Testing times part 2

In a follow-up to his article in the October 2016 edition of the *STEP Journal*, **Quintin Rayer** discusses the pros and cons of different types of portfolio stress test

KEY POINTS

WHAT IS THE ISSUE?

Stress tests can help to assess the adverse impacts of extreme market moves on portfolios. Different types of stress test have advantages and disadvantages that make them more (or less) appropriate for addressing specific concerns.

WHAT DOES IT MEAN FOR ME?

Appreciating different stress-testing approaches helps you critically appraise proposed test suitability, helping ensure robust outcomes when determining the impact on portfolios and any resulting restructuring.

WHAT CAN I TAKE AWAY?

Protecting portfolios from adverse consequences of extreme events is possible, and, in the process, you will have made an active contribution to fulfilling your fiduciary duties.

Accurately assessing portfolio risks is difficult. Conventional risk measures generally do not fully capture all risks inherent in a portfolio, particularly under difficult market conditions. For these conditions, a trustee (or other individuals responsible for portfolio oversight) may wish to consider stress testing a portfolio against significant historical market events, or against some invented scenario that reflects their particular concerns.

A previous article for the *STEP Journal*[1] outlined how portfolio stress testing helps to identify and quantify portfolio risks, and how it can reassure trustees regarding the ways in which their portfolio might respond to specific market outcomes or other concerns. The article also noted that, while stress testing identifies potential problems, it does not resolve them. It discussed the implementation of portfolio stress tests and the contributions that trustees, portfolio managers and advisors can make.

Classification of stress tests can be difficult, as there is a range of approaches, but can be helpful for framing discussion.[1,2] A key distinction is between historical and artificial stress tests; there is a range of techniques for each. Historical tests can include 'historical value at risk' and 'event periods', while artificial tests include 'hypothetical' and 'algorithmic' stress tests, as well as other approaches. Historical events may suggest ideas, although practitioners can freely imagine any damaging situation and attempt to quantify its portfolio impact. Indeed, any potential set of market events that might keep one awake at night could be regarded as a starting point for a stress test. The table on page 69 outlines some main types of stress test, together with advantages and disadvantages.

HISTORICAL v ARTIFICIAL STRESS TESTING

Historical scenarios replicate previous market events, while artificial scenarios are invented to capture some particular concern. For example, as the UK's Brexit negotiations and EU exit approach, a further sterling devaluation might be feared. A scenario might follow the devaluation seen following the Brexit referendum, making it a historical scenario. Alternatively, if one were concerned about the impacts of loss of access to the EU trade zone, regulations, market confidence or other unique Brexit factors, an artificial scenario would result, since Brexit has no historical precedent.

Historical stress testing provides credibility: assets actually behaved as captured by the scenario. However, market changes since the scenario period (perhaps regulatory, or other, changes) may mean such responses are no longer possible. Historical events can also be 'messy'; numerous knock-on effects and proxy shocks make it difficult to isolate the individual aspects relevant to the portfolio.

A concern with artificial stress tests is whether the proposed scenario is actually possible or realistic. How can all possible responses, direct and indirect, affecting portfolio assets be included? But artificial stress tests can attempt to include the impacts of new market developments (perhaps regulations), new currencies and so on. They can also isolate specific portfolio concerns.

HISTORICAL STRESS TESTING

Historical scenarios comprise a period with defined start and end dates spanning an interval when the portfolio (or its assets) performed poorly. The period's asset price movements are applied to the portfolio to see how it would respond.

'A concern with an artificial stress test is whether it is actually possible or realistic'

Approaches include 'value at risk' (VaR) and 'event period' tests.

Portfolio managers frequently use the VaR measure, estimating potential losses and likelihoods over specific timescales from return distributions. VaR may assume Gaussian-shaped returns distributions.[3] This may be inadequate during stressed periods, making a technique known as 'historical VaR' more appropriate.

Historical VaR uses actual historical returns, usually over a certain period to date. Historical VaR stress tests incorporate returns from a different historic period to see how these affect the result. Suppose returns from January 2014 to December 2016 were used. If a period in 2008 caused concerns, one would include these returns and recalculate the result. Criticisms include: using an arbitrarily shaped distribution, loss of returns path dependency, and historical events not being a guide to the future.

Historical event-period stress tests require well-defined start and end dates for a crisis, which may be less obvious than at first sight. For a single index, peaks and troughs can be identified. But, across markets, historical events may evolve over extended periods with market linkages and feedback. In portfolios, a significant decline in one asset's value may occur while another rises. The second asset may collapse, but while the first is recovering.

There are two approaches: either select fixed dates and allow the rise in one asset to reduce the impact of the other's decline, or 'break the timeline' and apply the maximum declines in each as though they occurred simultaneously. Preserving the timeline, with the uplift from one asset offsetting the fall from another, makes better economic sense, but is a less demanding stress test. Breaking the timeline with simultaneous price falls makes little economic sense, but is more demanding.

ARTIFICIAL STRESS TESTING

Artificial stress tests can explore the robustness of asset diversification or liquidity events, or shock specific risk

Approach	Summary	Description	Advantages	Disadvantages
Historical	• Replay crisis event	Re-enactment of significant historical market event	• It actually occurred, so it must be reasonable	• May be proxy shocks • No probabilistic interpretation • Not necessarily 'worst case'
Hypothetical	• Test diversification • Create event • Sensitivity analysis	Test diversification. Specify hypothetical shocks for chosen factors. Define liquidity events. Isolate factors	• Relatively easy • Very flexible • Can be detailed	• Empirical support mixed • Limited risk information • Not necessarily 'worst case'
Algorithmic	• Factor push • Maximum loss	Systematically identify worst outcomes within defined envelope. Push risk factors in direction resulting in losses. Identify changes in risk factors that cause greatest loss	• Minimal qualitative judgment • Targets 'worst case' outcome	• Still cannot guarantee 'worst case' • Ignores diversification • Assumes business-as-usual data

factors. Portfolio managers select decorrelated assets to achieve diversification. Intuitively, correlations often increase during market crises, so stress testing diversification involves increasing selected correlations. Values of selected correlations can be increased using 'covariance matrix' stress testing, generally increasing some correlations while leaving others unchanged.

The magnitudes of correlation changes may be guided by analysing correlation variability, or else reflect specific concerns. The impact of increased correlations (reduced diversification) can be quantified by portfolio risk measures, such as volatility or VaR. However, mathematically, correlations cannot be changed arbitrarily. For example, say Chinese, UK and US equities have low correlations between all three. Suppose a test isolates US-UK and UK-China correlations, increasing them significantly; this should imply higher US-China correlations. Consequently, such stress tests can be mathematically intensive,[4] with various techniques available, each with pros and cons.

Hypothetical created-event stress tests use invented scenarios, so the practitioner has significant freedom to choose factors to 'shock' the portfolio with. A weakness is the difficulty of inventing economically meaningful scenarios. An envelope approach[5] can help promote consistency and inclusion of important factors. Stress factors are identified and, for each, the worst possible shock determined. A range of scenarios can be created based on envelope values. Generally, not all factors will be used in any single scenario, and the shock magnitude for factors selected will be somewhat lower than envelope maximums. Multiple stressed scenarios can reflect differing concerns. However, this does not ensure economically consistent individual scenarios are created, resulting in no guarantee that the scenarios are realistic, possible or sufficiently extreme. Portfolio diversification is also ignored. The advantage is flexibility to assess impacts of any imagined scenario, including changes to regulations, new market developments, geopolitics and so forth, giving an opportunity to add real value.

IMPLEMENTATION

My previous article for the *STEP Journal* gave more detail on stress-test implementation. In practice, trustees are likely to require professional advice on implementation, although some online training is available.[6] Broadly, once stress-test results are known, trustees and portfolio managers can consider the outcomes against trust and portfolio objectives. Sometimes, an identified scenario has little impact, giving trustees reassurance that perhaps the event is of less concern than they feared. However, if the stress test suggests that the scenario may adversely impact the portfolio to an unacceptable level, discussions can follow on how to restructure and reposition the portfolio to make it more resilient against the possible events considered.

By following an ongoing programme of stress testing during portfolio review and oversight, with scenarios, methods and outcomes documented, it will be clear that trustees are actively working to protect portfolio assets against extreme market events. Such a programme would help demonstrate that trustees are seriously considering their fiduciary responsibilities.

1 Quintin Rayer, 'Testing Times', *STEP Journal*, Vol 24 Iss 8 (October 2016), pp62–63
2 Quintin Rayer, 'Dissecting Portfolio Stress-testing', *Review of Financial Markets*, Vol 7, Chartered Institute for Securities & Investment (2015), pp2–7,
3 Also known as the normal distribution, and sometimes informally as the 'bell curve'. Naturally occurring data may often approximately follow a normal distribution (e.g. population heights and weights). Under certain conditions, the sums of random events can approximate to a normal distribution, making it widely used in statistics, economics, and natural and social sciences
4 Quintin Rayer, 'An Investigation of Hypothetical Variance-Covariance Matrix Stress-testing', *Journal of Risk Management in Financial Institutions*, Vol 9 No 3 (Summer 2016), pp264–288
5 Michel Crouhy, Dan Galai and Robert Mark, *The Essentials of Risk Management*, 2nd ed, New York: McGraw-Hill Education (2014)
6 Advisors/consultants: www.p1-im.co.uk, www.fortgreyconsulting.com; online training: www.fortgreyconsulting.com/training

DR QUINTIN RAYER IS A CHARTERED FELLOW OF THE CISI AND A CHARTERED WEALTH MANAGER, PREVIOUSLY AT LYN FINANCIAL SERVICES