Introduction to Risk Parity and Budgeting

Chapter 5 – Risk Parity Applied to Alternative Investments

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[†]Evry University & Lyxor Asset Management, France

Instructors may find the description of the book at the following addresses:

`http://www.crcpress.com/product/isbn/9781482207156`

`http://www.thierry-roncalli.com/RiskParityBook.html`

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Figure: Term structure of crude oil futures
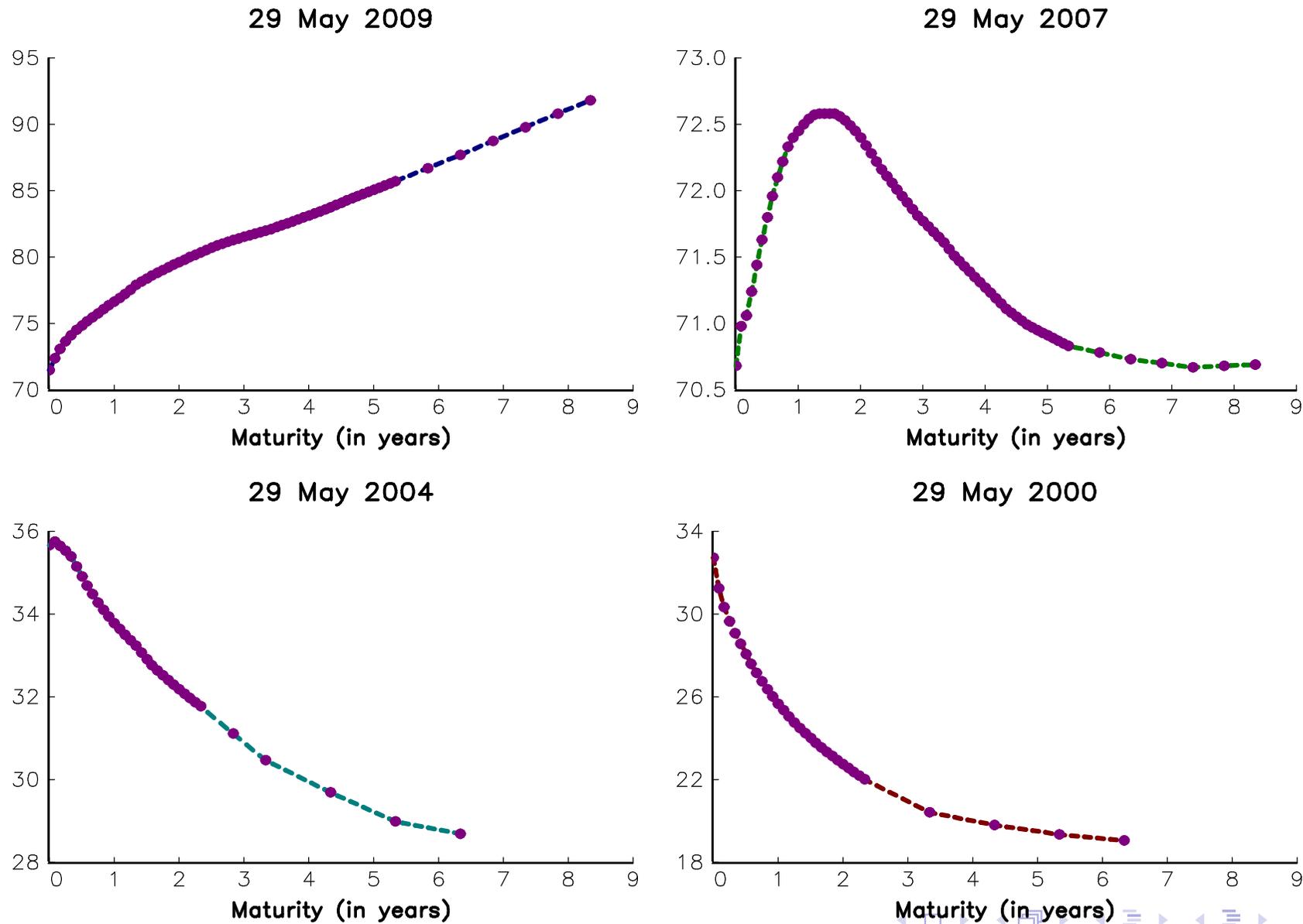
Figure: Contango and backwardation movements
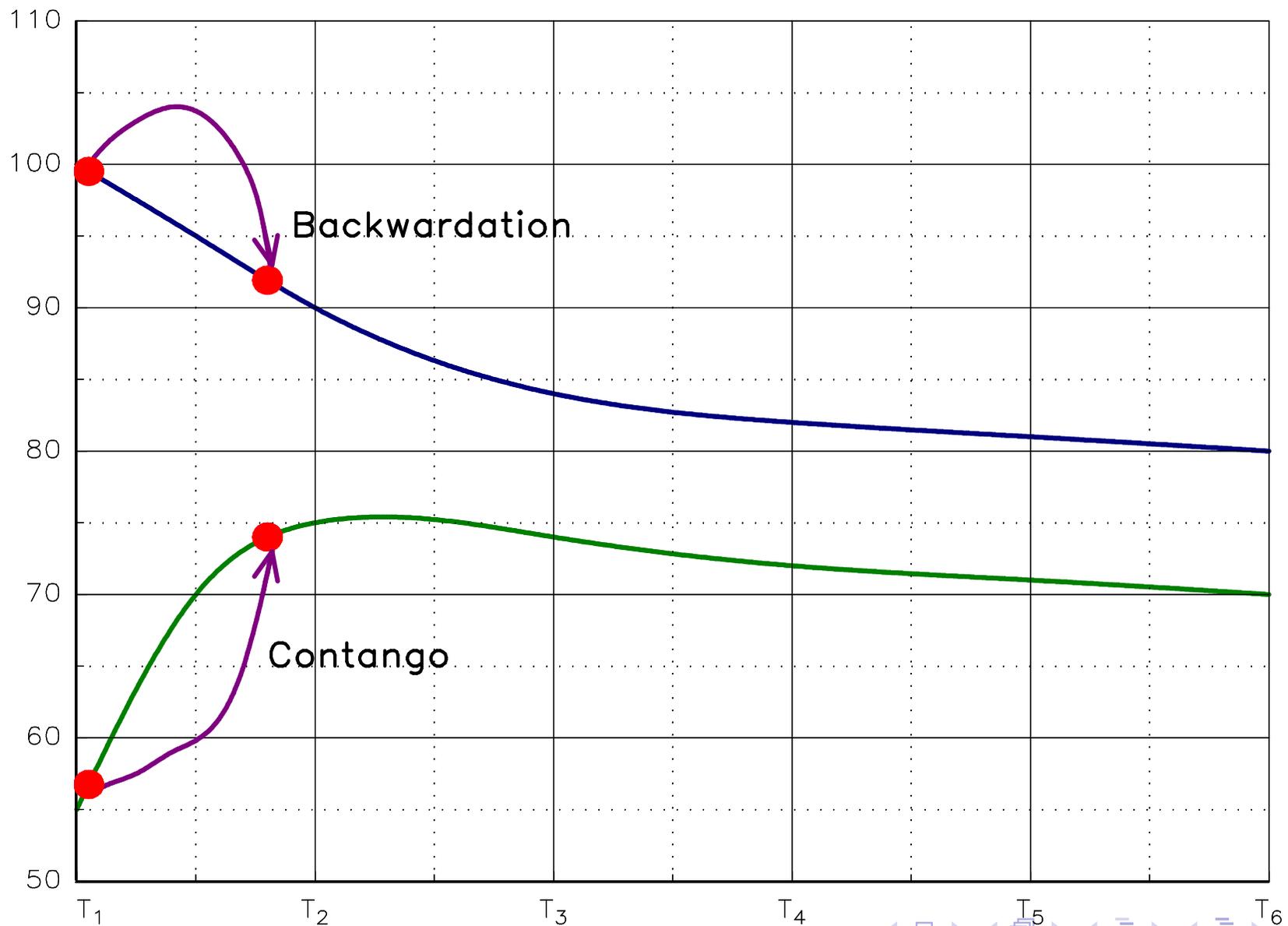
Table: Annualized excess return (in %) of commodity futures strategies

	1990 − 2012	One-year rolling window				
		Min	10%	50%	90%	Max
Crude Oil	−4.9	−75.7	−40.4	6.3	89.3	175.1
Brent	−10.2	−69.4	−33.2	13.9	74.5	231.2
Natural Gas	19.2	−83.3	−58.0	−20.0	86.0	360.2
Heating Oil	−8.3	−70.6	−30.7	8.4	76.8	230.3
Wheat	8.3	−64.9	−34.2	−8.1	29.5	146.6
Corn	6.4	−60.5	−30.5	−9.9	35.8	104.9
Soybeans	−3.4	−47.3	−20.9	1.5	40.9	89.8
Cotton	6.9	−63.3	−36.8	−8.9	38.3	185.5
Copper	−6.0	−62.4	−26.0	2.4	58.6	223.1
Gold	−2.9	−25.9	−14.4	1.9	26.3	63.2
Silver	−4.3	−41.3	−19.9	1.5	45.0	158.9
Platinum	−5.0	−55.2	−19.7	5.3	42.7	86.9
Average	−0.3					

Table: Annualized volatility (in %) of commodity futures strategies

| | 1990 − 2012 | One-year rolling window | | | | |
		Min	10%	50%	90%	Max
Crude Oil	36.5	15.6	21.4	32.5	48.5	70.3
Brent	34.8	16.2	21.6	30.6	43.9	68.4
Natural Gas	51.0	24.0	36.0	49.2	66.0	73.6
Heating Oil	35.1	19.4	23.1	32.0	43.3	62.9
Wheat	28.2	16.6	18.4	24.4	40.0	51.2
Corn	25.0	12.7	15.7	22.2	33.8	44.8
Soybeans	22.8	11.4	16.7	20.6	31.5	41.4
Cotton	26.0	12.2	18.6	23.4	34.4	42.4
Copper	27.2	13.1	17.6	23.8	35.9	56.5
Gold	16.2	5.9	8.0	14.7	22.4	33.0
Silver	29.0	11.5	16.8	25.7	43.4	54.6
Platinum	21.4	8.5	13.6	19.6	27.3	43.3
Average	29.4					

Table: Main statistics of EW and ERC commodity portfolios

Portfolio	$\hat{\mu}_{1\mathrm{Y}}$	$\hat{\sigma}_{1\mathrm{Y}}$	SR	$\mathscr{MDD}$	γ_1	γ_2
EW	8.26	16.48	0.28	-57.79	-0.31	5.16
ERC	7.24	14.46	0.25	-56.06	-0.22	4.95

Figure: Simulated performance of EW and ERC commodity portfolios

RC of the EW portfolio

Weights of the ERC portfolio

Simulated performance
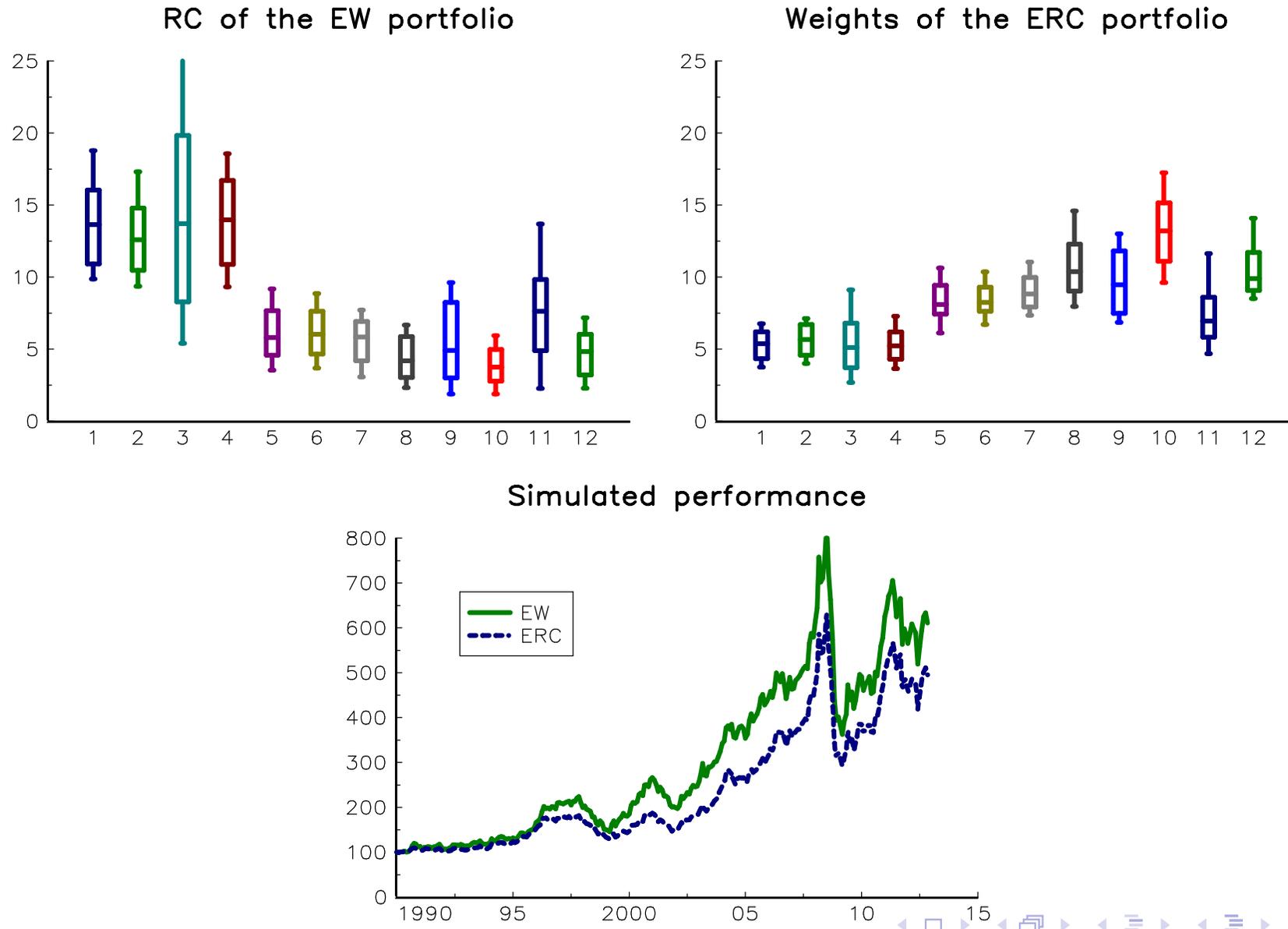
Table: Calibration of the EMN portfolio

j	Market practice x_j^+	$\mathscr{RC}_j$	$\mathscr{RC}_j^\star$	ERC x_j^+	$\mathscr{RC}_j$	$\mathscr{RC}_j^\star$
1	42.7%	2.1%	20.8%	38.5%	2.0%	20.0%
2	19.3%	2.5%	24.8%	18.6%	2.0%	20.0%
3	25.1%	3.0%	29.6%	21.5%	2.0%	20.0%
4	13.9%	0.6%	6.5%	18.7%	2.0%	20.0%
5	38.6%	1.8%	18.3%	45.2%	2.0%	20.0%
$\sigma(x)$	10.0%			10.0%		

Table: Statistics of monthly returns of hedge fund strategies

Strategy	$\hat{\mu}_{1Y}$	γ_1	γ_2	$\mathscr{MDD}$	VaR (G)	VaR (H)	ES (G)	ES (H)
1	12.2	−3.5	18.0	−47.9	5.6	3.5	7.0	12.5
2	16.3	0.0	0.7	−44.3	8.1	7.6	10.1	10.7
3	14.5	−1.6	5.7	−48.3	6.5	6.2	8.2	11.9
4	10.2	−2.8	16.3	−38.4	5.0	4.4	6.2	10.6
5	8.1	−0.8	1.6	−22.3	3.5	4.3	4.5	6.2
6	10.3	−3.8	24.7	−42.4	5.1	3.9	6.3	11.6
7	9.1	−1.8	8.8	−30.1	4.2	3.6	5.3	7.9
8	9.2	−1.4	3.1	−32.3	4.1	4.5	5.2	7.7
9	10.2	−0.1	−0.8	−9.2	4.3	4.1	5.5	5.1
10	8.0	−2.7	14.4	−35.8	3.5	3.2	4.5	7.9

Table: Statistics of ERC HF portfolios (Sep. 2006 – Aug. 2012)

| | Index | ERC-weighted | | |
		Vol	ES	CF
$\hat{\mu}_{1Y}$ (in %)	0.86	0.23	1.81	1.34
$\hat{\sigma}_{1Y}$ (in %)	7.93	4.85	4.66	5.93
$\mathscr{MDD}$ (in %)	-27.08	-18.22	-16.02	-19.14
γ_1	-2.04	-1.84	-1.37	-1.96
γ_2	6.24	6.88	5.38	8.98
$\bar{\tau}$	0.00	0.89	1.88	2.35
τ^+	0.00	0.41	1.31	0.77
$\mathscr{H}^\star$	0.72	0.29	0.65	0.13
$\mathscr{N}^\star$	1.40	3.05	2.67	5.42
$\mathscr{G}$	0.83	0.65	0.63	0.62
$\mathscr{I}^\star$	1.77	3.98	3.68	3.38

Figure: Weights (in %) of ERC HF portfolios
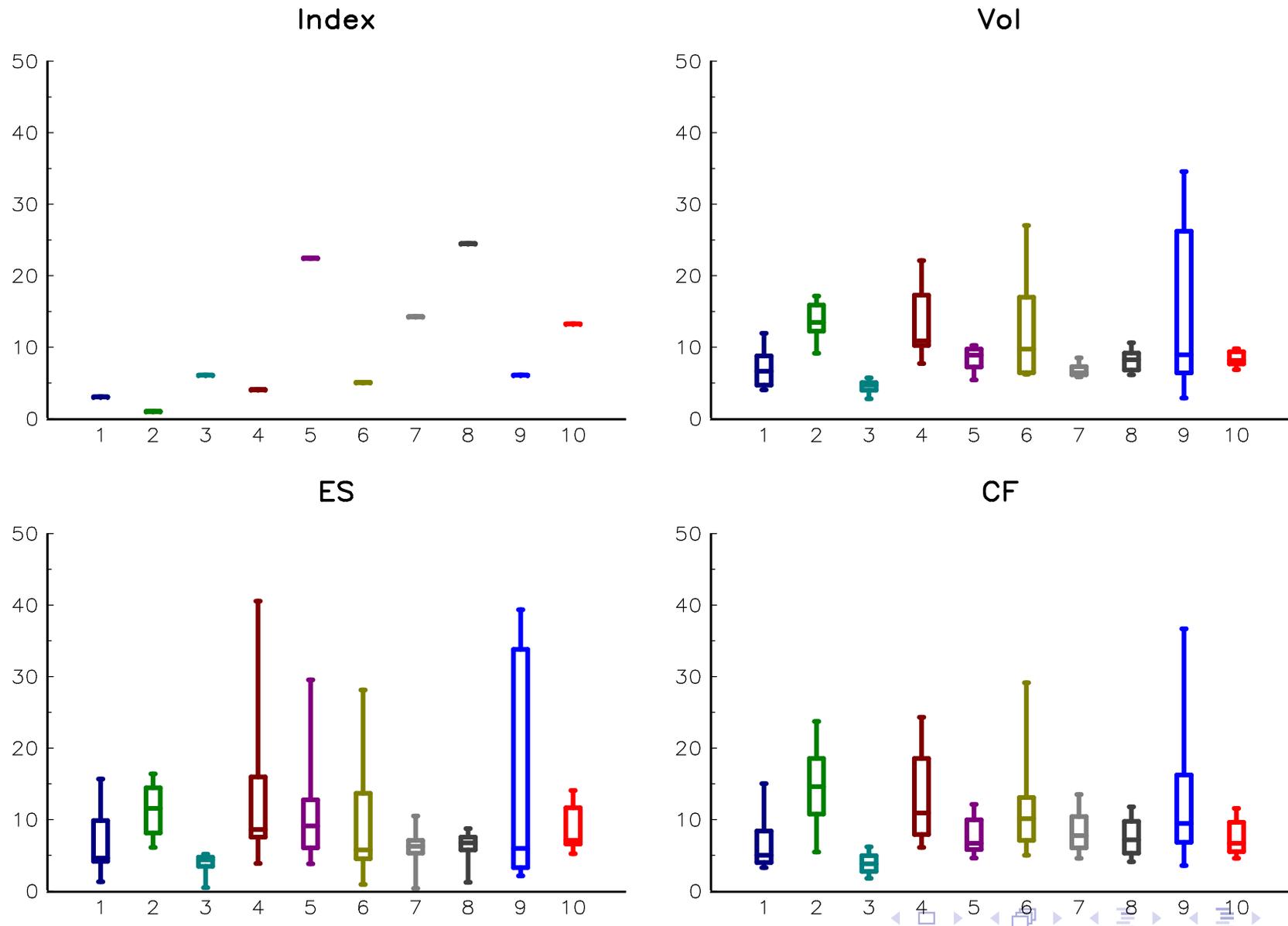
Figure: Risk contributions (in %) of ERC HF portfolios
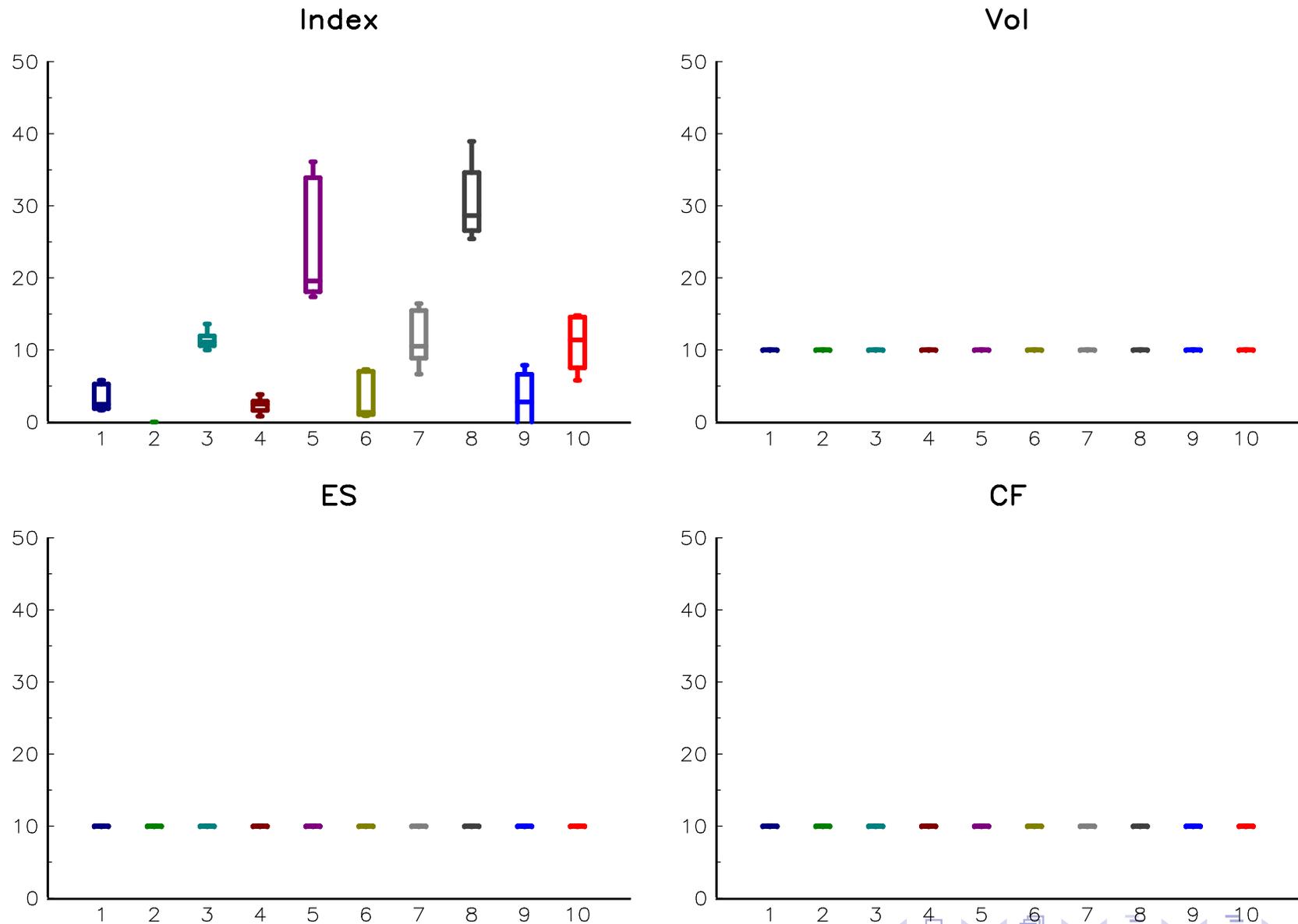
Figure: Simulated performance of ERC HF portfolios
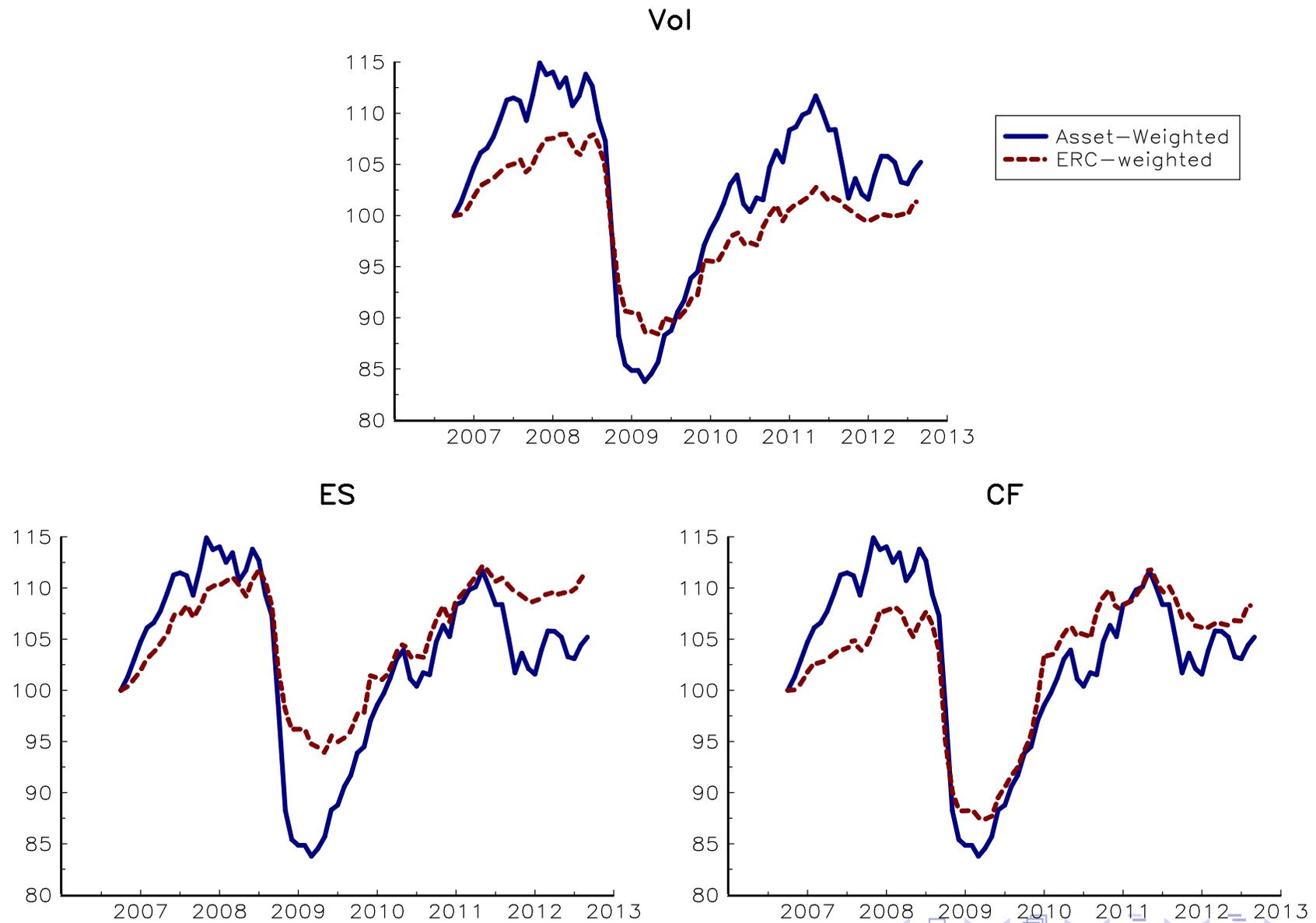
Figure: Risk factor contributions (in %) of ERC HF portfolios
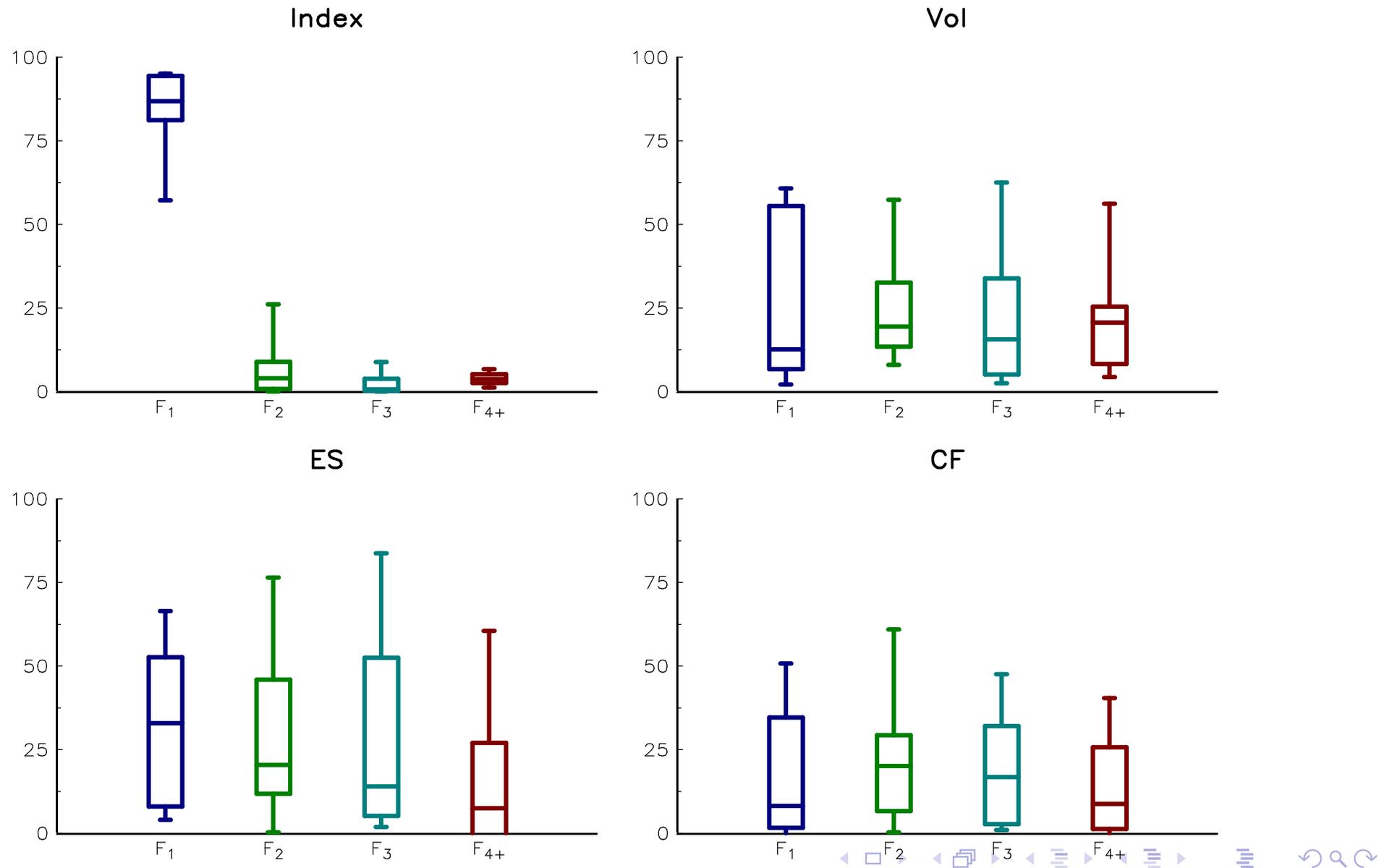
Figure: Weights (in %) of RFP HF portfolios
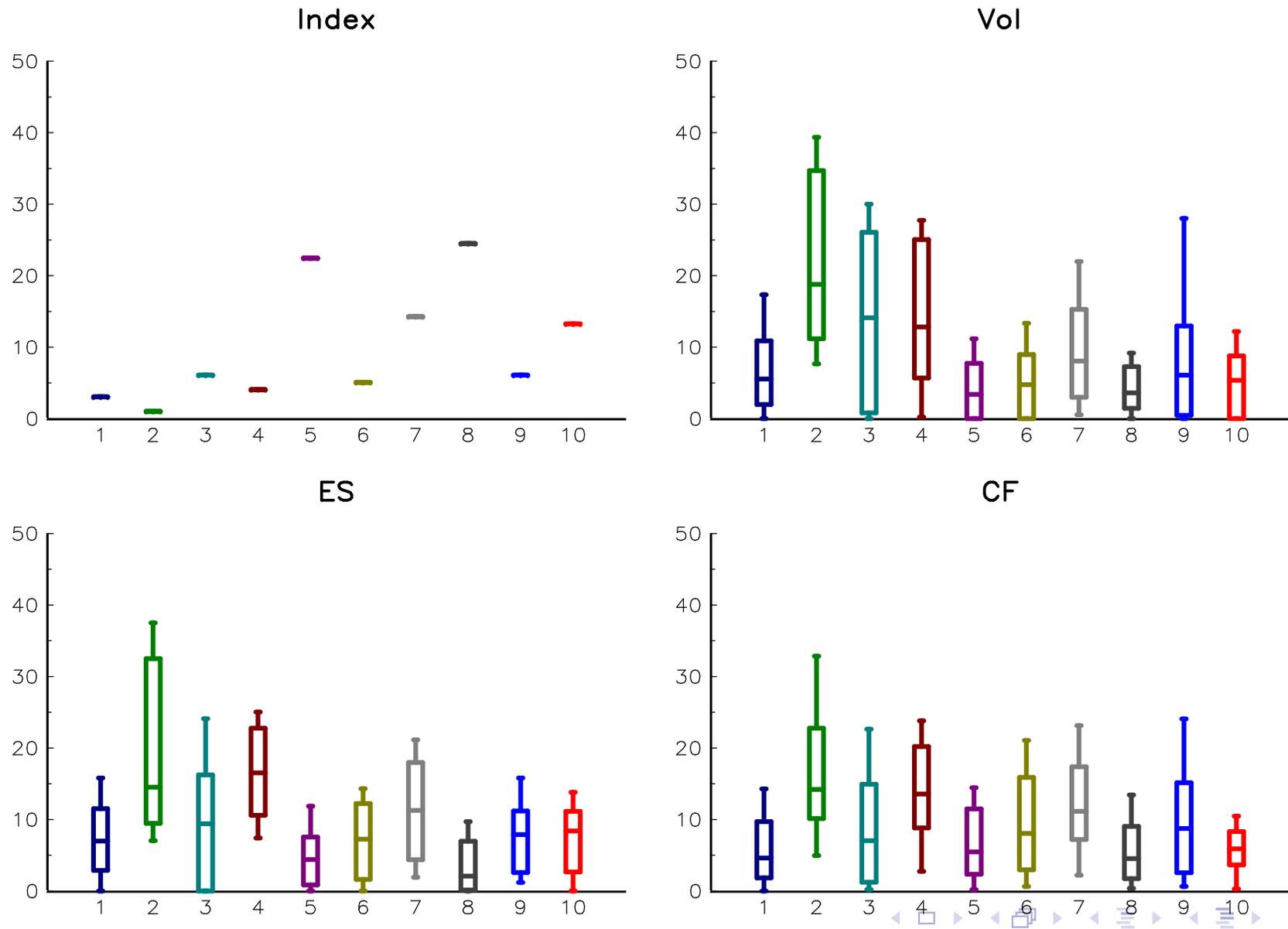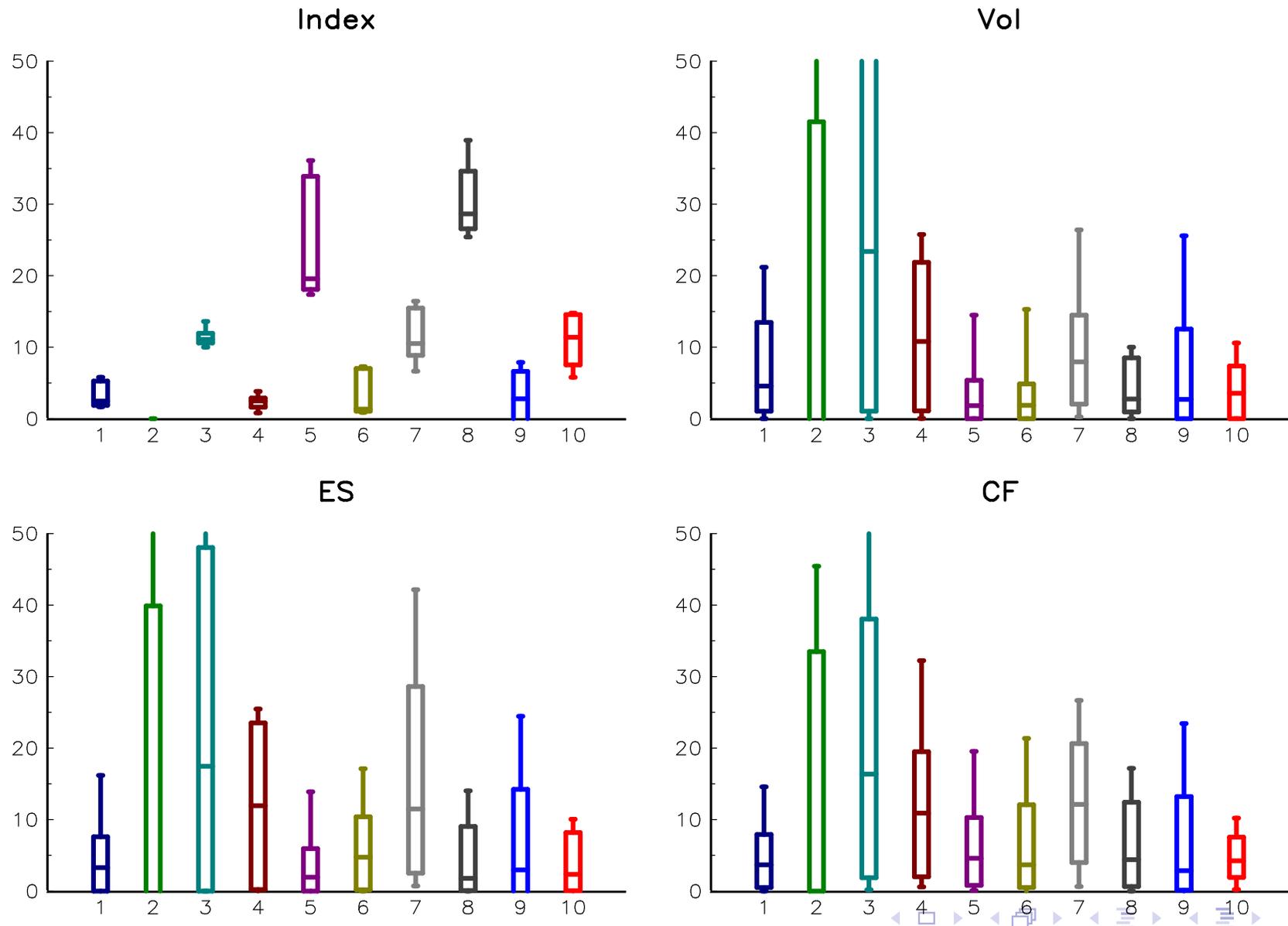
Figure: Risk contributions (in %) of RFP HF portfolios

Figure: Risk factor contributions (in %) of RFP HF portfolios
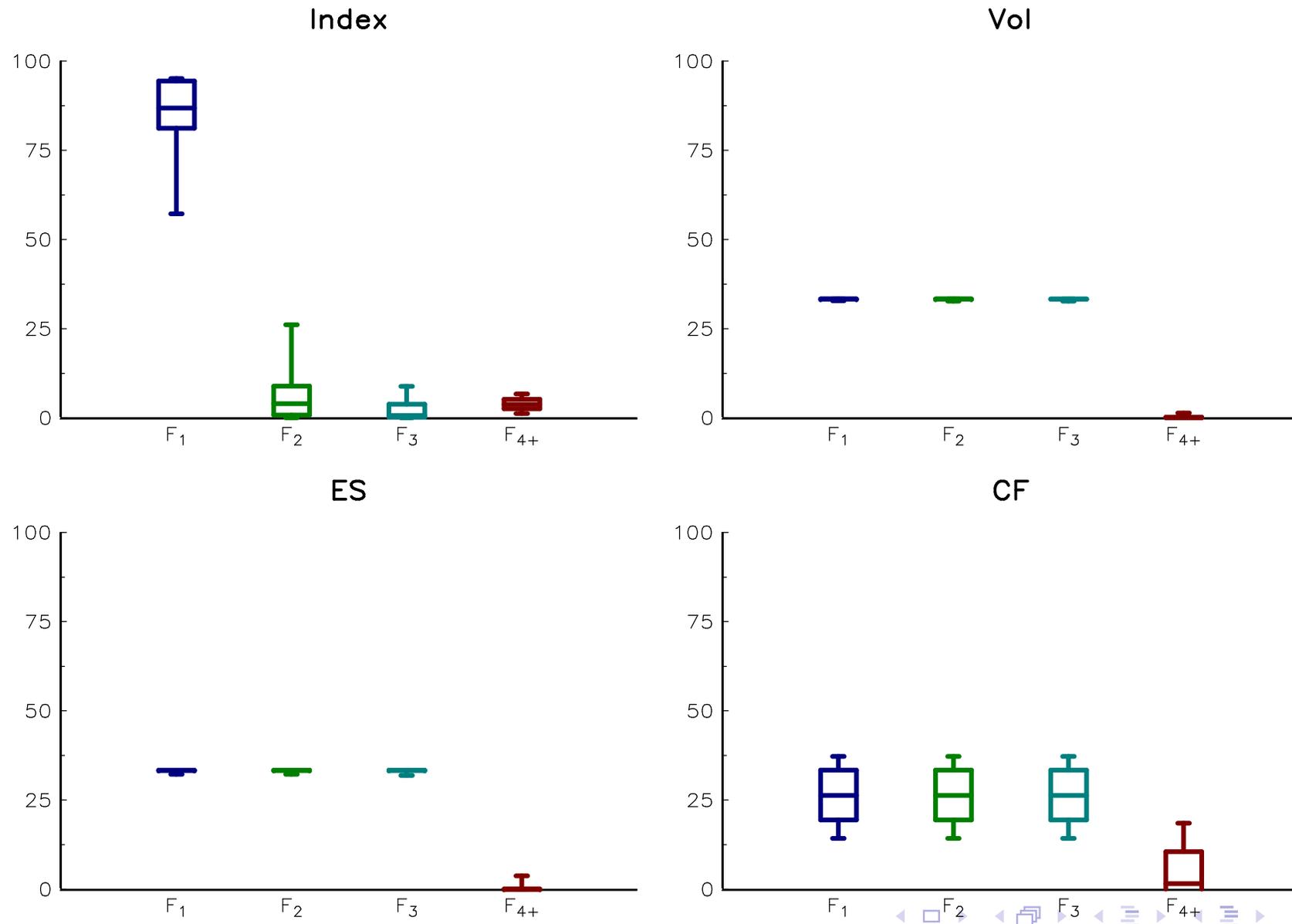
Figure: Simulated performance of RFP HF portfolios

Vol

Legend:
- Asset–Weighted
- RFP–weighted

ES

CF
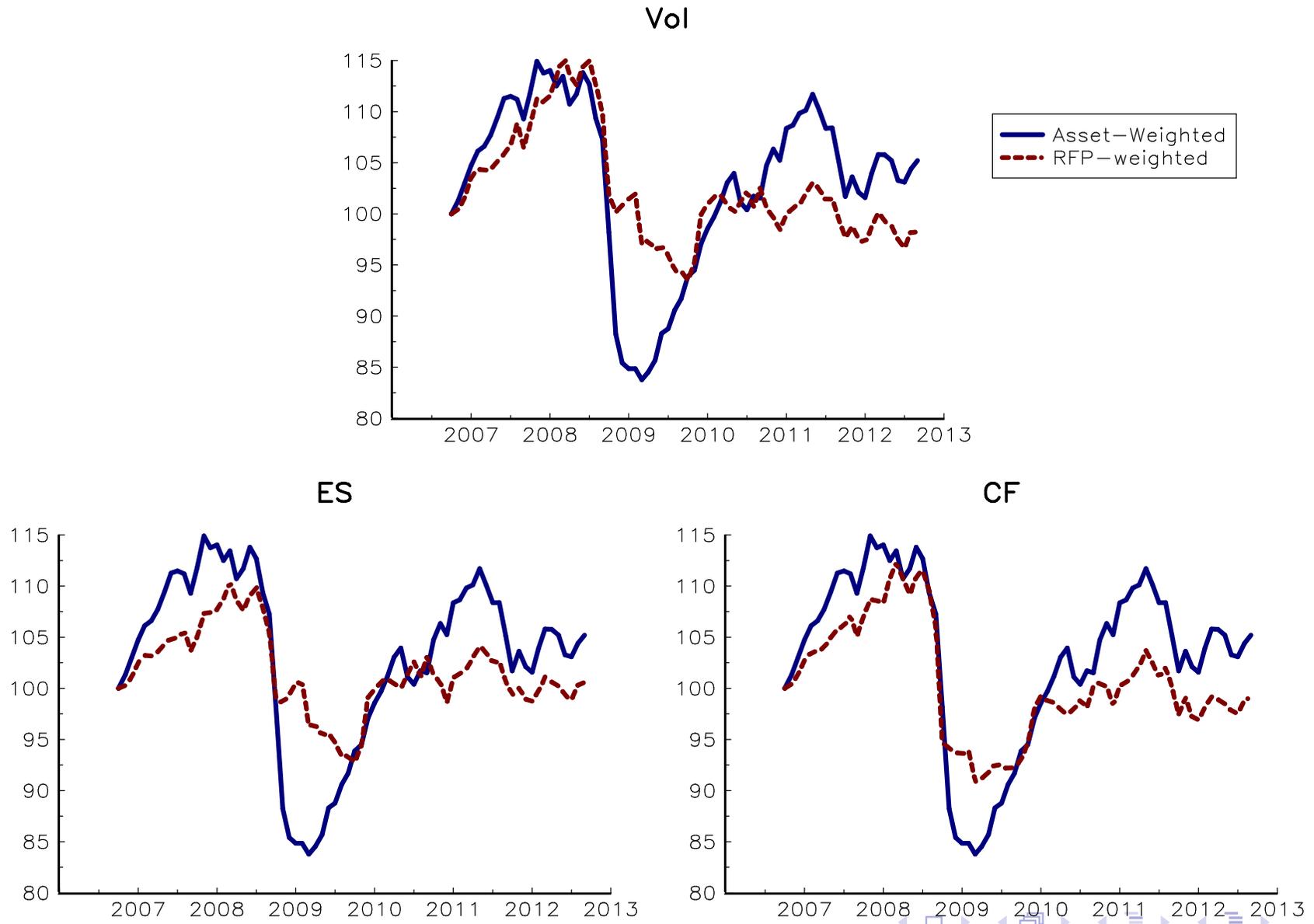
Table: Statistics of RFP HF portfolios (Sep. 2006 – Aug. 2012)

	Asset-weighted	RFP-weighted		
		Vol	ES	CF
$\hat{\mu}_{1Y}$ (in %)	0.86	-0.31	0.10	-0.16
$\hat{\sigma}_{1Y}$ (in %)	7.93	5.98	5.33	6.35
$\mathscr{MDD}$ (in %)	-27.08	-19.23	-15.96	-19.12
γ_1	-2.04	-1.00	-0.70	-2.87
γ_2	6.24	3.87	3.71	14.68
$\bar{\tau}$	0.00	3.47	4.84	6.01
τ^+	0.00	1.50	1.63	1.39
$\mathscr{H}^\star$	0.72	0.24	0.22	0.10
$\mathscr{N}^\star$	1.40	3.02	3.01	6.78
$\mathscr{G}$	0.83	0.63	0.52	0.51
$\mathscr{I}^\star$	1.77	3.06	3.54	3.74

Table: Risk decomposition of the current allocation x^0

Asset	x_i	$\mathscr{MR}_i$	$\mathscr{RC}_i$	$\mathscr{RC}_i^{\star}$
1	20.00	10.90	2.18	17.68
2	40.00	10.20	4.08	33.07
3	5.00	12.26	0.61	4.97
4	35.00	15.61	5.46	44.28
Volatility			12.34	

Table: Risk decomposition of the RB portfolio $x^{\star}$

Asset	x_i	$\mathscr{MR}_i$	$\mathscr{RC}_i$	$\mathscr{RC}_i^{\star}$
1	25.68	12.08	3.10	25.00
2	33.56	9.24	3.10	25.00
3	18.84	16.46	3.10	25.00
4	21.93	14.14	3.10	25.00
Volatility			12.41	

Table: Risk decomposition of the constrained RB portfolio $x^\star(\delta)$ when $\tau^+ = 5\%$

Asset	x_i	$\mathscr{MR}_i$	$\mathscr{RC}_i$	$\mathscr{RC}_i^\star$
1	20.59	11.06	2.28	18.51
2	39.13	10.11	3.95	32.15
3	6.91	12.92	0.89	7.26
4	33.37	15.51	5.18	42.08
Volatility			12.30	

Table: Risk decomposition of the constrained RB portfolio $x^\star(\alpha)$ when $\tau^+ = 5\%$

Asset	x_i	$\mathscr{MR}_i$	$\mathscr{RC}_i$	$\mathscr{RC}_i^\star$
1	20.73	11.10	2.30	18.71
2	39.17	10.12	3.96	32.24
3	6.77	12.86	0.87	7.08
4	33.33	15.48	5.16	41.96
Volatility			12.29	

Table: Risk decomposition of the constrained RB portfolio $x^\star(\delta)$ when $\tau^+ = 20\%$

Asset	x_i	$\mathcal{MR}_i$	$\mathcal{RC}_i$	$\mathcal{RC}_i^\star$
1	22.64	11.52	2.61	21.26
2	36.58	9.77	3.57	29.12
3	12.36	14.68	1.81	14.78
4	28.42	15.04	4.28	34.84
Volatility			12.27	

Table: Risk decomposition of the constrained RB portfolio $x^\star(\alpha)$ when $\tau^+ = 20\%$

Asset	x_i	$\mathcal{MR}_i$	$\mathcal{RC}_i$	$\mathcal{RC}_i^\star$
1	22.91	11.61	2.66	21.70
2	36.70	9.80	3.60	29.33
3	12.09	14.55	1.76	14.35
4	28.30	14.99	4.24	34.61
Volatility			12.26	