Scenarios-based portfolio management: from theory to practice

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Hypothetical scenario

March 2020:

⟶ COVID-19 fear and equity markets have fallen by 40%

⟶ But central banks are intervening in markets and providing liquidity and support

⟶ A portfolio manager identifies two possible scenarios for the next 12 months:

1. Equities fall another 20% (30% likelihood)
2. Equities rally 50% (70% likelihood)

Incorporating scenarios into portfolio construction

How can insight into market scenarios be efficiently incorporated into portfolio management decisions?

1. We explore how academic research techniques address this problem
2. We consider the practical challenges regarding industry application

Relevant literature

1. Single-period mean-variance efficient portfolio construction

⟶ Markowitz (1952), Tobin (1958), Sharpe (1963)

2. Multi-period utility maximization

   a. Terminal wealth: Balduzzi and Lynch (1999), Johannes et al. (2014)

   b. Lifetime income: Samuelson (1969), Merton (1969), Viceira and Campbell (2001)

Relevant literature

3. Regime-switching

⟶ Honda (2003), Graflund and Nilsson (2003), Guidolin and Timmermann (2007)

4. Parameter uncertainty

⟶ Barberis (2000), Hoevenaars et al (2014)

5. Robust portfolio construction

⟶ Peijnenburg (2011)

Analysis

Explore the effectiveness of different approaches to acknowledging scenarios.

Problem setting:

⟶Seek to maximise utility of terminal wealth assuming CRRA preferences (A_R = 5)

⟶Institutional constraints: no leverage or net short positioning

⟶Two assets, each with normal i.i.d. returns

	'Bad' Scenario		'Good' Scenario	
	Exp. Return	Volatility	Exp. Return	Volatility
Cash	0%	0%	0%	0%
Stocks	-20%	18%	40%	18%

Maximising utility

Detail objective function

$$U(W_T) = \frac{W_T^{1-A_R}}{(1 - A_R)}$$

Solution technique:

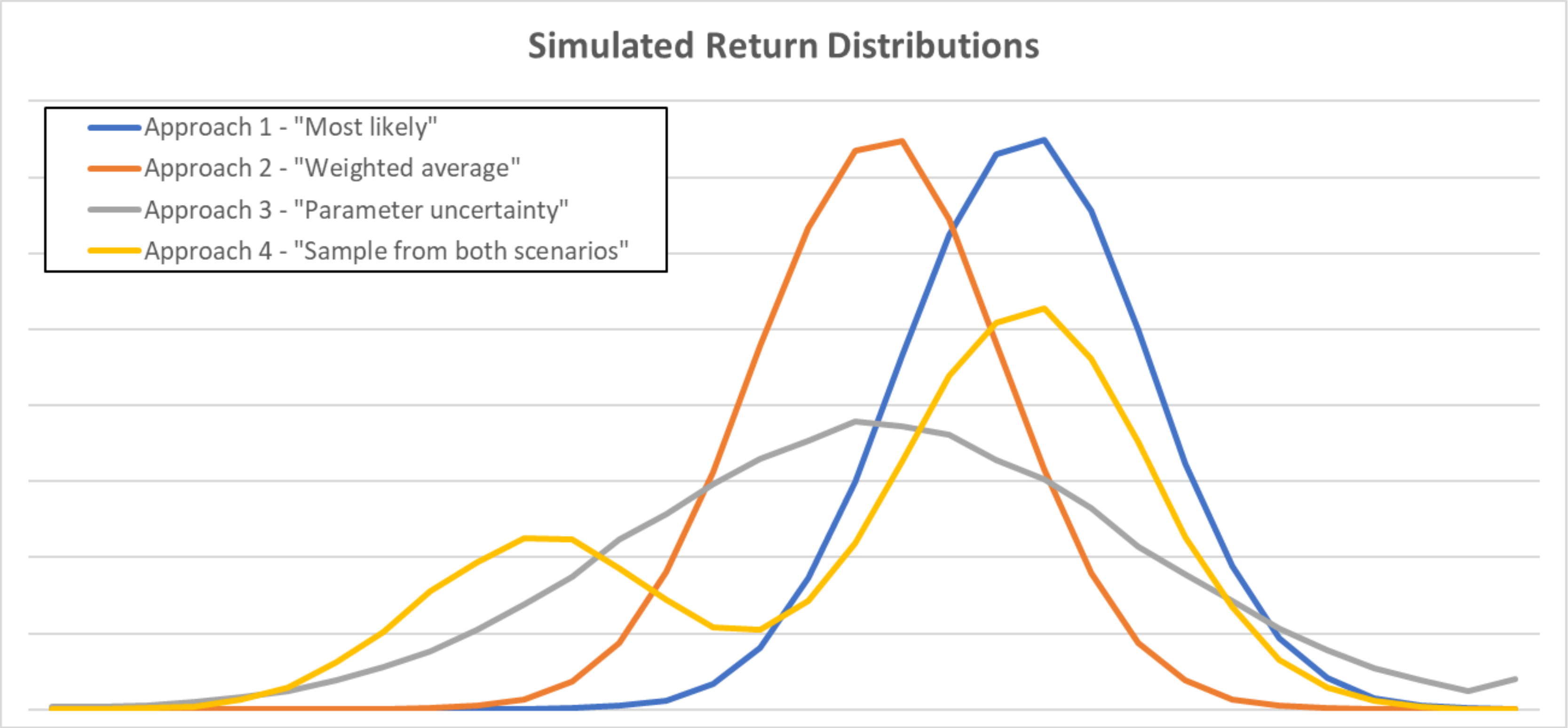
- Determine distribution to be sampled from
- Sample from this distribution to approximate the distribution of outcomes
- Consider different weights and compare which one maximises expected utility

Alternative portfolio construction approaches

Four alternative portfolio construction approaches

	Approach 1	Approach 2	Approach 3	Approach 4
Description	Use the most likely scenario	Take a mean of the expectations	Account for parameter uncertainty in expected returns	Sample from both distributions
Mean	50%	29%	29% (p/u: 32.1%)	N/A
Volatility	18%	18%	18%	N/A

Simulated distributions



Sample summary statistics

Comparison of sample summary statistics

	Approach 1	Approach 2	Approach 3	Approach 4
Description	Use the most likely scenario	Take a mean of the expectations	Account for parameter uncertainty in expected returns	Sample from both distributions
Mean	50%	29%	29% (p/u: 32.1%)	N/A
Volatility	18%	18%	18%	N/A
Mean (sampled)	50%	29%	29%	29%
Volatility (sampled)	18%	18%	36.8%	36.8%

Optimal allocations

Optimal allocations

	Approach 1	Approach 2	Approach 3	Approach 4
Description	Use the most likely scenario	Take a mean of the expectations	Account for parameter uncertainty in expected returns	Sample from both distributions
Optimal allocation	100%	100%	42.5%	40%

Efficiency assessment

We use CEW (certainty equivalent wealth) to compare outcomes.

	Approach 1	Approach 2	Approach 3	Approach 4
Description	Use the most likely scenario	Take a mean of the expectations	Account for parameter uncertainty in expected returns	Sample from both distributions
CEW	-80.8%	-80.8%	-0.04%	N/A

Discussion of results

⟶Ignoring information about expected returns is inefficient (Approach 1)

⟶Ignoring information about the variability in outcomes is inefficient (Approach 1 and Approach 2)

⟶In this case, using parameter uncertainty appears a reasonable proxy to sampling from both distributions

⟶Sampling from both distributions is most efficient (if applying a sampling-based solution technique)

In practice

⟶It appears intuitive to make full use of scenario-based information when constructing portfolios

⟶In practice there are a range of challenges:

1. Large universe of assets
2. Potentially more than two scenarios
3. Correlation structure required (and possibly correlation scenarios)
4. Parametrisation challenges – need to derive well-formed parameters for each asset / scenario combination
5. Computational challenges – curse of dimensionality

In practice

⟶Nonetheless, some interesting reflections:

- ⟶Use scenarios, where available, to sense-check parameter estimates
- ⟶Acknowledge that there can be great uncertainty in estimates of expected return

Conclusion

- ⟶The academic literature has considered techniques for accommodating scenario-based views on assets
- ⟶Ignoring the uncertainty created by divergent scenarios can generate significant utility cost
- ⟶In practice there are many factors which make a pure scenarios-based approach difficult
- ⟶But there is the possibility to integrate some of the academic techniques into industry practice