Advanced Asset Management – Master 203

Alternative Risk Premia

Part 3: Construction and management of ARP allocations

November 23, 2020

Guillaume Monarcha

Head of Research, Orion Financial Partners

Section 1 | Agenda

The academic view | Top/down asset allocation

Two main asset allocation approaches, with distinct objectives

- ✓ Strategic asset allocation
  - Long-term
  - Passive
  - Diversification-based

- ✓ Tactical asset allocation
  - Medium-term
  - Active
  - Objective of over-performance driven by the market timing skill of the manager

- ✓ These approaches are often combined in institutional portfolios (core-satellite approach)

The academic view | **Asset allocation approaches**

Aside their investment horizon, these two approaches rely on different hypothesis

- ✓ **Hypothesis 1:** the returns of the various asset classes and investment strategies are hardly predictable, but their risk structures display known characteristics
  - Focus on **risk-based allocation approaches**, i.e. on the estimation of the 2^{nd} moment (and eventually higher ones) of the joint return distribution
  - The value added by the asset managers relies on its risk management skills
  - In line with the efficient market hypothesis

- ✓ **Hypothesis 2**: the returns of several asset classes or investment strategies are predictable, and their risk structures display known characteristics
  - Primary focus on the forecast of the expected returns (1^{st} moment of the distribution of asset returns), secondary focus on risks
  - The value added by the manager relies on both his **market timing** and risk management skills
  - Against the efficient market hypothesis

- ✓ **Hypothesis 3**: both risk and returns are hardly predictable
  - What approach?
  - **Purely agnostic**: equal weight

The academic view | **No room for market timing in ARP allocations**

Several recent academic studies conclude that the market timing of ARP strategies appears particularly difficult

- ✓ Asness C., Chandra S., Ilmanen A., and Israel R. (2018), “Contrarian Factor Timing is Deceptively Difficult”, Practical Applications, Institutional Investor Journals, vol. 5(3).
  - Test the predictability of equity ARP strategies based on their value spread, through contrarian value timing
  - Hypothesis: undervalued factors should outperform undervalued ones
  - Conclusions:
    - The returns of value-based factor timing is significantly correlated with the value factor itself
    - Eventual performance gains for single strategies disappear when applied in a portfolio already allocated to the value premia

- ✓ Ilmanen A., Israel R., Moskowitz T. J., Thapar A., and Wang F. (2019), “Factor Premia and Factor Timing: A Century of Evidence”, working paper, AQR.
  - investigate a wide range of factor timing strategies, based on value spread signals, but also on signals based on macroeconomic variables (liquidity, volatility, growth, inflation, geopolitical risks…).
  - Conclusions: in line with Asness et al. (2018).

The academic view | No room for market timing in ARP allocations

✓ Bellone B., Declerck P., Nordine M., and Vy T. (2019), “Multi-Asset Style Factors have their Shining Moments”, working paper.

- Investigate the conditional performance of ARP strategies in different phases of the equity market cycle, volatility and interest regimes.
- Results:
  - market regimes have little impact on ARP performances
  - The performances of cyclical and defensive factors exhibit seems to be affected by volatility and interest rate régimes. However, they note that the high variability of these factors (especially volatility) could be a strong limitation for timing signal detection.

More generally, risk metrics are more stable than returns, and are therefore less prone to forecast errors (cf ML, slide 10).

Put all together, these conclusions gives support to the statement made by Asness (2016), who evoked “**the siren Song of factor timing**”, and to the **mainstream practice of ARP fund managers, who mainly implement risk-based allocation methodologies.**

Section 2 | Agenda

Section 1: The academic view

Section 2: ARP allocation in practice

Section 3: Risk-based allocation

Section 4: Tactical allocations

ARP allocation in practice | **From cross-correlation properties…**

	EQU VAL	EQU QUAL	EQU LR	EQU MOM	EQU TRD	EQU MR	EQU SV	COM CARa	COM CARt	COM LIQ	COM TRD	COM SV	IR CAR	IR MOM	IR TRD	IR SV	FX VAL	FX MR	FX SV	FX TRD
EQU QUAL	-0.35																			
EQU LR	-0.22	0.58																		
EQU MOM	-0.31	0.60	0.29																	
EQU TRD	0.14	-0.01	0.09	-0.02																
EQU MR	0.11	0.04	0.29	0.04	0.36															
EQU SV	0.37	0.00	0.14	0.10	0.35	0.57														
COM CARa	0.10	0.09	-0.03	0.02	0.09	0.09	0.10													
COM CARt	0.03	0.03	-0.08	0.07	0.05	-0.15	-0.17	0.59												
COM LIQ	0.12	0.00	-0.21	0.01	-0.05	-0.19	-0.09	0.29	0.47											
COM TRD	-0.24	0.14	-0.02	0.12	0.19	0.15	-0.27	0.30	0.34	0.00										
COM SV	0.29	-0.02	-0.07	-0.01	0.10	0.11	0.48	0.10	-0.09	0.04	-0.26									
IR CAR	0.03	0.15	0.19	0.20	-0.17	0.00	0.11	0.06	-0.01	0.09	-0.06	0.07								
IR MOM	-0.14	0.13	0.18	0.06	-0.06	-0.07	-0.18	0.03	0.12	0.15	0.18	-0.18	0.38							
IR TRD	-0.20	0.23	0.32	0.14	-0.19	-0.18	-0.23	-0.01	0.13	0.10	0.08	-0.18	0.49	0.77						
IR SV	0.21	0.13	0.11	0.07	0.06	0.16	0.43	0.04	-0.09	-0.06	-0.17	0.36	0.21	-0.10	-0.10					
FX VAL	0.02	-0.05	0.07	-0.19	0.00	0.01	-0.23	-0.02	0.04	0.07	0.07	-0.22	-0.09	0.10	0.06	-0.10				
FX MR	0.06	0.09	0.02	-0.03	0.10	0.05	0.08	0.04	-0.08	0.05	0.08	0.20	-0.15	0.07	-0.05	0.29	0.19			
FX SV	0.28	-0.01	0.03	-0.03	0.05	0.03	0.56	0.08	-0.03	0.06	-0.25	0.48	0.11	-0.06	-0.11	0.48	-0.19	0.19		
FX TRD	-0.23	0.08	0.06	0.08	0.24	0.01	-0.21	0.03	0.10	0.00	0.50	-0.20	-0.02	0.28	0.19	-0.17	0.08	-0.10	-0.28	
FX CAR	0.27	-0.14	-0.11	-0.09	0.00	0.03	0.39	-0.12	-0.15	-0.10	-0.24	0.34	0.15	-0.21	-0.19	0.28	-0.04	-0.01	0.35	-0.20

Estimated correlations between Orion ARP indices, from January 2005 to March 2020, (monthly returns).

Average = 0.06

ARP allocation in practice | … to risk-based allocations (ex. 1)

3.4 Construction de Portefeuille (1/2)

Portefeuille equi-risque, turnover faible

- Les méthodes classiques utilisent des prévisions de rendements et de corrélations
- Ces prévisions sont peu fiables et instables

Diversification

Caractéristiques statistiques des Primes de Risque éligibles

- Leurs rendements sont relativement cycliques, les cycles peuvent être longs
- Leurs corrélations sont faibles et relativement stables

Equi-risque

La méthode de construction de portefeuille la plus efficace est l'« Equi-Risque »

- Budget de risque ex-ante equi-pondéré pour chaque Prime de Risque
- Contraintes min et max pour chaque Prime de Risque
- Objectif de volatilité long terme pour le portefeuille, re-balancement trimestriel

Faible turnover

Principaux avantages de l'allocation « Equi-Risque »

- Construction robuste et offrant une réelle diversification
- Ne repose pas sur des hypothèses de rendements futurs
- Faibles coûts de transactions

Pas d'hypothèses de rendements ni de corrélations futurs
Exploitation de la diversité et de la cyclicité des rendements

eraam

ARP allocation in practice | ... to risk-based allocations (ex. 2)

GAM Alternative Risk Premia

Sample Balanced Portfolio

- Portfolios are fully tailored to meet individual client needs
- Portfolio consists of value, momentum and carry premia actively managed by GAM
- Strategic weights determined through GAM Expected Drawdown methodology*

Style	Premia	Asset Class	Weight (% of gross)
Value	FX Value	FX	10.5
	Merger Arbitrage	Equity	10.1
	Low Volatility Value Market Neutral	Equity	7.8
	Developed Market Low Volatility	Equity	7.5
			35.9
Momentum	Bond Trend	Fixed Income	11.7
	FX Trend	FX	7.4
	Developed FX Trend	FX	3.6
	EM FX Trend	FX	3.0
			25.8
Carry	Fixed Income Carry	Fixed Income	5.7
	US High Yield	Fixed Income	5.4
	Bond Carry	Fixed Income	5.1
	FX Carry	FX	4.6
	Volatility Carry	Equity	2.2
	Short VIX	Equity	0.7
			23.7
GTAA	Global Tactical Asset Allocation	Multi-asset	14.6
			14.6
		Total	**100.0**

Section 3 | Agenda

Risk-based allocations | Main approaches

Risk-parity (or equal risk, or risk-weighting)

The optimal weight of each asset i ($i = 1, \dots, n$) is given by:

$$w_i = \frac{{}^{1}/_{risk_i}}{\sum_{j=1}^{n} {}^{1}/_{risk_j}}$$

where $risk_i$ is a univariate risk measure (volatility, VaR, CVaR…)

Equal risk contribution

$$ArgMax_w(w'R)$$
$$sc. TRC_1 = \cdots = TRC_i = \cdots = TRC_N$$
$$sc. investment\ bounds$$

where TRC_i is the total risk-contribution of asset I to the portfolio, defined by $TRC_i = w_i MRC_i$, MRC_i being its marginal risk contribution, $MRC_i = \frac{\sigma_{i,P}}{\sigma_P}$

Risk-based allocations | Main approaches

Minimum variance

The optimal weight of each asset i ($i = 1, \dots, n$) is determined by the following program:

$$ArgMin_w(w'Rw)$$
$$sc.\,investment\ bounds$$

Maximum diversification

The optimal weight of each asset i ($i = 1, \dots, n$) is determined by the following program:

$$ArgMax_w(DR)$$
$$sc.\,investment\ bounds$$

DR standing for the diversification ratio defined as $D = \frac{w'\Sigma}{\sqrt{w'\Omega w}}$ (Choueyfaty, Coignard, 2008), with Σ the vector of asset volatilities, and Ω their covariance matrix.

Risk-based allocations | **Simple risk-based implementations**

Example: JP Morgan Cross-Asset Risk Premia Index (sl15>)

- Risk Capital is divided between the 4 Styles: Carry, Value, Volatility and Momentum
- ERP Multi-factor is a composite style index and contains style exposure from Value, Momentum, Quality, Low Volatility and Size
- Each Component has 1/14 risk budget except for ERP Multi-factor which has 2/14 given its composite nature

Style	Asset Class	Risk Premia	Ticker	Risk Capital
Value	Commodities	Absolute return strategy based on fundamental signals	JCOPCFE	7.1%
	Credit	Relative value in Credit	JCRERVC2	7.1%
	FX	FX Value	JPFCVB4E	7.1%
Carry	Equity	VIX term premium and dividend carry	JPZMBA10	7.1%
	Rates	Carry in interest rates	JKBARCAE	7.1%
	FX	FX Carry	JPMZAFXD	7.1%
	Commodities	Carry in commodities	JMABCCAU	7.1%
Multi-Factor	Equity	Global Equity Risk Premia	ERJPMFGU	14.3%
Volatility	Equity	Implied to realised volatility carry	JPZMBA11	7.1%
Momentum	Equity	Absolute Momentum	JPZMBAS5	7.1%
	Rates	Relative momentum in rates	JKBARMCE	7.1%
	FX	Absolute Momentum in FX	JTRDX2CE	7.1%
	Commodities	Absolute Momentum in Commodities	CMDTOMGU	7.1%

Risk-based allocations | Simple risk-based implementations

Example: JP Morgan Cross-Asset Risk Premia Index (sl15>)

- Risk Capital is divided between the 4 Styles: Carry, Value, Volatility and Momentum
- ERP Multi-factor is a composite style index and contains style exposure from Value, Momentum, Quality, Low Volatility and Size
- Each Component has 1/14 risk budget except for ERP Multi-factor which has 2/14 given its composite nature

Style	Asset Class	Risk Premia	Ticker	Risk Capital
Value	Commodities	Absolute return strategy based on fundamental signals	JCOPCFE	7.1%
	Credit	Relative value in Credit	JCRERVC2	7.1%
	FX	FX Value	JPFCVB4E	7.1%
Carry	Equity	VIX term premium and dividend carry	JPZMBA10	7.1%
	Rates	Carry in interest rates	JKBARCAE	7.1%
	FX	FX Carry	JPMZAFXD	7.1%
	Commodities	Carry in commodities	JMABCCAU	7.1%
Multi-Factor	Equity	Global Equity Risk Premia	ERJPMFGU	14.3%
Volatility	Equity	Implied to realised volatility carry	JPZMBA11	7.1%
Momentum	Equity	Absolute Momentum	JPZMBAS5	7.1%
	Rates	Relative momentum in rates	JKBARMCE	7.1%
	FX	Absolute Momentum in FX	JTRDX2CE	7.1%
	Commodities	Absolute Momentum in Commodities	CMDTOMGU	7.1%

Risk-based allocations | **Simple risk-based implementations**

Example SOCGEN approach (SGI Diverse Risk Premia)

*Combining styles in a well balanced portfolio in term of risk (between aggressive and defensive profile) **

***SG Cross Asset Quant Research,**
Market uncertainty justifies a risk premia approach,
as of 03/02/2016

EQUITY RISK PREMIA

DIVERSIFYING EXPOSURE TO EQUITY FACTORS

AGGRESIVE	NEUTRAL		DEFENSIVE	
VALUE	PROFITABILITY	MOMENTUM	QUALITY	LOW VOL
<SGBVPHVE>	<SGBVPHPE>	<SGBVPMEU>	<SGBVPHQE>	<SGBVPHLE>

TREND FOLLOWING

CAPTURING LONG-TERM TRENDS IN TREND-FOLLOWING MARKETS

FX TREND	RATES TREND	COMMO. TREND
<SGIXTFFX>	<SGIXTFIR>	<SGIXTFCY>

TERM STRUCTURE CARRY

CAPTURING ROLL-YIELD AND CARRY IN TERM STRUCTURE ACROSS ASSET CLASSES

DIV. ROLL-YIELD	VIX ROLL-YIELD	EUR RATES ROLL-YIELD	COMMO. ROLL-YIELD	G5 RATES CARRY
<SGBVDCM1>	<DSVIX>	<SGIXMOE2>	<SGICLMFV>	<SGIXBHE5>

VOLATILITY CARRY

CAPTURING THE IMPLIED VS. REALIZED VOLATILITY PREMIUM IN MEAN REVERTING MARKETS

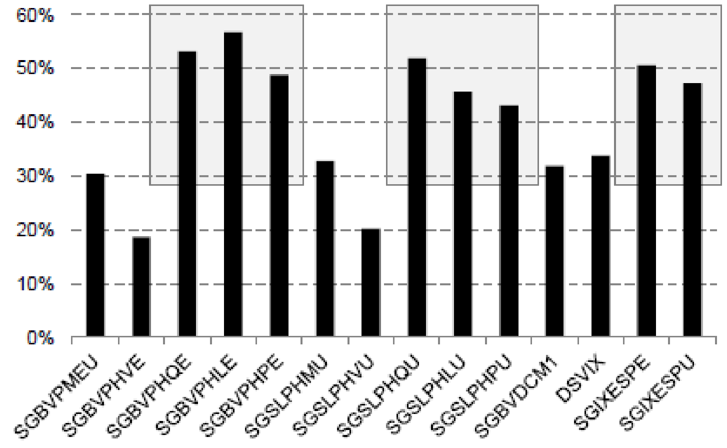
EQUITY SHORT VOL EURO	EQUITY SHORT VOL US	CREDIT SHORT VOL EURO
<SGIXESPE>	<SGIXESPU>	<SGIMCESP>

Risk-based allocations | Simple risk-based implementations

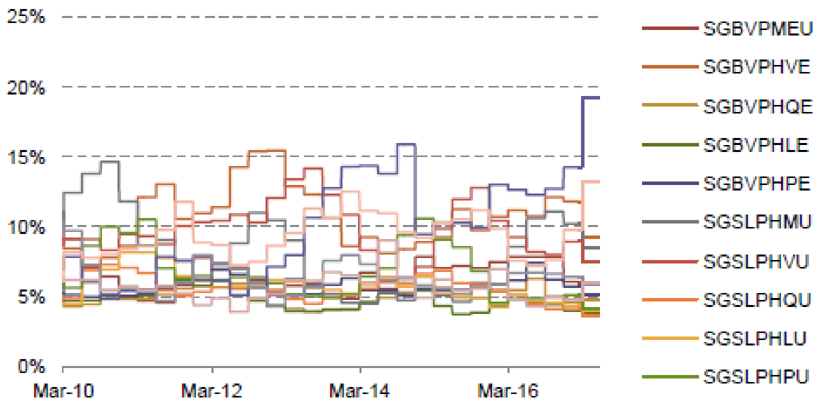
ERC* ALLOCATION

ERC ALLOCATION LIMITS THE RISK ON A SINGLE STRATEGY BUT REMAINS EXPOSED TO CLUSTERING RISK

Correlation of each component with the ERC allocation



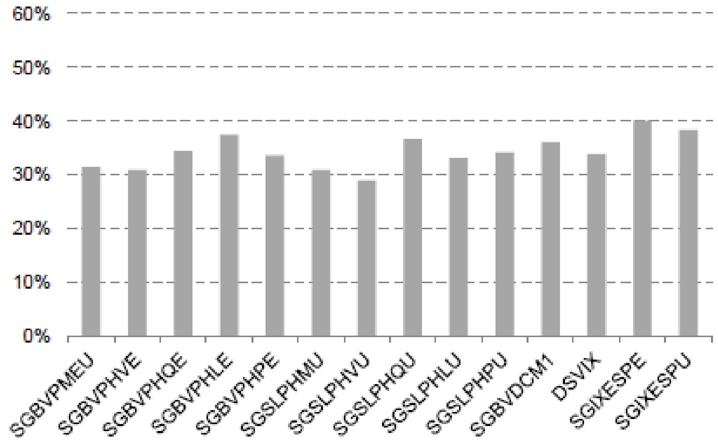
Weight of each component with the ERC allocation



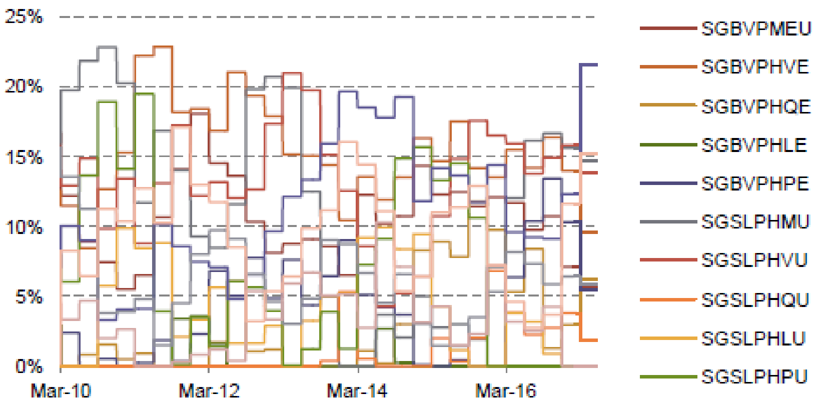
MDP* ALLOCATION

MDP ALLOCATION LIMITS THE CLUSTERING RISK BUT INCREASES THE RISK ON A SINGLE STRATEGY

Correlation of each component with the MDP allocation



Weight of each component with the MDP allocation

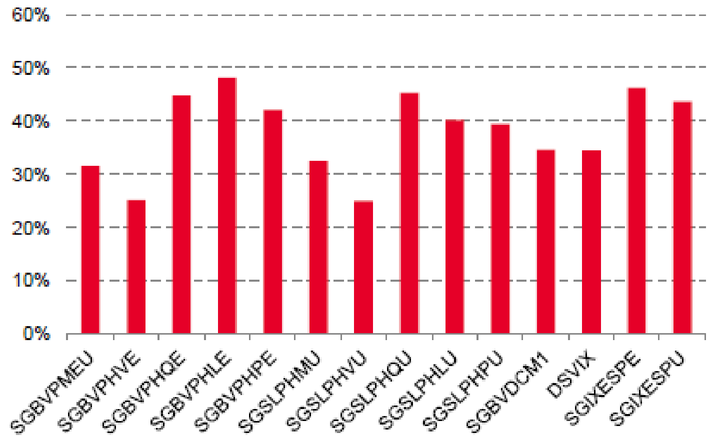


Risk-based allocations | Simple risk-based implementations

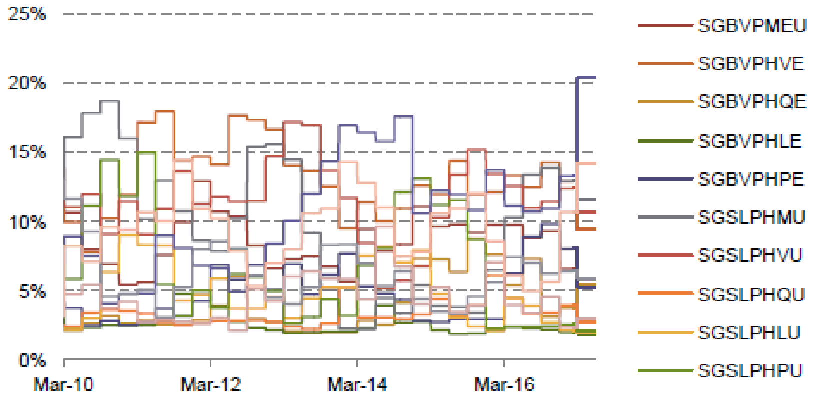
ERC/MDP* ALLOCATION

BY COMBINING THE ERC AND THE MDP ALLOCATIONS, BOTH IDIOSYNCRATIC AND CLUSTERING RISKS ARE CONTROLLED

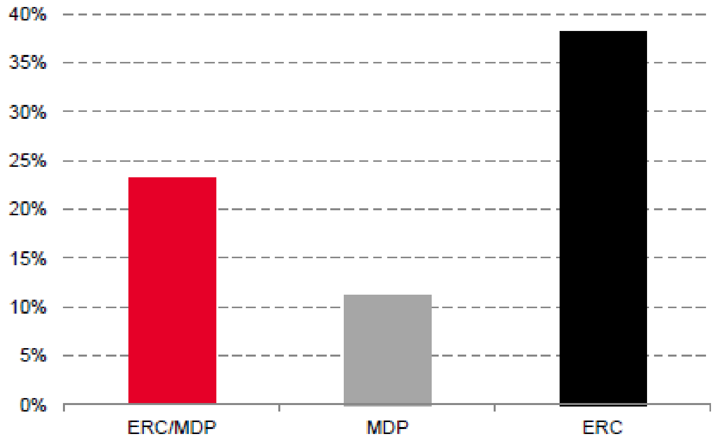
Correlation of each component with the ERC/MDP allocation



Weight of each component with the ERC/MDP allocation



Maximum divergence between the highest and the lowest correlation of each allocation



SUMMARY OF THE ERC/MDP ALLOCATION PROCESS

- **The portfolio is first optimized within the pure ERC framework**
- **The portfolio is then optimized within the pure MDP framework**
- **To calculate the weights of the ERC/MDP allocation, the sum of squared tracking errors (ERC + MDP) is minimized.**

Risk-based allocations | **Limits of straight application**

As in the previous examples, should we straightly apply risk-based allocation techniques to a set of ARP strategies?

- ✓ Yes, if applied to homogenous investment universe, characterized by stocks or investment strategies that are exposed to common systematic risk factors, and that exhibit low specific risk

- ✓ This is not the case with ARP strategies (cf. previous part on performance evaluation)

- ✓ Like in the case of the performance evaluation and selection of ARP strategies, **one should apply "cluster-based" risk-based allocation methodologies**

- ✓ **Ad-hoc clusters vs. risk-based clusters?**

Risk-based allocations | **Implementation with ad hoc clusters**

BoAML: "Quantitative Investment Strategies Panorama: Risk 'n mix – The what, why & how of cross asset Risk factor investing" (2016)

Equal Weight (EW)	⇨ **1/N sizing:** Special case of fixed weight sizing where each asset/strategy is given equal weight ✓ Simplest, most straightforward method: does not rely on return/risk projections × Fails to differentiate between embedded leverage (risk) in different strategies
Equal Vol (EV)	⇨ Each asset is given **equal (marginal) volatility** – using tail event vol may make sense for some strategies ✓ Relatively simple method to account for different embedded leverage between strategies × Ignores diversification benefits different strategies offer; can result in significantly higher weight to low vol assets
Min Variance (MV)	⇨ **Targets a portfolio with lowest possible volatility** ✓ Includes the impact of correlation in addition to marginal vol ; targets an efficient (frontier) portfolio × Complex calculation; needs both vol & correl estimates; can result in significantly higher weight to low vol assets
Equal Risk Contribution (ERC)	⇨ **Equal total risk contribution from each asset**, i.e. for each asset, sum of covar vs all the others is equal ✓ Includes impact of correlation & vol, aims for equal risk exposure from each strategy × Complex calculation; needs both vol & correlation estimates
Most Diversified (MDP)	⇨ **Solves for maximum diversification ratio**, i.e. maximises ratio of weighted component vols vs portfolio vol ✓ One of the key motivations behind portfolio construction is diversification and this approach tries to maximise it × Complex calculation; needs both vol & correlation estimates
Maximum Sharpe Ratio (MSR)	⇨ **Targets a portfolio with the highest Sharpe ratio** ✓ Uses return, vol, correlation input to maximise portfolio risk adjusted return × Complex calculation; relies on both vol & correlation estimates – returns particularly hard to forecast ex-ante

Risk-based allocations | Implementation with ad hoc clusters

BoAML: “Quantitative Investment Strategies Panorama: Risk ‘n mix – The what, why & how of cross asset Risk factor investing” (2016)

Table 1: Generalising Carry, Momentum and Value across asset classes

	Risk factors		
	Carry	**Momentum**	**Value**
Asset classes	*(Positive) expected returns if status quo prevails*	*Behavioural preference for winners over losers*	*Compensation for risk of buying cheap assets*
Equities[1]	Long high div yield stocks / short market	Long high price performance stocks / short market	Long cheap stocks / short market
Credit[2]	Long 3-5yr / short 10yr+ duration neutral	Long +ve momentum / short -ve momentum corp bonds	Long cheapening / short richening corp bonds
Rates[3]	Long 4th Eurodollar future / short 1st Eurodollar future	Long +ve momentum / short -ve momentum govt bonds	Long cheapening / short richening govt. bonds
FX[4]	Long high-yielding / short low-yielding currencies	Long +ve momentum / short -ve momentum currencies	Long undervalued / short overvalued currencies
Commodities[5]	Long far-dated / short near-dated commodity futures	Long +ve momentum / short -ve momentum commodity futures	Long cheapening / short richening commodity futures

Risk-based allocations | Implementation with ad hoc clusters

BoAML: “Quantitative Investment Strategies Panorama: Risk ‘n mix – The what, why & how of cross asset Risk factor investing” (2016)

Table 3: Statistics for a cross asset Risk factor portfolio constructed using a factor-based clustering approach

	Method	CAGR	Sharpe	Stdev	Max DrawDown	VaR	cVaR	Turnover	Concentration	Diversification Ratio
Carry + Momentum + Value	EW	1.8%	1.69	1.0%	-2.3%	-0.10%	-0.15%	7%	0%	3.94
	EV	1.3%	1.70	0.7%	-1.8%	-0.06%	-0.11%	37%	35%	4.04
	ERC	1.3%	1.68	0.7%	-2.0%	-0.06%	-0.11%	40%	32%	4.21
	MV	0.7%	0.92	0.7%	-2.9%	-0.06%	-0.11%	69%	63%	3.09
	MDP	1.3%	1.59	0.8%	-2.2%	-0.07%	-0.11%	55%	30%	3.98
	MSR	2.6%	2.05	1.2%	-1.6%	-0.11%	-0.17%	224%	67%	2.57

Source: BofA Merrill Lynch Global Research. Data: Jan-06 to Jan-16. CAGR = compounded annual growth rate VaR and cVaR are for a 95% confidence interval. Turnover = Strategy notional traded as a proportion of portfolio

Table 4: Statistics for a cross asset Risk factor portfolio constructed using an asset class-based clustering approach

	Method	CAGR	Sharpe	Stdev	Max DrawDown	VaR	cVaR	Turnover	Concentration	Diversification Ratio
Credit + FX + Commo. + Rates + Equity	EW	1.8%	1.69	1.0%	-2.3%	-0.10%	-0.15%	7%	0%	3.94
	EV	1.3%	1.67	0.7%	-2.0%	-0.06%	-0.11%	48%	36%	4.04
	ERC	1.2%	1.61	0.7%	-2.0%	-0.06%	-0.11%	54%	32%	4.25
	MV	0.6%	0.86	0.6%	-2.7%	-0.05%	-0.10%	82%	63%	3.24
	MDP	1.1%	1.39	0.8%	-2.2%	-0.07%	-0.11%	75%	32%	4.29
	MSR	2.7%	2.18	1.2%	-1.9%	-0.10%	-0.17%	188%	69%	2.16

Table 5: Statistics for a cross asset Risk factor portfolio constructed using a kitchen sink approach (no clustering, all strategies are rebalanced together)

		CAGR	Sharpe	Stdev	Max DrawDown	VaR	cVaR	Turnover	Concentration	Diversification Ratio
1-step allocation	EW	1.8%	1.69	1.0%	-2.3%	-0.10%	-0.15%	14%	0%	3.94
	EV	1.3%	1.78	0.7%	-1.8%	-0.06%	-0.10%	41%	35%	4.08
	ERC	1.1%	1.50	0.7%	-2.2%	-0.06%	-0.11%	63%	34%	4.19
	MV	0.5%	0.78	0.7%	-3.3%	-0.05%	-0.10%	89%	63%	3.35
	MDP	1.0%	1.12	0.9%	-2.5%	-0.07%	-0.13%	113%	38%	4.13
	MSR	2.2%	2.10	1.0%	-1.6%	-0.09%	-0.14%	191%	59%	2.71

Risk-based allocations | Implementation with ad hoc clusters

BoAML: "Quantitative Investment Strategies Panorama: Risk 'n mix – The what, why & how of cross asset Risk factor investing" (2016)

One way to ensure stable inter-relationships is to group strategies into clusters that share a common driving force (be it factor or asset-class based). The strategies within a cluster may then behave similarly in stressed market environments when broader historical trends become less reliable. A good example of such a cluster would be cross asset volatility. While we do not work with the volatility Risk factor in this piece, it has (by construction) predictable behaviour across asset classes in stressed market conditions. Moreover, a clustering approach is less operationally intensive and relies on fewer (ideally more stable) inter-relationships. For instance, we would only have 33 pair-wise relationships for 3 (factor) clusters of 5 strategies each.

Favour Risk factor clustering. The organisation of some investment teams (eg by asset class, geography or other Risk factors) will naturally tilt them towards their choice of clustering (usually asset class). However, we are inclined to adopt the factor clustering approach as asset class clusters often have multiple overlapping factors that drive performance. Indeed multi-asset investors may benefit most from factor clustering as it allows for the construction of (inherently cross asset) modules that could slot into an 'Alternative' allocation bucket.

EV and ERC allocations would have had the most well balanced scores across the broad range of evaluation criteria we developed earlier to assess allocation techniques (Exhibit 7). On balance we still favour ERC as it takes into account historical correlations explicitly and may make a greater impact on portfolio performance if strategy correlations weren't as low (close to 0) as they are in our example. Indeed, this is also a reason why the factor-based and asset class-based clustering approaches did not yield very different historical results, in our back-tested analysis.

ARP allocation in practice | Implementation with risk-based clusters (skew)

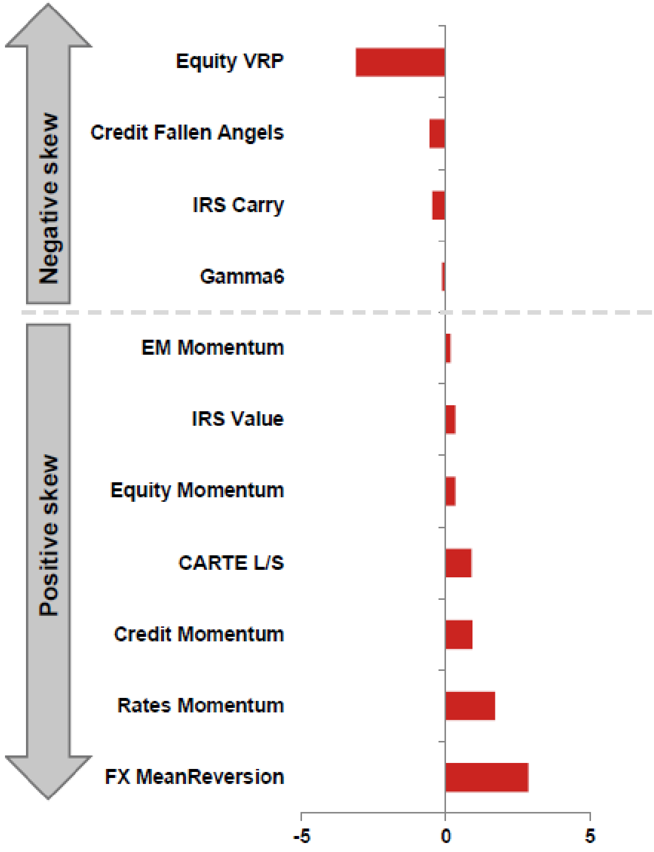
Selected strategies from the Nomura suite

	Trend Following	Value	Carry
Equities (factors)	Carte – Dynamic Multi factor Global Long/short: Momentum, Value, Quality, Min Volatility, Size		
Equities	Equities Trend Following		Volatility Risk Premium (eVRP)
Fixed income	IR Swaps Trend Following	Interest Rate Swaps Value	Interest Rate Swaps Carry
Currencies	EM FX Trend Following	G10 FX Mean Reversion	
Credit	Credit Trend Following		Fallen Angels Premium

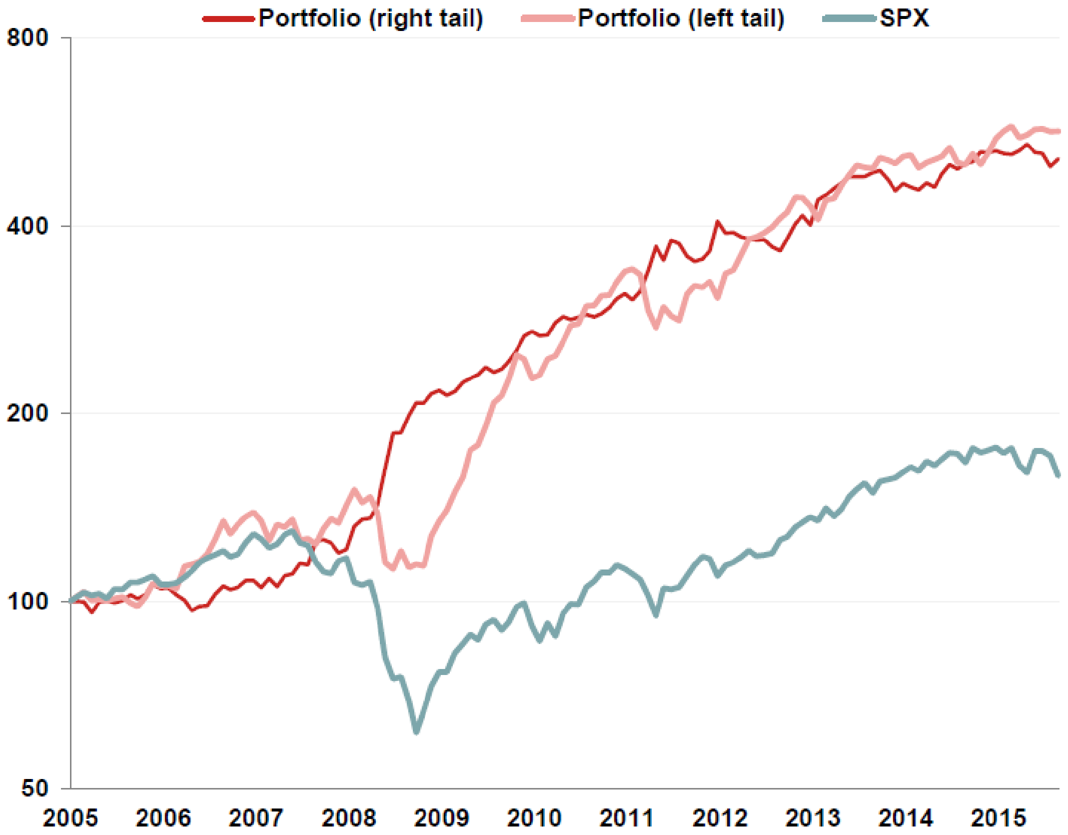
ARP allocation in practice | Implementation with risk-based clusters (skew)

The risk premia strategies exhibit different skew characteristics which could be exploited to achieve a basket portfolio with desired risk/return profile

Skew of monthly returns (2005-2015)



Strategy descriptions



ARP allocation in practice | Implementation with risk-based clusters (skew)

A risk-weighted portfolio of risk premia strategies

Combining risk premia strategies in a portfolio

	Left tail strategies				Right tail strategies			
Sub-indices (risk weight)	IRS Carry NMRSCOVU 40%	Credit Fallen Angels NMCDANGW 20%	Equity VRP NMEDVRPC 20%	Equity Gamma6 NMEDGAM6 20%	IRS Value NMRSVD3U 25%	Carte (5 factor L/S) NMEDCRAW 25%	FX Reversion NMSYGRNU 25%	Trend Following 25%
	G4 Swap markets	CDS swaps Europe & N America	S&P Variance swaps	S&P 500 call options	G4 Swap markets	MSCI stocks	G10 ex G3 pairs	Equity NMX2EQMU 8% Rates NMRSMOVU 8% EM FX NMX2EMLU 5% Credit NMCDMOMU 4%
	5y, 10, 20y, 30y tenors	Investment Grade and High Yield	Systematic volatility selling	daily hedged option selling	5y, 10, 20y, 30y tenors	*Momentum* *Value* *Quality* *Min Vol* *Size*	1-day vs 30-day variance	
Leverage on each sub-index	*Target Volatility (30%)* *Long term volatility of the sub-index*				*Target Volatility (30%)* *Long term volatility of the sub-index*			
Sub portfolios	Left tail portfolio 50%				Right tail portfolio 50%			

Risk Premia Portfolio

- *Sub-index returns are combined in fixed weights to arrive at two sub-portfolios with a left and a right tail return characteristics. These sub-portfolios are further combined in equal risk weights to achieve a portfolio with a realized volatility of 11% since 2005 and 9% over last 5 years*
- *A portfolio construction charge of 50bps per annum is embedded in the portfolio returns*
- *Portfolio weights are rebalanced once at the start of each calendar year*

Risk-based allocations | **Generalizing cluster-based approaches**

Ad-hoc clustering might be misleading, as:

- ✓ it is quite subjective
- ✓ especially when dealing with a set of ARP from different providers (non-homogenous strategy classification and definition)

One should therefore consider approaches combining risk-based clustering and risk-based allocation.

Some academic references:

- ✓ López de Prado (2016), “Building Diversified Portfolios that Outperform Out-of-Sample”. Journal of Portfolio Management, 2016.
- ✓ Raffinot (2018), “Hierarchical Clustering-Based Asset Allocation”, The Journal of Portfolio Management Multi-Asset Special Issue 2018, 44 (2) 89-99.
- ✓ Lohre, Rother, Schläfer (2020), “Hierarchical Risk Parity: Accounting for Tail Dependencies in Multi-Asset Multi-Factor Allocations”, Chapter 9 in: Machine Learning and Asset Management, Emmanuel Jurczenko (ed.), Iste and Wiley, 2020, pp. 332-368

Risk-based allocations | **Hierarchical clustering-based asset allocation**

Introduction

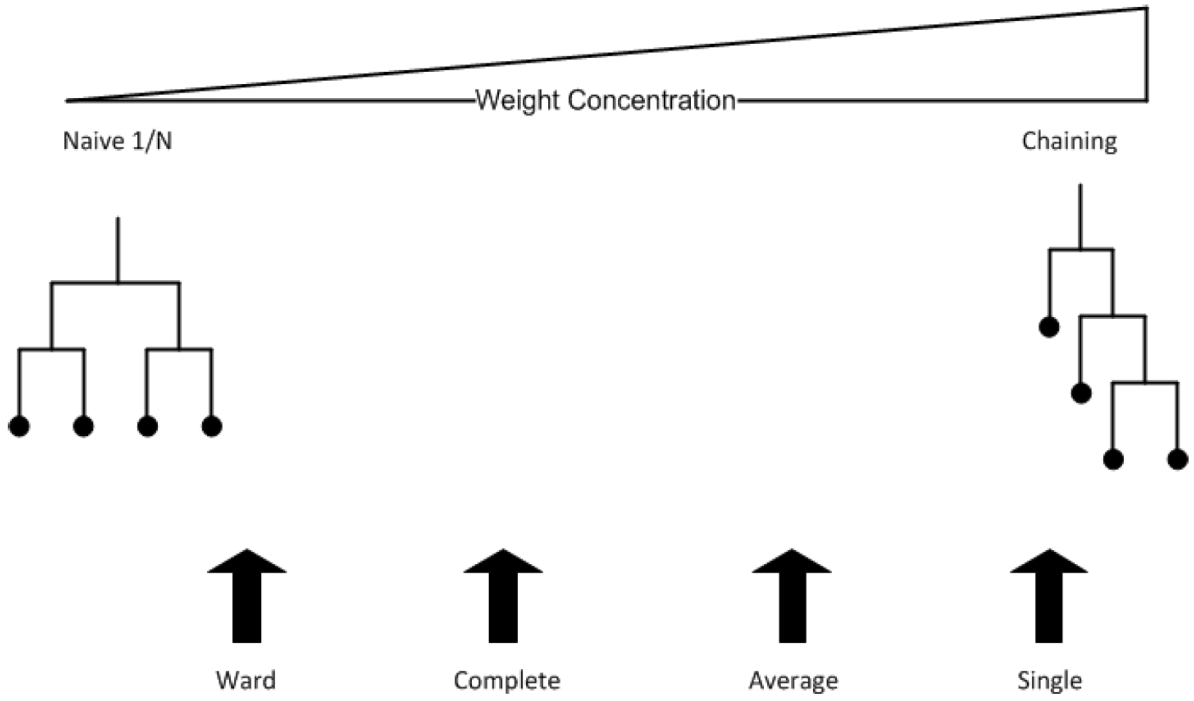
- ✓ Recent approach, introduced by Marcos Lopez de Prado (2016)
- ✓ Objective: design risk-based allocations from the hierarchical clustering of the underlying asset classes
- ✓ Favor allocation across clusters vs. allocation across asset classes or strategies

The various approaches rely on 4 main steps

- ✓ Step 1: hierarchical tree clustering
- ✓ Step 2: determination of the optimal number of clusters
- ✓ Step 3: allocation of capital across clusters
- ✓ Step 4: allocation of capital within clusters

Risk-based allocations | **Hierarchical clustering-based asset allocation**

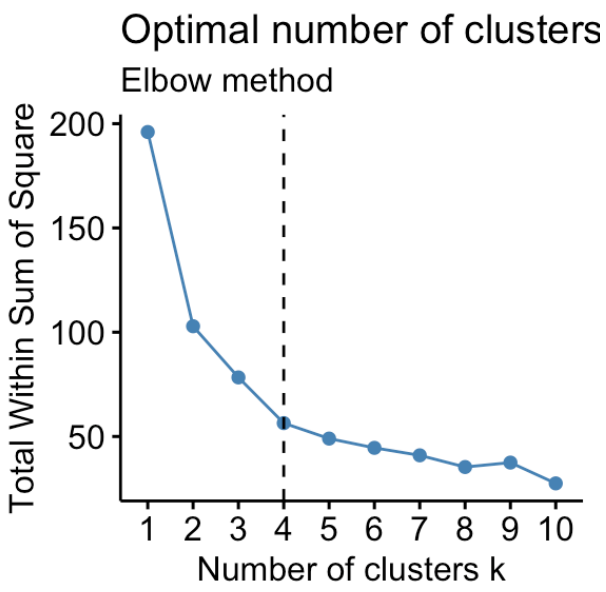
✓ Step 1: hierarchical tree clustering
- choice of the risk measure
- choice of the distance metric
- choice of the linkage methodology...



- ✓ Step 2: determination of the optimal number of clusters
  - Graph-based
  - Elbow method
    - Objective find the balance between the number of clusters and the within cluster sum of squared distances

$$WSS = \sum_{i=1}^{k} \sum_{x \in C_i} d\left(x, \bar{x}_{C_i}\right)$$

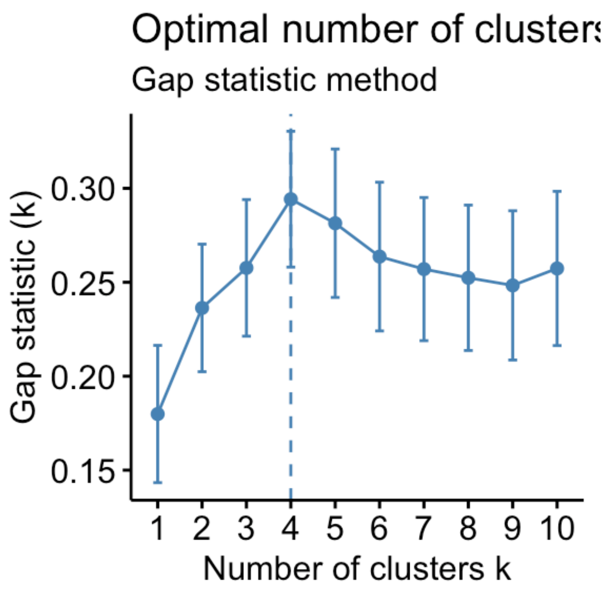
in which k is the number of clusters, and $\bar{x}_{C_i}$ is the centroid of cluster i.



Risk-based allocations | **Hierarchical clustering-based asset allocation**

✓ Step 2: determination of the optimal number of clusters

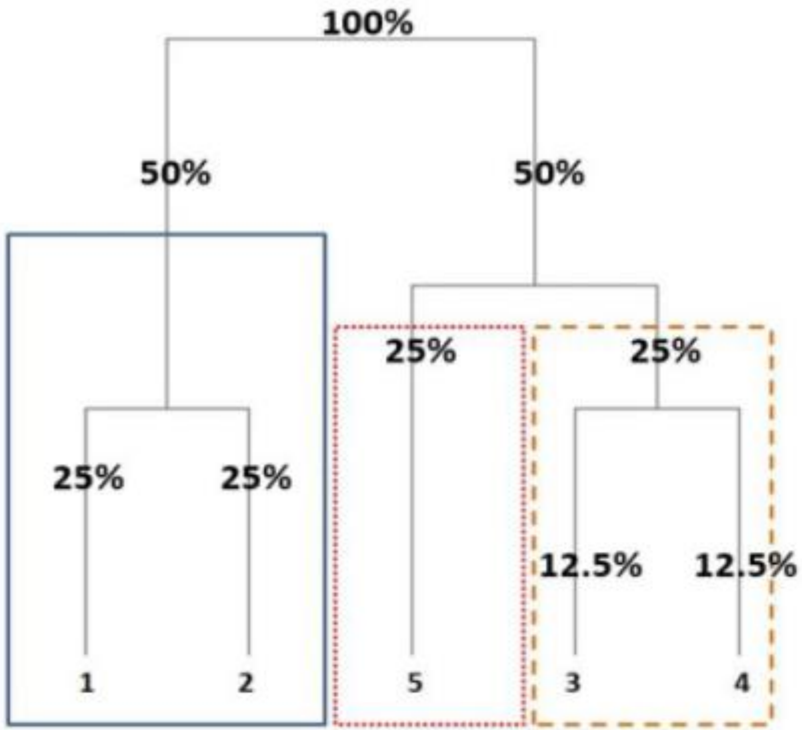
- Quantitative criteria, such as the Gap-statistic
  - Sum of pairwise distances in each cluster r: $D_r = \sum_{i,j/\in C_r} d_{i,j}$
  - Cluster inertia: $W_k = \sum_{r=1}^{k} \frac{D_r}{2n_r}$
  - $Gap_n(k) = E_n^*[log(W_k)] - log(W_k)$, where $E_n^*[log(W_k)]$ is the expected inertia of randomly built clusters (ie. reference null clustering hypothesis)



Risk-based allocations | **Hierarchical clustering-based asset allocation**

✓ Step 3: allocation of capital across clusters

- The « waterfall » approach



Risk-based allocations | **Hierarchical clustering-based asset allocation**

✓ Step 3: allocation of capital across clusters

$$ArgMin_w\left(TR - \sum_{n=1}^{k} RC_n\right)$$

$$RC_1 = \cdots = RC_n = \cdots = RC_k$$

$$RC_{n\in k} = \sum_{i\in n} RC_i$$

$$RC_{1\in n} = \cdots = RC_{i\in n} = \cdots = RC_{I\in n}$$

$$RC_i = w_i MRC_i$$

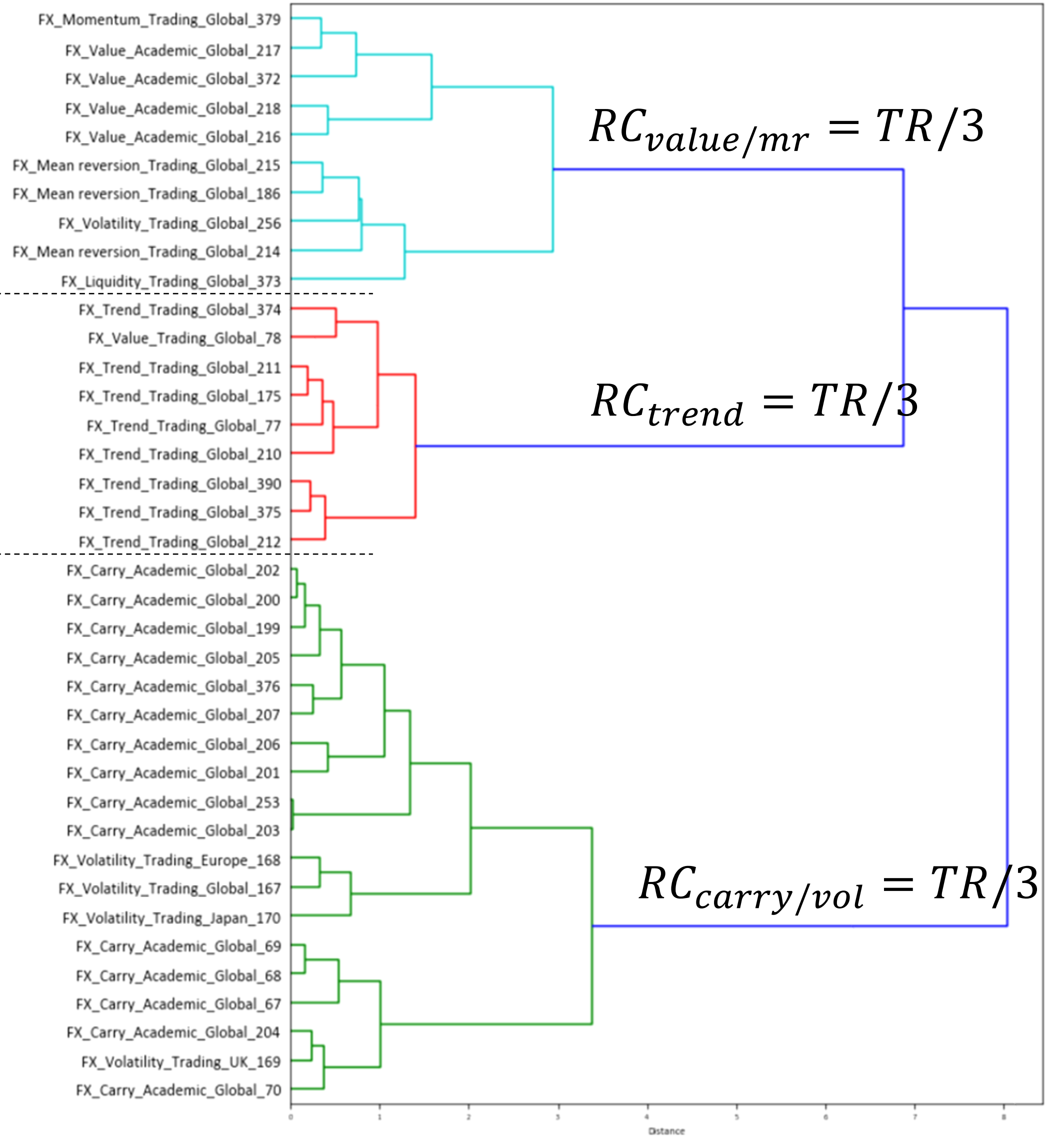
with w_i the weight allocated to asset i, TR the total risk of the allocation, RC_n the risk contribution of cluster n to the total risk, RC_i the risk contribution of asset i to the allocation, and MRC_i its marginal risk contribution.

Risk-based allocations | **Hierarchical clustering-based asset allocation**

$$RC_i = RC_{value/mr}/10$$

$$RC_i = RC_{trend} =/9$$

$$RC_i = RC_{carry/vol}/19$$



$$RC_{value/mr} = TR/3$$

$$RC_{trend} = TR/3$$

$$RC_{carry/vol} = TR/3$$

With RC_n the risk contribution of cluster n to portfolio total risk TR.

Risk-based allocations | **Example**

Diversified ARP allocation

1. Hierarchical clustering
   - ✓ PCA decomposition of the covariance matrix.
   - ✓ Features = ARP exposures to PCs
   - ✓ Dendrogram
     - Ward linkage
     - Euclidean distance

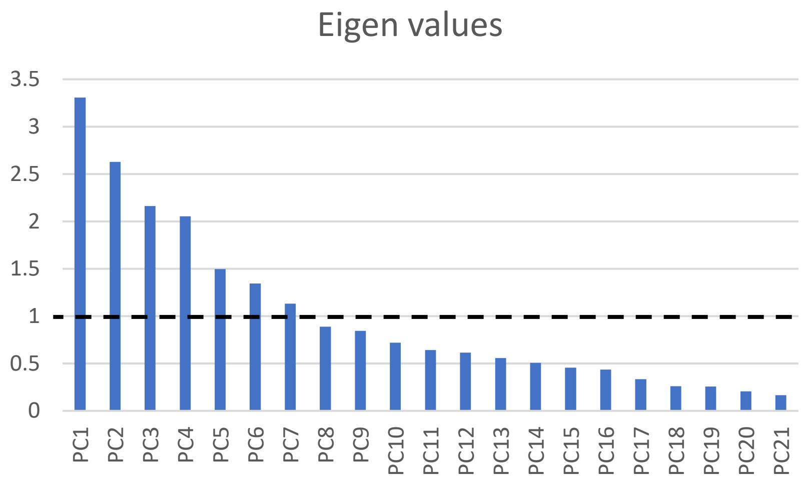
2. Optimal number of clusters

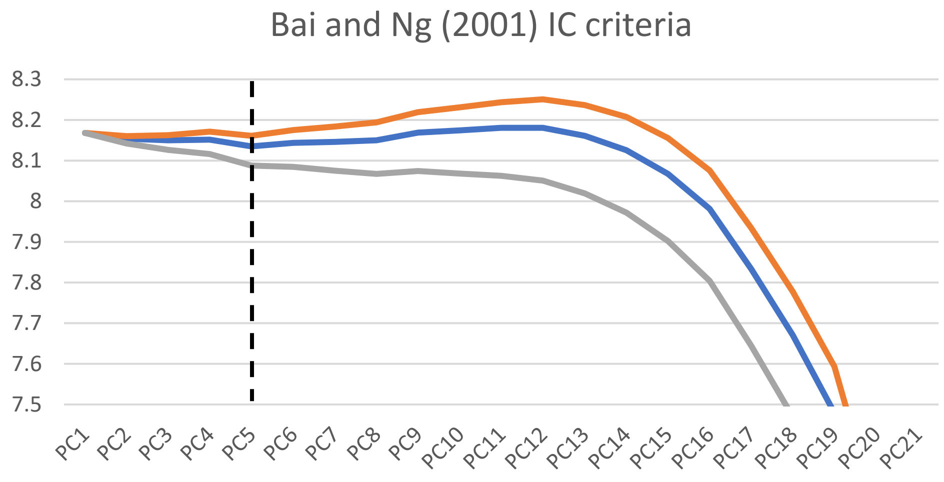
3. Equal risk allocation within the clusters (volatility weighted)

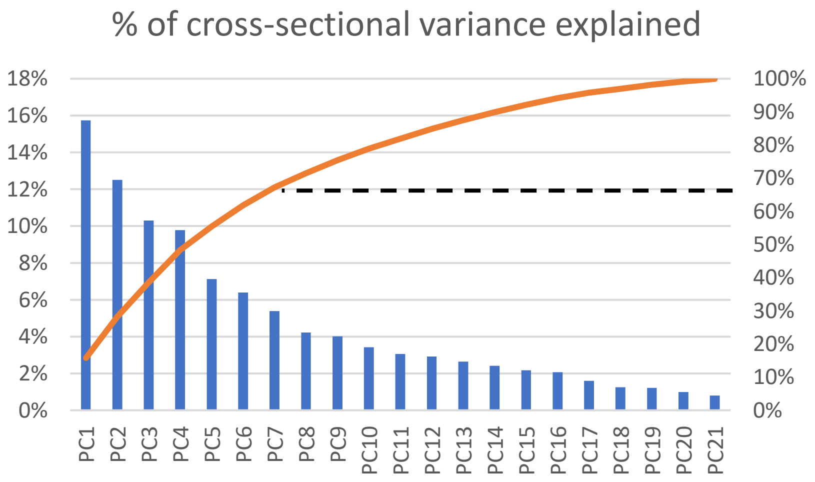
4. Equal CVaR allocation across the clusters

Risk-based allocations | **Example**

1. Hierarchical clustering – PCA decomposition of the covariance matrix.

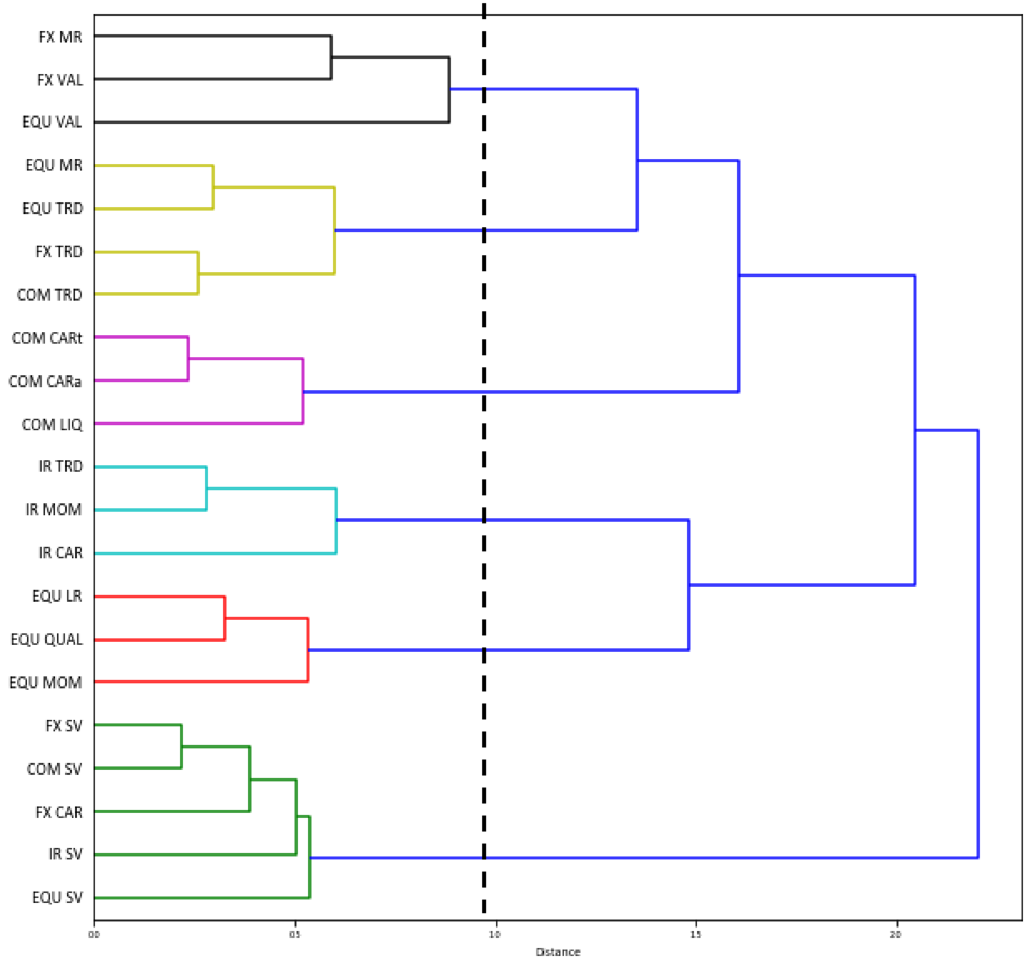






Risk-based allocations | **Example**

1./2. Hierarchical clustering – Dendrogram and optimal number of cluster from graph



Risk-based allocations | **Example**

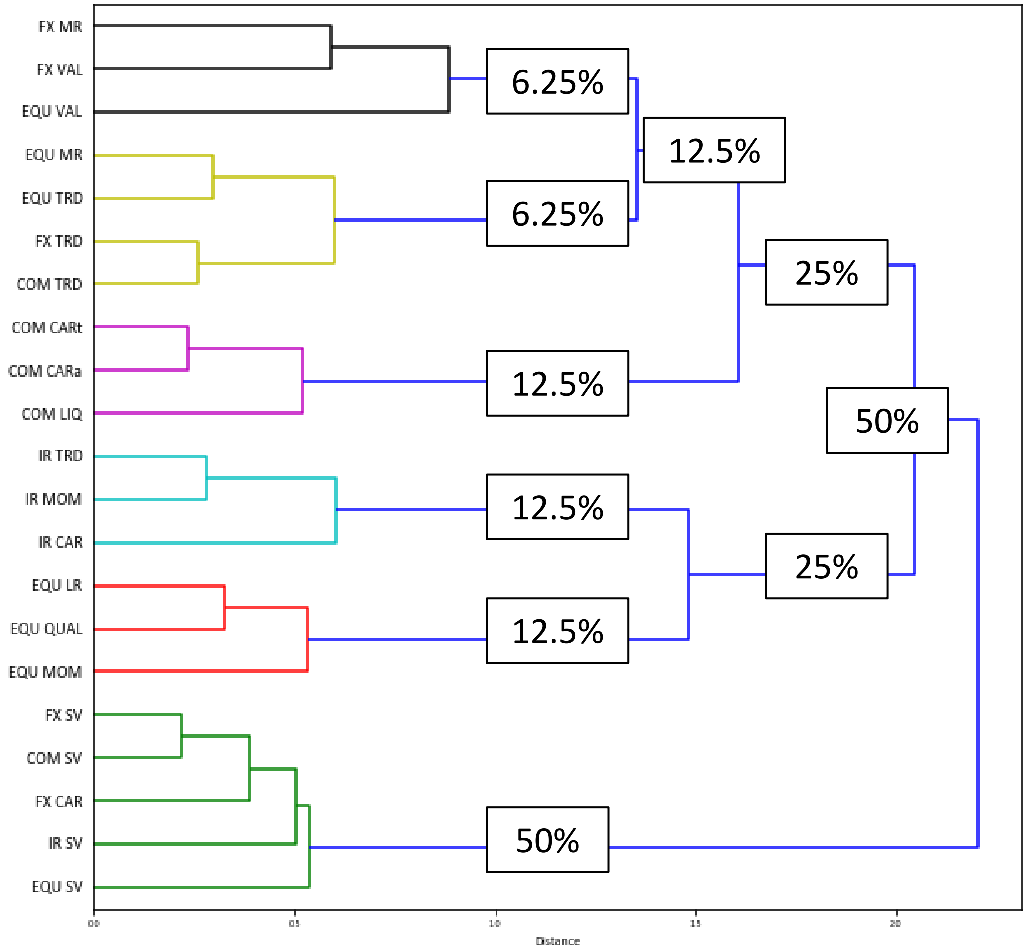
3. Equal volatility within cluster allocations

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6
EQU VAL	0%	0%	0%	0%	0%	40%
EQU QUAL	0%	45%	0%	0%	0%	0%
EQU LR	0%	28%	0%	0%	0%	0%
EQU MOM	0%	27%	0%	0%	0%	0%
EQU TRD	0%	0%	0%	0%	25%	0%
EQU MR	0%	0%	0%	0%	31%	0%
EQU SV	16%	0%	0%	0%	0%	0%
COM CARa	0%	0%	0%	22%	0%	0%
COM CARt	0%	0%	0%	36%	0%	0%
COM LIQ	0%	0%	0%	42%	0%	0%
COM TRD	0%	0%	0%	0%	15%	0%
COM SV	14%	0%	0%	0%	0%	0%
IR CAR	0%	0%	52%	0%	0%	0%
IR MOM	0%	0%	23%	0%	0%	0%
IR TRD	0%	0%	25%	0%	0%	0%
IR SV	30%	0%	0%	0%	0%	0%
FX VAL	0%	0%	0%	0%	0%	36%
FX MR	0%	0%	0%	0%	0%	24%
FX SV	27%	0%	0%	0%	0%	0%
FX TRD	0%	0%	0%	0%	29%	0%
FX CAR	12%	0%	0%	0%	0%	0%

Risk-based allocations | **Example**

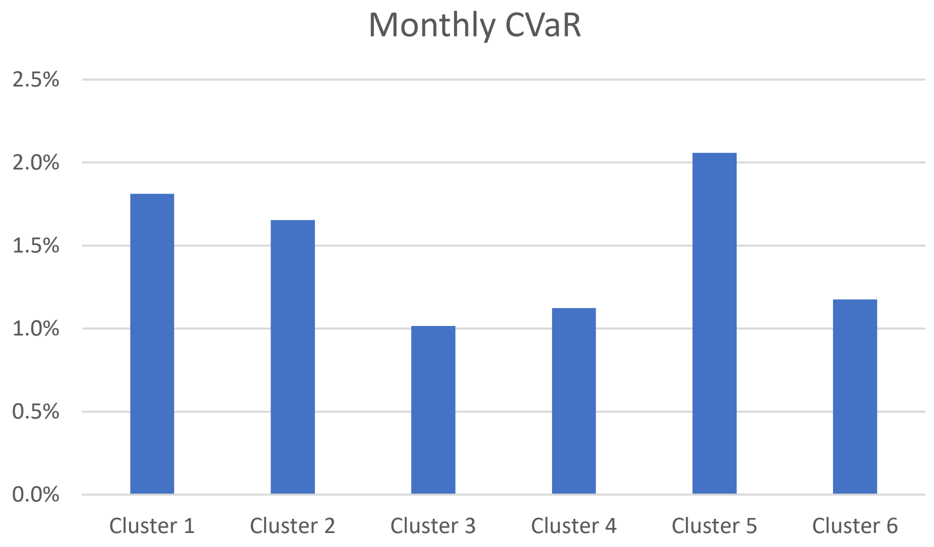
4. Across-cluster allocation: waterfall approach

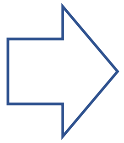
Is the waterfall approach appropriated in this case?

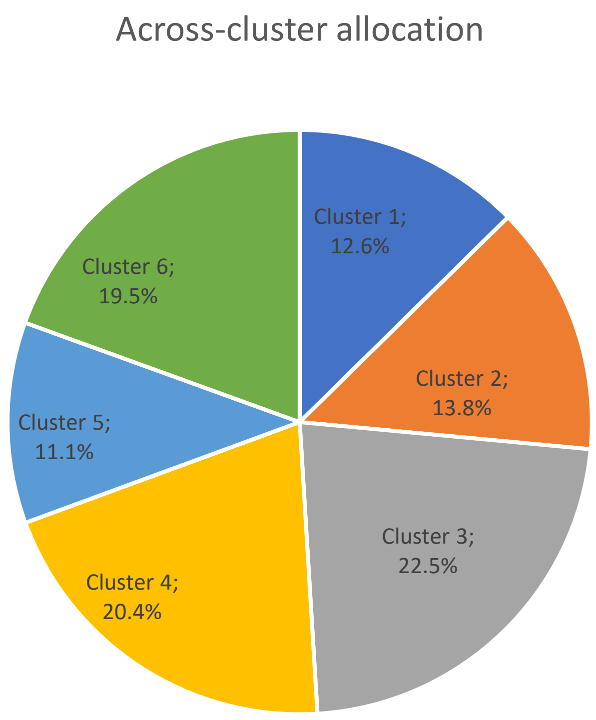


Risk-based allocations | **Example**

4. Across-cluster allocation: equal CVaR







Risk-based allocations | **Example**

4. Global Allocation