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On The Value of Portfolio Construction

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Northfield Webinar
July 25, 2019

Active Portfolio Management - 1

- Active Portfolio Management essentially consists of two things:

STOCK SELECTION + PORTFOLIO CONSTRUCTION

- In my experience, many fund managers spend the majority of their time and effort on Stock Selection, and little on Portfolio Construction
- Finance theory tells us to optimise, trading off Expected Returns against Risks, to create efficient portfolios. Harry Markowitz was given a Nobel prize for having this idea, and to my knowledge, no-one has come up with a better portfolio construction paradigm since
- Despite this fact, many Portfolio Managers still prefer to use simple heuristic methods to create and rebalance their portfolios

Active Portfolio Management - 2

- The explosive growth of ETFs over the past decade is almost a case study of this phenomenon, since almost all ETFs use one of the common heuristic methods of portfolio construction
- These include :
  - **Equal-weighting**
  - **Capitalisation-weighting**
  - **Attribute-weighting**
  - **Inverse Volatility weighting**
  - **Risk Parity weighting**
- Notice that NONE of these methods make any attempt to trade-off Expected Return contributions against Risk contributions, so NONE of them will create efficient portfolios

Portfolio Management vs Stock Selection

- Many managers will happily describe themselves as 'stock pickers'
- Their focus is very much on the individual stocks in a portfolio
- If they are asked why a particular stock is being held, they will usually respond with a story about the attractive features of that stock
- On the other hand, I have yet to hear a manager say they are holding a particular stock because it helps to diversify portfolio risks
- Analysts are paid to pick individual stocks
- Portfolio Managers are paid (usually a lot more) to manage portfolios
- Portfolio Managers should not only consider the expected returns of their stocks, but also their covariances with the rest of the portfolio
- Optimisation is about weighing the return contribution of a holding against its risk contribution, allowing for these covariances

Everyone Does It, So What's the Problem?

- There has been an on-going debate in the finance literature for decades about whether active managers have "Skill"
- The essential argument is that if managers did have Skill, then their portfolios would outperform their benchmarks
- Since this usually doesn't happen, finance academics conclude that active managers either don't (or can't, if anyone still believes in the Efficient Market Hypothesis!) have any Skill
- But there is a perfectly sensible alternative explanation
- It is my firmly-held belief that most institutional managers do have Skill; the reason it does not show up in their portfolio performance is because they do not create efficient portfolios
- And the inefficiencies can easily swamp the returns from their Skill

Why Not Optimise?

- Why is it that managers prefer heuristics to optimisation?
- First, optimisers are notorious for giving counter-intuitive results, which is a polite way of saying that they often generate very strange portfolios that managers wouldn't touch with a bargepole
- Second, unless they are heavily constrained, they will do lots of trading, and incur lots of transaction costs
- Third, the biggest difficulty with optimisation is that the manager has to provide a set of Expected Returns – and despite their avowed Stock Selection prowess, most managers seem reluctant to do so . . .

- . . . It is a curious fact, however, that even though they won't commit themselves to actual Expected Returns, managers can always tell you which of two stocks in their portfolio they prefer. Go figure!

Definitions of Portfolio Efficiency

- Formally, rational investors (**$0 < \lambda < \infty$**) seek to maximise return and minimise risk, subject to the Budget constraint, thus:-

$$\textbf{Max } U = R_P - \lambda * V_P \quad \textbf{such that} \quad \sum x_i = 1 \qquad \text{(a)}$$

- However, efficiency also means that the effects of a manager's Skill are maximised, and the effects of noise, or unwanted bets, are minimised as far as possible, given the usual long-only constraint
- Many fund managers operate within a risk budget. In an inefficient portfolio a significant part of this may be taken up with unintended bets. If these are minimised in a more efficient portfolio, it creates more scope for the manager to make bigger Skill bets, and, if they do have Skill, thereby improve their portfolio performance

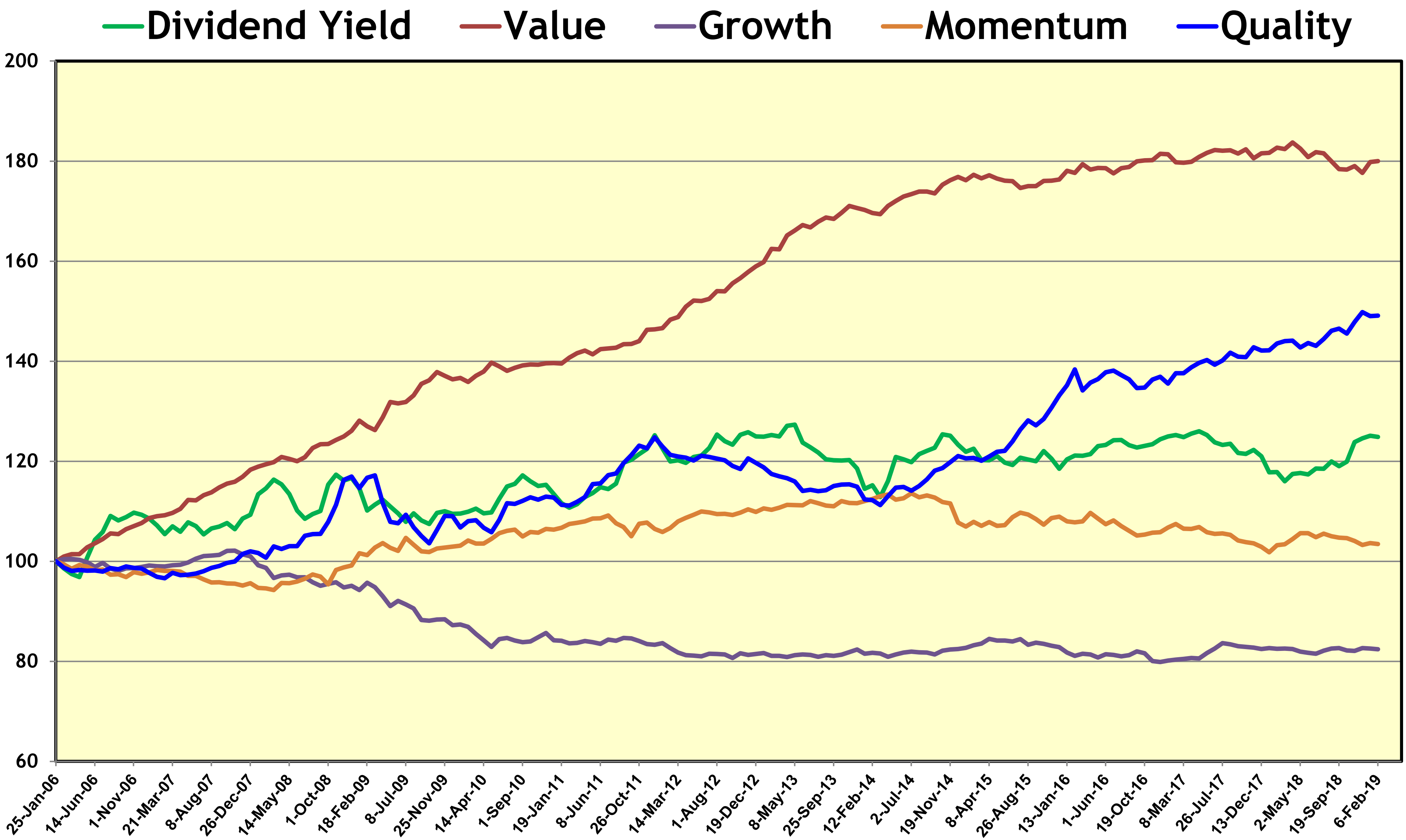
The Value of Portfolio Construction

- My purpose today is to show that the Portfolio Construction method used can make a big difference to the performance of a portfolio
- To do this, I adopt a very simple Stock Selection rule, as used in the construction of a number of Style factor ETFs
- For each Style factor investment strategy, we create initial portfolios of $100 million at the end of December 2005 using our Stock Selection rule and one of the Portfolio Construction methods
- Each portfolio is rebalanced every 12 weeks (think quarterly), and they are run for just over 13 years, up to February 2019
- We assume round-trip transaction costs of 30 bps, and an annual management fee, payable quarterly, also of 30 bps
- Performance figures will be given <u>after</u> these two estimated costs

Style Factor Portfolios

- We use 5 different Style factors from the Northfield US XRD risk model to create portfolios, namely :-
  - **Dividend Yield** Trailing 12-month Dividend Yield
  - **Growth** 5-year Trend & Momentum of EPS, BPS and SPS
  - **Value** B/P, E/P and CF/P
  - **Momentum** 12 month return to 1 month ago
  - **Quality** ROA, ROE, CF/Sales and –Leverage
- The US XRD Style factor returns are shown on the next slide
- The Stock Selection rule is very simple: at each rebalancing date we rank the S&P 500 stocks high to low by the selected Style beta, and then select the top 100 stocks

Style Factor Returns



Portfolio Optimisation methods

- In addition to the 5 heuristic portfolio construction methods given above, we will also use standard Markowitz Optimisation, (warts and all), as well as a method called Smart Portfolio Optimisation (SPO)
- SPO tries to deal with the usual problems of Markowitz Optimisation, and recognises that in reality, all portfolios are inefficient all the time; the interesting question is which holdings are the most inefficient?
- In essence, SPO identifies the most inefficient holdings in a portfolio, and whether they are too large or too small; if they are too large they become possible Sells, if too small, they become possible Buys
- Any holding that is considered efficient enough, given the limits on our stock return forecasting ability, become Holds. Once these constraints are set, the Optimiser is then set loose to decide which trades to make to improve the efficiency of the current portfolio

Smart Portfolio Optimisation - 1

- In order to identify inefficient holdings, we run a reverse optimisation on the current portfolio and derive the Implied Returns for efficiency
- These are given by the following :-

$$IR_I = R_P + \varphi * S_P * (Beta_{iP} - 1) \qquad \text{(b)}$$

where

R_P	=	Portfolio return
S_P	=	Portfolio risk
$Beta_{iP}$	=	Beta of the Stock to the Portfolio
φ	=	Return/Risk trade-off $(0 < \varphi < \infty)$

- Clearly, there are many different solutions as φ varies. We need to find a solution in which the Implied Returns are on the same scale as the Expected Returns, so that we can do a fair comparison.

Smart Portfolio Optimisation - 2

- We do this by minimising the sum of squared differences between the Implied and Expected Returns :-

$$\textbf{Min } Z = \text{Sum}_i(IR_i - ER_i)^2 \qquad \text{(c)}$$

- Substituting equation (b) for the Implied Returns $\mathbf{IR_i}$ in equation (c) and then solving and re-arranging, we obtain the following :-

$$J = \varphi^* \, S_P = \frac{\text{Sum}_i\{(ER_i - R_P)^*(\text{Beta}_{iP} - 1)\}}{\text{Sum}_i\{(\text{Beta}_{iP} - 1)^2\}} \qquad \text{(d)}$$

- This is a particularly interesting equation. Note the denominator is a sum of squared terms, and must therefore be positive. The sign of **φ, and hence J, is therefore determined by the numerator.**

What exactly is $Beta_{iP}$?

- Portfolio risk (as variance) is given by :-

$$V_P = Sum_i\{Sum_j(x_i * x_j * C_{ij})\}$$

where $\mathbf{x_i}$, $\mathbf{x_j}$ are holdings of stocks **i** and **j**, $\mathbf{C_{ij}}$ is the full covariance matrix

Hence the % contribution of risk (variance) from holding **i** is given by :-

$$PCV_{iP} = [100 * Sum_j\{x_i * x_j * C_{ij}\}] / V_P$$

$$= [100 * x_i * Sum_j \{x_j * Cov(R_i ,R_j)\}] / V_P$$

$$= [100 * x_i * Cov(R_i , Sum_j \{x_j * R_j\})] / V_P$$

$$= [100 * x_i * Cov(R_i , R_P)] / V_P$$

Dividing the % contribution of risk by the % holding size, we get :-

$$PCV_{iP} = \frac{[100 * x_i * Cov(R_i , R_P)]}{100 * x_i * V_P} = \frac{Cov(R_i , R_P)}{V_P} = Beta_{iP}$$

Smart Portfolio Optimisation - 3

- So **$Beta_{iP}$** shows whether a holding is more or less risky than average
- To remind you, we have :-

$$J = \varphi^* S_P = \frac{Sum_i\{(ER_i - R_P)^*(Beta_{iP} - 1)\}}{Sum_i\{(Beta_{iP} - 1)^2\}} \qquad \text{(d)}$$

and by re-arranging equation (b) and substituting **$J = \varphi^* S_P$** , we get:-

$$(IR_i - R_P) = J^*(Beta_{iP} - 1) \qquad \text{(e)}$$

- So this says that in an efficient portfolio the more attractive stocks (**$IR_i > R_P$**) will be the more risky holdings **($Beta_{iP} > 1$)**, and there is a constant return/risk trade-off **φ** throughout the Portfolio

A Perspective on Inefficient Portfolios

- Our numerator, which determines the sign of **J** and **φ** is :-

$$\mathbf{Sum_i\{(ER_i - R_P)*(Beta_{iP} - 1)\}}$$

- We are hoping that this will be positive, which would imply that the manager is a rational investor **($0 < \varphi < \infty$),** but sometimes it turns out to be negative. What does this mean?
- If you think about it, the only way this can happen is if some of the less attractive stocks (**$ER_i < R_P$**) are also among the more risky holdings, and so have (**$Beta_{iP} > 1$**), and *vice versa*
- This, in turn implies a negative **J** and **φ**; we would have to call these irrational portfolios . . . .
- Perhaps you should check your correlation between **ER_i** and **$Beta_{iP}$** ?

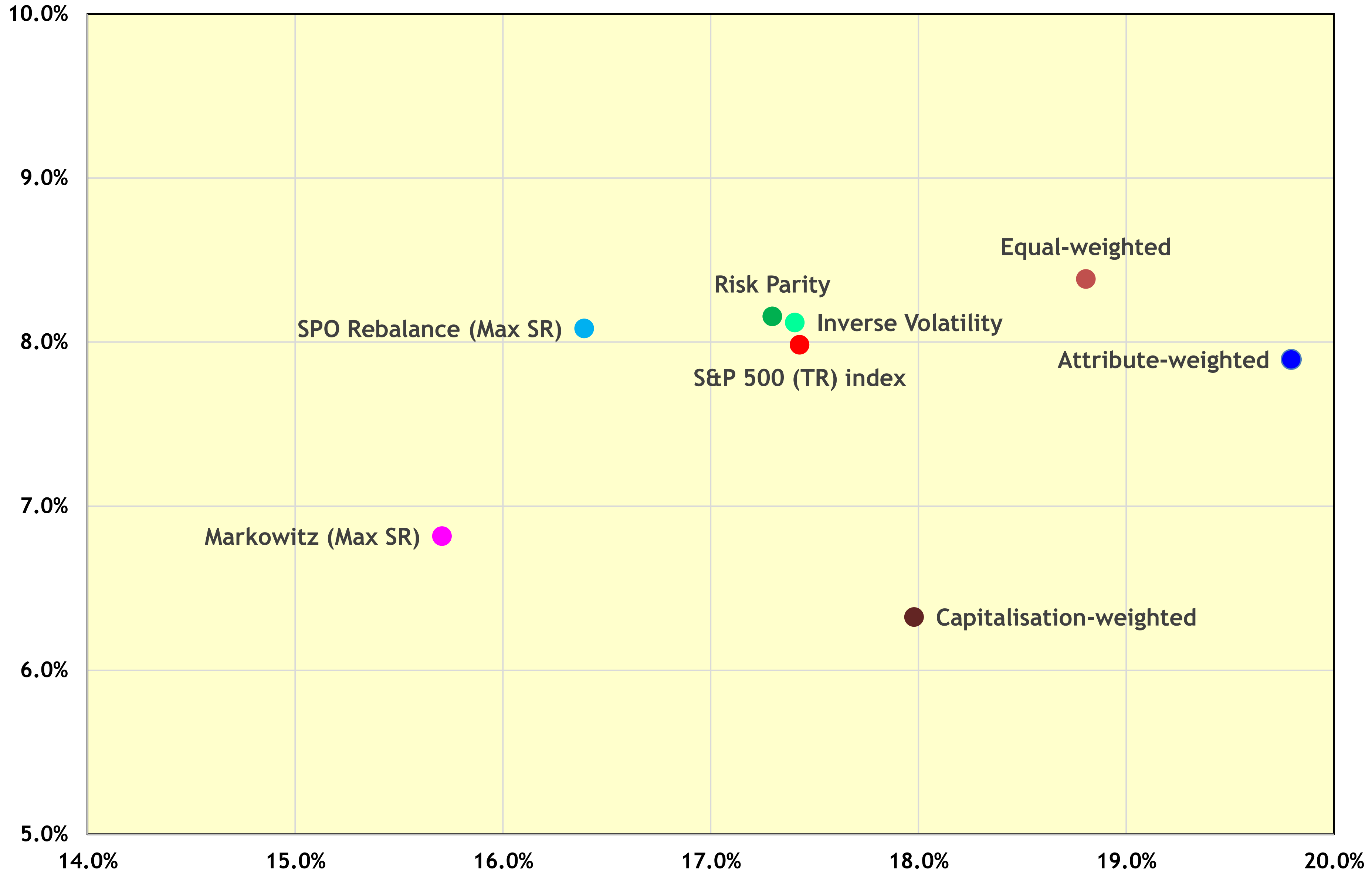
Dividend Yield Portfolio results - 1

	DIVIDEND YIELD	Average number of holdings	Annual Turnover	Average Annual Costs	Annualised Return after costs	Annualised Risk after costs	Return / Risk Ratio
AW	Attribute-weighted	101	95.2%	-0.57%	7.89%	19.80%	0.399
CW	Capitalisation-weighted	101	79.0%	-0.52%	6.32%	17.98%	0.352
EW	Equal-weighted	101	81.0%	-0.53%	8.38%	18.81%	0.446
IV	Inverse Volatility	101	76.4%	-0.51%	8.12%	17.41%	0.466
RP	Risk Parity	101	81.4%	-0.53%	8.16%	17.30%	0.472
MK	Markowitz (Max SR)	25.0	116.9%	-0.63%	6.82%	15.71%	0.434
SPO	SPO Rebalance (Max SR)	35.9	47.1%	-0.43%	8.08%	16.39%	0.493
S&P	S&P 500 (TR) index	500			7.98%	17.43%	0.458
AVERAGES (excluding S&P 500)			82.4%	-0.53%	7.68%	17.63%	0.437

Dividend Yield Portfolio results - 2

	DIVIDEND YIELD	Beta to S&P 500 (TR)	Annualised Alpha	Annualised Tracking Error	Average Div Yield beta	Div Yield Return	As % of Total Return
AW	Attribute-weighted	1.045	-0.45%	7.80%	1.074	1.70%	20.65%
CW	Capitalisation-weighted	0.952	-1.27%	6.99%	0.807	1.24%	18.26%
EW	Equal-weighted	1.001	0.39%	7.01%	0.867	1.37%	15.60%
IV	Inverse Volatility	0.917	0.80%	7.06%	0.851	1.33%	15.68%
RP	Risk Parity	0.918	0.83%	6.71%	0.856	1.32%	15.48%
MK	Markowitz (Max SR)	0.798	0.45%	8.11%	1.214	1.98%	27.92%
SPO	SPO Rebalance (Max SR)	0.842	1.36%	7.81%	1.149	1.73%	21.07%
S&P	S&P 500 (TR) index	1.000	0.00%	0.00%	0.403	0.59%	7.64%
AVERAGES (excluding S&P 500)		0.925	0.30%	7.36%	0.945	1.49%	18.93%

Dividend Yield - Return vs Risk over 13 years



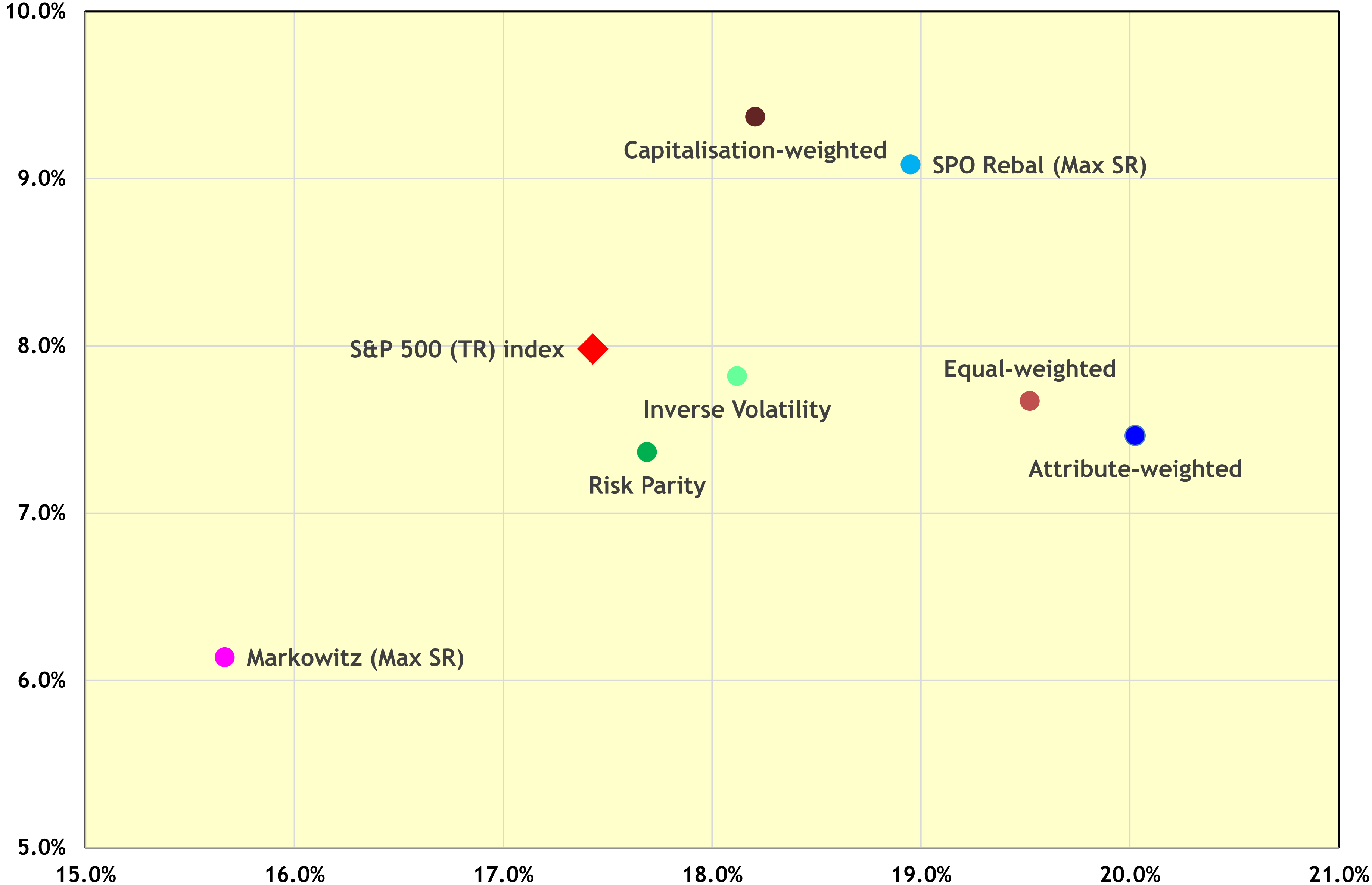
Growth Portfolio results - 1

	GROWTH	Average number of holdings	Annual Turnover	Average Annual Costs	Annualised Return after costs	Annualised Risk after costs	Return / Risk Ratio
AW	Attribute-weighted	101	209.0%	-0.91%	7.46%	20.03%	0.373
CW	Capitalisation-weighted	101	174.8%	-0.81%	9.37%	18.21%	0.515
EW	Equal-weighted	101	195.8%	-0.87%	7.67%	19.52%	0.393
IV	Inverse Volatility	101	204.6%	-0.90%	7.82%	18.12%	0.432
RP	Risk Parity	101	204.3%	-0.90%	7.37%	17.69%	0.416
MK	Markowitz (Max SR)	25.5	251.4%	-1.04%	6.14%	15.67%	0.392
SPO	SPO Rebal (Max SR)	24.0	108.5%	-0.59%	9.08%	18.95%	0.479
S&P	S&P 500 (TR) index	500			7.98%	17.43%	0.458
	AVERAGES (excluding S&P 500)		192.6%	-0.86%	7.84%	18.31%	0.428

Growth Portfolio results - 2

	GROWTH	Beta to S&P 500 (TR)	Annualised Alpha	Annualised Tracking Error	Average Growth beta	Growth Return	As % of Total Return
AW	Attribute-weighted	1.109	-1.39%	5.59%	0.633	-1.02%	-12.36%
CW	Capitalisation-weighted	1.009	1.32%	4.72%	0.605	-0.90%	-8.88%
EW	Equal-weighted	1.089	-1.02%	4.81%	0.523	-0.80%	-9.47%
IV	Inverse Volatility	1.015	-0.28%	3.94%	0.496	-0.73%	-8.54%
RP	Risk Parity	0.989	-0.53%	4.01%	0.508	-0.78%	-9.55%
MK	Markowitz (Max SR)	0.829	-0.48%	6.76%	0.695	-1.12%	-15.69%
SPO	SPO Rebal (Max SR)	0.989	1.19%	7.87%	0.765	-1.21%	-12.44%
S&P	S&P 500 (TR) index	1.000	0.00%	0.00%	0.124	-0.19%	-2.41%
	AVERAGES (excluding S&P	1.004	-0.17%	5.39%	0.577	-0.89%	-10.75%

Growth Summary - Return vs Risk over 13 years

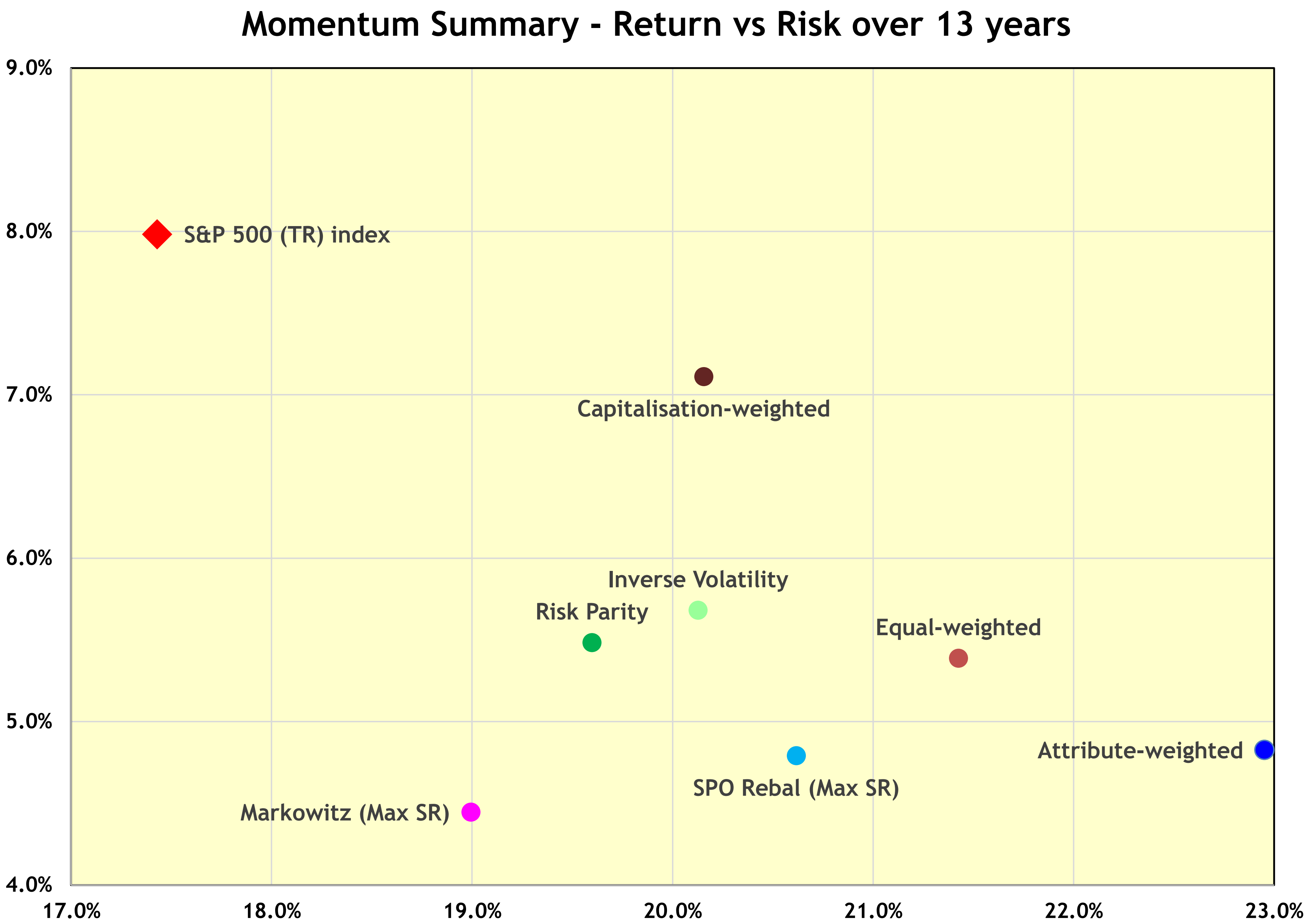


Momentum Portfolio results - 1

	Momentum	Average number of holdings	Annual Turnover	Average Annual Costs	Annualised Return after costs	Annualised Risk after costs	Return/Risk Ratio
AW	Attribute-weighted	101	300.4%	-1.18%	4.83%	22.95%	0.210
CW	Capitalisation-weighted	101	295.7%	-1.17%	7.11%	20.16%	0.353
EW	Equal-weighted	101	290.1%	-1.15%	5.39%	21.43%	0.251
IV	Inverse Volatility	101	300.1%	-1.18%	5.68%	20.13%	0.282
RP	Risk Parity	101	299.9%	-1.18%	5.48%	19.60%	0.280
MK	Markowitz (Max SR)	25.7	337.9%	-1.30%	4.45%	18.99%	0.234
SPO	SPO Rebal (Max SR)	25.8	242.7%	-1.01%	4.79%	20.62%	0.232
S&P	S&P 500 (TR) index	500			7.98%	17.43%	0.458
	AVERAGES (excluding S&P 500)		295.2%	-1.17%	5.39%	20.55%	0.263

Momentum Portfolio results - 2

	Momentum	Beta to S&P 500 (TR)	Annualised Alpha	Annualised Tracking Error	Average Momentum beta	Momentum Return	As % of Total Return
AW	Attribute-weighted	1.224	-4.95%	9.31%	0.491	0.30%	5.32%
CW	Capitalisation-weighted	1.087	-1.56%	7.05%	0.395	0.34%	4.14%
EW	Equal-weighted	1.163	-3.89%	7.52%	0.376	0.28%	4.45%
IV	Inverse Volatility	1.092	-3.04%	6.75%	0.355	0.35%	5.18%
RP	Risk Parity	1.063	-3.00%	6.49%	0.364	0.37%	5.64%
MK	Markowitz (Max SR)	0.962	-3.23%	8.95%	0.574	0.75%	13.64%
SPO	SPO Rebal (Max SR)	1.051	-3.60%	9.51%	0.553	0.48%	8.53%
S&P	S&P 500 (TR) index	1.000	0.00%	0.00%	0.077	0.25%	3.29%
	AVERAGES (excluding S&	1.092	-3.33%	7.94%	0.426	0.40%	6.40%


Momentum Summary - Return vs Risk over 13 years
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
17.0%
18.0%
19.0%
20.0%
21.0%
22.0%
23.0%
S&P 500 (TR) index
Capitalisation-weighted
Inverse Volatility
Risk Parity
Equal-weighted
Attribute-weighted
SPO Rebal (Max SR)
Markowitz (Max SR)

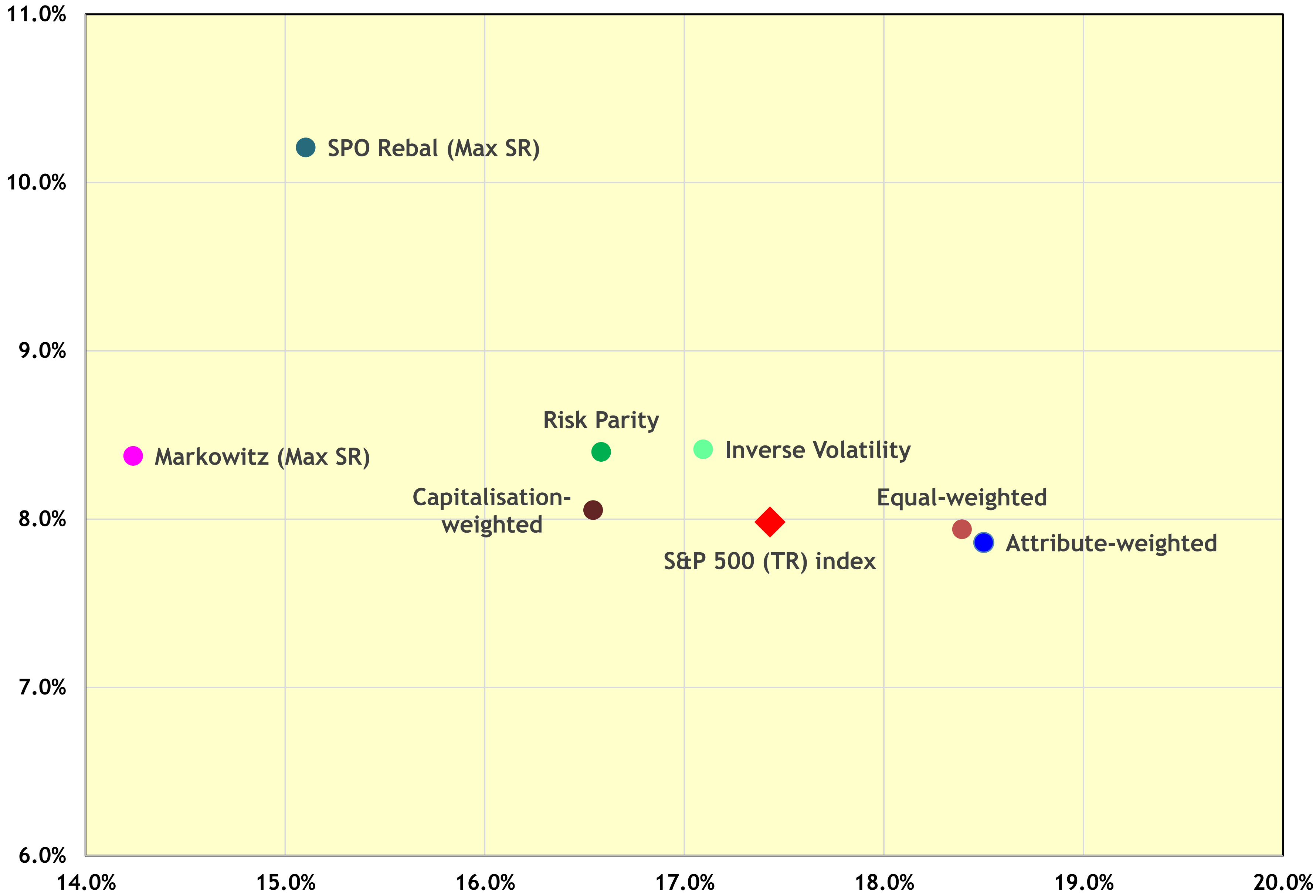
Quality Portfolio results - 1

	Quality	Average number of holdings	Annual Turnover	Average Annual Costs	Annualised Return after costs	Annualised Risk after costs	Return/Risk Ratio
AW	Attribute-weighted	101	136.8%	-0.69%	7.86%	18.50%	0.425
CW	Capitalisation-weighted	101	115.8%	-0.63%	8.05%	16.54%	0.487
EW	Equal-weighted	101	133.3%	-0.68%	7.94%	18.39%	0.432
IV	Inverse Volatility	101	133.3%	-0.68%	8.41%	17.10%	0.492
RP	Risk Parity	101	137.5%	-0.70%	8.40%	16.58%	0.506
MK	Markowitz (Max SR)	25.6	165.2%	-0.78%	8.37%	14.24%	0.588
SPO	SPO Rebal (Max SR)	30.6	87.3%	-0.55%	10.21%	15.10%	0.676
S&P	S&P 500 (TR) index	500			7.98%	17.43%	0.458
	AVERAGES (excluding S&P 500)		129.9%	-0.67%	8.46%	16.64%	0.515

Quality Portfolio results - 2

	Quality	Beta to S&P 500 (TR)	Annualised Alpha	Annualised Tracking Error	Average Quality beta	Quality Return	As % of Total Return
AW	Attribute-weighted	1.030	-0.37%	4.47%	0.777	2.43%	28.75%
CW	Capitalisation-weighted	0.908	0.81%	5.09%	0.727	2.23%	25.51%
EW	Equal-weighted	1.027	-0.26%	4.22%	0.697	2.14%	25.18%
IV	Inverse Volatility	0.958	0.77%	3.73%	0.692	2.12%	23.56%
RP	Risk Parity	0.926	1.01%	4.02%	0.695	2.13%	23.61%
MK	Markowitz (Max SR)	0.733	2.52%	7.80%	0.907	2.84%	31.20%
SPO	SPO Rebal (Max SR)	0.798	3.83%	6.84%	0.889	2.68%	25.00%
S&P	S&P 500 (TR) index	1.000	0.00%	0.00%	0.258	0.72%	9.27%
	AVERAGES (excluding S&P	0.912	1.19%	5.17%	0.749	2.32%	26.30%

Quality Summary - Return vs Risk over 13 years



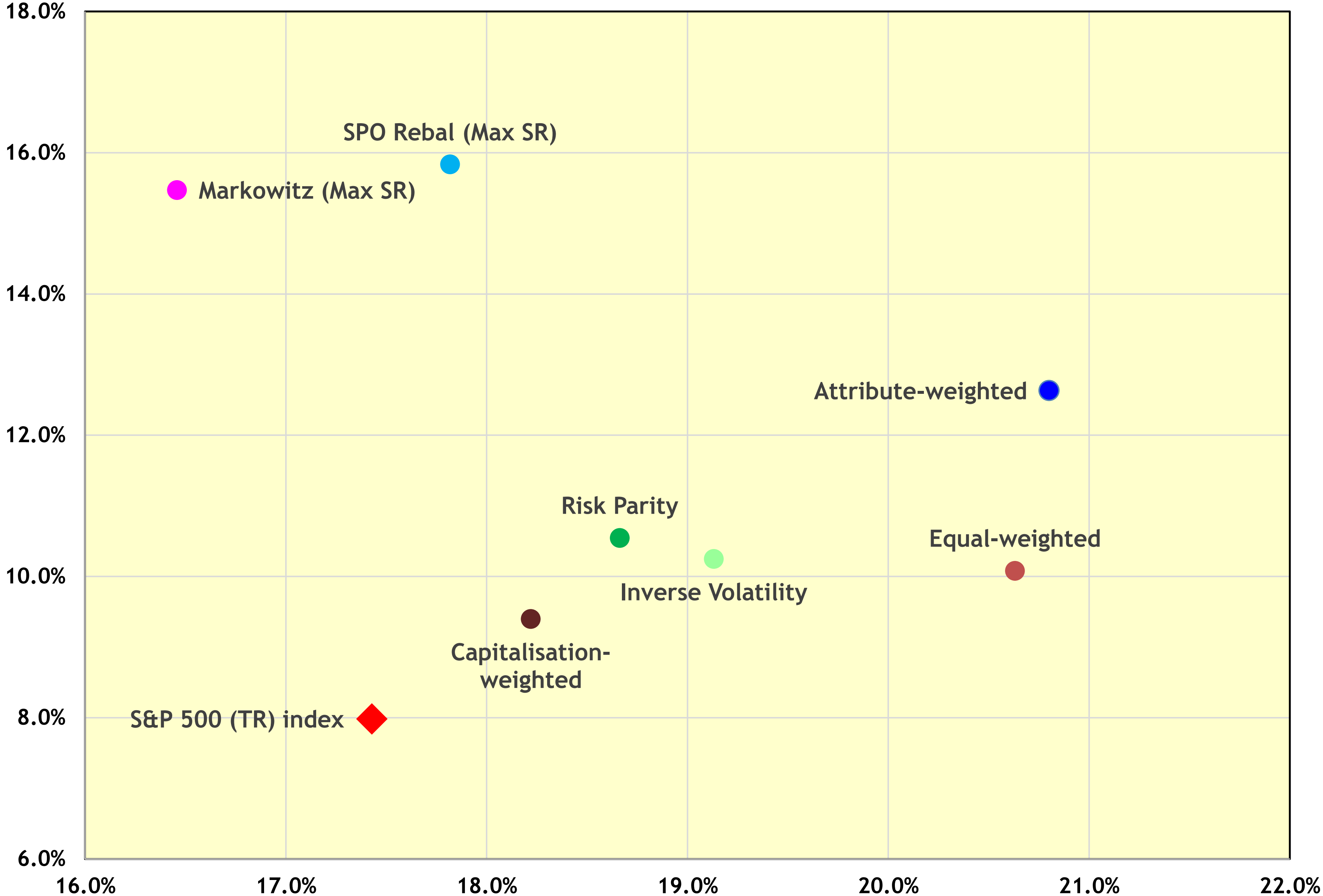
Value Portfolio results - 1

	Value	Average number of holdings	Annual Turnover	Average Annual Costs	Annualised Return after costs	Annualised Risk after costs	Return/Risk Ratio
AW	Attribute-weighted	101	149.0%	-0.73%	12.63%	20.80%	0.607
CW	Capitalisation-weighted	101	118.1%	-0.64%	9.40%	18.22%	0.516
EW	Equal-weighted	101	142.0%	-0.71%	10.08%	20.63%	0.489
IV	Inverse Volatility	101	135.9%	-0.69%	10.25%	19.13%	0.536
RP	Risk Parity	101	141.8%	-0.71%	10.54%	18.66%	0.565
MK	Markowitz (Max SR)	24.3	145.1%	-0.72%	15.47%	16.46%	0.940
SPO	SPO Rebal (Max SR)	29.5	73.1%	-0.48%	15.83%	17.82%	0.889
S&P	S&P 500 (TR) index	500			7.98%	17.43%	0.458
	AVERAGES (excluding S&P 500)		129.3%	-0.67%	12.03%	18.82%	0.649

Value Portfolio results - 2

	Value	Beta to S&P 500 (TR)	Annualised Alpha	Annualised Tracking Error	Average Value beta	Value Return	As % of Return after costs
AW	Attribute-weighted	1.147	3.47%	6.29%	1.076	5.46%	41.38%
CW	Capitalisation-weighted	1.017	1.28%	4.20%	0.549	2.85%	28.58%
EW	Equal-weighted	1.151	0.89%	5.50%	0.592	3.06%	28.75%
IV	Inverse Volatility	1.071	1.70%	4.38%	0.604	3.15%	39.11%
RP	Risk Parity	1.043	2.22%	4.32%	0.598	3.10%	27.83%
MK	Markowitz (Max SR)	0.880	8.45%	6.35%	1.288	6.68%	41.64%
SPO	SPO Rebal (Max SR)	0.954	8.22%	6.46%	1.227	6.34%	39.11%
S&P	S&P 500 (TR) index	1.000	0.00%	0.00%	0.058	0.34%	4.40%
	AVERAGES (excluding S8	1.037	3.75%	5.36%	0.785	4.05%	34.55%

Value Summary - Return vs Risk over 13 years



Summary and Conclusion

- It should now be quite clear that the way in which a portfolio is constructed can make a very significant difference to its performance
- In several of these cases, some of the portfolio construction methods generate higher returns than the S&P 500, and others generate lower returns, while some have higher risk and some have lower risk
- In each of these strategy back tests, we are using the same Stock Selection method, the same transaction costs and management fees; this is a controlled experiment in Portfolio Construction methods
- HOWEVER THEY CHOOSE THEIR STOCKS, FUND MANAGERS CAN OUTPERFORM OR UNDERPERFORM THEIR BENCHMARK, DEPENDING ON THEIR PORTFOLIO CONSTRUCTION METHOD
- To make the most obvious point: building more efficient portfolios generally leads to better performance if a manager has any Skill