015)



The Lasso approach

Selection procedure of risk factors for the HFRI index (in-sample, static, 2000-2015)

TRP

1. **SPX**
2. **HY**
3. **MXEF**
4. **RTY**
5. GSCI
6. EMBI
7. GOLD
8. TPX
9. EUR
10. SX5E
11. etc.

TRP + ARP

1. **SPX**
2. **HY**
3. **equities/growth/US**
4. **equities/low volatility/EM**
5. MXEF
6. **equities/volatility/carry/US**
7. **currencies/carry/FRB/EM**
8. equities/event/merger-arbitrage/DM
9. equities/low volatility/Japan
10. GSCI
11. etc.

$\Rightarrow$ A break in 2008 concerning the repartition between TRP and ARP

Application to HF indices

- HFR
  Fund Weighted Composite index (**HFRI**), Macro:Systematic Diversified index (**CTA**), Event Driven: Distressed/Restructuring index (**DS**), Event Driven index (**ED**), Equity Hedge index (**EH**), Emerging Markets index (**EM**), Equity Hedge: Equity Market Neutral index (**EMN**), Event Driven: Merger Arbitrage index (**MA**), Macro index (**MAC**), Relative Value index (**RV**), Equity Hedge: Short Bias index (**SB**), Fund of Funds Composite index (**FOF**)
- EDHEC indices
  Convertible Arbitrage index (**CA**), CTA Global index (**CTA**), Distressed Securities index (**DS**), Event Driven index (**ED**), Emerging Markets index (**EM**), Equity Market Neutral index (**EMN**), Fixed Income Arbitrage index (**FIA**), Global Macro index (**GM**), Long/short Equity index (**LSE**), Merger Arbitrage index (**MA**), Relative Value index (**RV**), Short Selling index (**SB**), Funds of Funds index (**FOF**)

Application to HF indices

In-sample $\mathbf{R}^2$ (in %) for HFR indices (static beta, 2000-2015)

Strategy	TRP		ARP		SPX + ARP		TRP + ARP	
	5F	10F	5F	10F	5F	10F	5F	10F
HFRI	81.0	85.4	47.0	78.0	73.8	86.2	81.0	86.9
CTA	15.9	24.8	21.2	42.7	37.0	46.1	37.0	46.1
DS	60.1	62.8	41.3	50.1	46.3	59.7	60.1	67.4
ED	78.1	80.7	32.8	72.5	59.1	78.5	78.1	81.7
EH	85.3	87.0	57.7	80.8	81.3	85.8	85.3	88.9
EM	88.9	89.4	57.9	76.0	70.2	81.7	88.9	89.9
EMN	20.9	22.8	31.1	52.2	31.1	52.2	31.1	52.2
MA	45.7	50.2	19.2	54.2	49.1	60.5	49.1	63.0
MAC	30.0	35.0	25.2	49.3	28.7	58.3	35.8	58.3
RV	66.5	73.3	61.1	69.9	61.2	69.9	66.5	74.9
SB	67.0	70.0	68.3	74.4	81.8	85.3	81.8	85.3
FOF	63.3	68.5	37.8	68.7	50.6	73.8	63.3	73.8

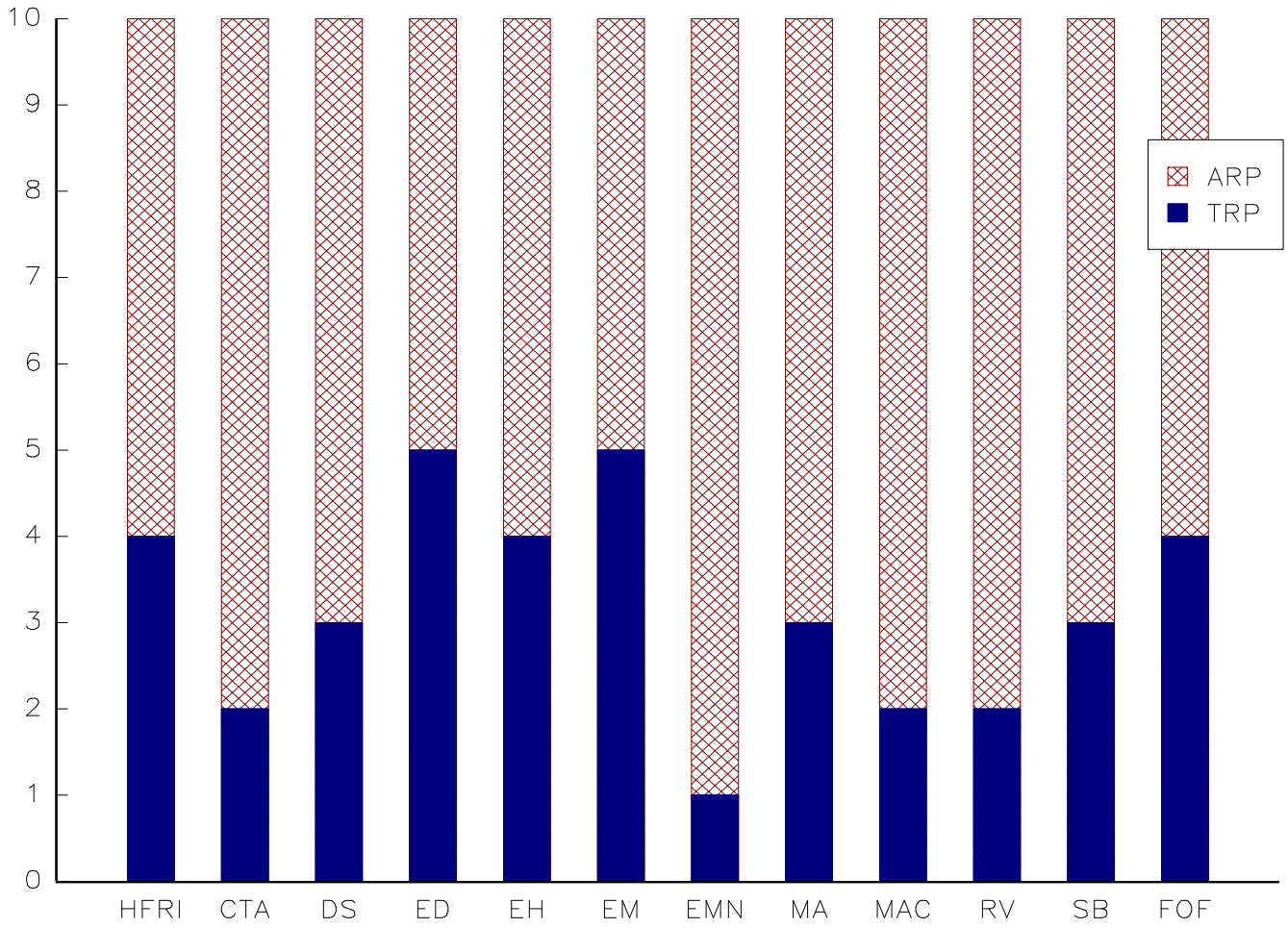
Application to HF indices

In-sample $\mathbf{R}^2$ (in %) for EDHEC indices (static beta, 2000-2015)

Strategy	TRP		ARP		SPX + ARP		TRP + ARP	
	5F	10F	5F	10F	5F	10F	5F	10F
CA	58.9	63.1	49.3	61.0	49.3	61.0	59.7	70.8
CTA	13.3	18.4	54.4	62.8	54.5	63.6	54.5	63.6
DS	61.0	64.2	42.6	53.8	48.6	61.3	61.0	66.4
ED	73.7	77.3	42.1	66.6	51.8	71.2	73.7	77.9
EM	87.4	87.8	62.9	77.5	71.2	80.7	87.4	88.6
EMN	33.0	37.0	24.2	46.9	31.4	46.9	33.9	46.9
FIA	57.6	64.4	54.3	60.3	54.3	60.3	61.7	73.4
GM	44.8	53.3	39.0	54.5	39.0	62.4	51.9	62.7
LSE	81.5	84.8	46.9	76.2	80.8	87.9	81.5	87.9
MA	46.7	50.1	24.0	50.0	39.6	62.4	46.7	64.4
RV	74.8	79.2	56.0	74.8	66.5	78.4	74.8	82.0
SB	78.9	81.0	59.2	71.6	86.2	89.1	86.2	89.1
FOF	62.0	66.9	43.5	68.4	53.7	74.1	62.0	74.1

Application to HF indices

Number of TRP and ARP selected factors (static beta, 2000-2015)



Dynamic out-of-sample analysis

Dynamic beta approach

The procedure described below is the core of hedge fund replication:

- The exposures $\hat{\beta}_{i,t}^{j}$ are estimated by using a 24-month rolling window $[t-24, t-1]$:
  1. With the lasso method, we select the 10 most pertinent risk factors
  2. We perform a linear regression with the 10 selected risk factors to estimate the nominal exposures
- The nominal exposures are implemented for the time period t, meaning that the monthly returns forecasted by the model is:

$$\hat{R}_{i,t} = R_{f,t} + \sum_{j=1}^{10} \hat{\beta}_{i,t}^{j} \mathcal{F}_{j,t}$$

Dynamic out-of-sample analysis

Out-of-sample statistics for HFR indices (dynamic beta, 2000-2015)

Strategy	Correlation				Tracking error				Performance ratio			
	TRP	ARP	SPX + ARP	TRP + ARP	TRP	ARP	SPX + ARP	TRP + ARP	TRP	ARP	SPX + ARP	TRP + ARP
HFRI	89.4	82.3	88.9	87.2	3.2	3.8	3.0	3.3	0.72	0.93	1.05	0.84
CTA	34.9	54.9	55.3	53.9	9.1	8.0	7.8	7.8	0.32	0.81	0.65	0.62
DS	61.4	45.3	48.2	65.4	5.5	6.1	6.2	5.0	0.71	0.73	0.76	0.81
ED	81.1	69.1	76.9	81.7	4.1	4.9	4.2	3.7	0.68	0.90	1.00	0.89
EH	89.8	83.7	89.3	90.0	4.1	5.0	4.0	3.9	0.78	1.04	0.95	0.97
EM	85.9	69.6	71.6	87.9	6.4	8.9	8.5	5.7	0.60	1.08	1.05	0.68
EMN	39.8	56.3	59.0	59.0	3.3	2.7	2.7	2.6	0.74	0.87	0.91	0.83
MA	58.6	61.9	63.4	63.9	3.3	3.0	2.8	2.8	0.69	0.85	0.90	0.91
MAC	55.0	65.7	65.5	65.4	5.4	4.5	4.4	4.7	0.71	1.22	1.21	1.27
RV	77.8	58.4	62.5	73.8	2.9	3.6	3.4	2.9	0.64	0.78	0.81	0.82
SB	81.6	81.6	88.2	88.9	10.1	9.8	7.8	7.6	1.97	1.76	1.39	1.69
FOF	75.6	74.2	76.9	77.8	4.2	4.1	3.9	3.8	0.86	1.07	1.04	0.93

The 10 most frequent risk factors (2000-2015)

HFR CTA		EDHEC CTA	
56.0	SPX	84.8	currencies/momentum/time-series/DM
44.5	commodities/momentum/cross-section	72.8	commodities/momentum/time-series
42.4	commodities/momentum/time-series	72.8	rates/momentum/time-series/DM
40.8	equities/growth/US	48.2	commodities/momentum/cross-section
37.7	currencies/momentum/time-series/DM	38.7	currencies/momentum/time-series/EM
35.1	currencies/momentum/time-series/EM	31.9	GSCI
27.2	rates/momentum/time-series/DM	29.3	GOLD
25.1	equities/low volatility/Japan	24.6	equities/growth/Japan
24.6	equities/event/merger arbitrage/DM	23.0	commodities/carry/TSS
24.6	equities/value/US	23.0	commodities/liquidity
HFR EH		**EDHEC LSE**	
100.0	SPX	98.4	SPX
77.0	equities/growth/US	75.4	equities/growth/US
55.5	HY	57.1	equities/volatility/carry/US
50.3	equities/volatility/carry/US	53.9	HY
46.1	MXEF	44.0	equities/low volatility/Asia Pacific
46.1	equities/low volatility/EM	42.4	currencies/carry/FRB/EM
39.8	equities/low volatility/Asia Pacific	37.2	equities/event/merger arbitrage/DM
36.6	equities/low volatility/US	36.6	MXEF
35.1	RTY	33.5	equities/momentum/cross-section/US
34.6	equities/event/merger arbitrage/DM	31.4	equities/low volatility/EM

The 10 most frequent risk factors (2000-2015)

HFR MA	
88.0	equities/event/merger arbitrage/DM
65.4	SPX
62.3	HY
51.8	equities/volatility/carry/US
38.7	equities/quality/Europe
28.3	equities/momentum/cross-section/Europe
27.7	RTY
27.7	equities/volatility/carry/Europe
26.2	equities/reversal/time-series/US
25.1	equities/low volatility/EM

EDHEC MA	
89.5	equities/event/merger arbitrage/DM
72.3	HY
58.6	SPX
51.8	equities/volatility/carry/US
40.8	equities/quality/Europe
34.0	equities/growth/US
33.0	equities/volatility/carry/Europe
30.4	equities/momentum/cross-section/Europe
27.7	equities/reversal/time-series/US
20.9	EMBI

HFR RV	
81.7	HY
67.5	equities/volatility/carry/US
55.0	equities/event/merger arbitrage/DM
39.3	currencies/carry/FRB/DM
37.7	currencies/carry/FRB/EM
37.2	equities/momentum/cross-section/Europe
33.0	SPX
29.3	equities/value/DM
27.7	EMBI
25.7	commodities/carry/TSS

EDHEC RV	
79.6	HY
67.5	SPX
66.5	equities/volatility/carry/US
63.4	equities/event/merger arbitrage/DM
40.3	currencies/carry/FRB/DM
36.1	equities/quality/Europe
29.8	currencies/carry/FRB/EM
28.8	equities/growth/US
28.8	equities/growth/Europe
27.7	equities/value/DM

Dynamic out-of-sample analysis

Some additional results:

- The size factor (RTY) is less present since 2008
- The Credit factor (HY) is more present since 2008
- For CTAs, exposures on momentum risk factors have increased over time (TRP $\rightarrow$ ARP)
- Long/short equity strategies:
  value/growth $\rightarrow$ low volatility/momentum/quality
- Merger arbitrage = stable over time
- Relative value = more exposed to the short volatility risk factor since 2009

A balanced portfolio of ARP is not of portfolio of HFs

Skewness risk premia

- Volatility (Equities)[1]
- Volatility (Rates)[1]
- Size (Equities)[1]
- Value (Equities)[1]

Equity-specific risk premia

- Low Beta[1]
- Momentum Cross-Section[1]
- Quality[1]
- Merger Arbitrage[1]

Carry risk premia

- Equities (HDY)[1]
- Rates (FRB)[1]
- Currencies (FRB)[2]
- Commodities (FRB)[2]

Momentum risk premia

- Equities (Time-Series)[2]
- Rates (Time-Series)[1]
- Currencies (Time-Series)[2]
- Commodities (Time-Series)[2]

[1]Each risk premium = 50% US risk premium + 50% EUROPE risk premium
[2]Global universe

A balanced portfolio of ARP is not of portfolio of HFs

Two-year rolling correlation (in %) between HFRI and ERC-ARP