DISSECTING PORTFOLIO STRESS-TESTING

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ABSTRACT

Attempting to put meaningful numbers to portfolio risks is always challenging. Conventional risk measures are often considered not to fully capture all risks inherent in a portfolio, particularly under difficult market conditions. Under such conditions, stress-testing against significant historical market events, or using invented scenarios may help identify and quantify risks within a portfolio. Stress tests also help reassure a portfolio or risk manager as to how a portfolio might respond to specific market outcomes or other concerns.

This paper introduces stress-testing a portfolio of conventional assets against market risks using historical and artificial scenarios. It includes a definition of stress-testing and a classification to aid ongoing discussions, as well as thoughts on practical implementation. Four stress-testing methodologies are explored: two 'historical' stress tests and two 'hypothetical' stress tests. Examples illustrate key concepts, drawing out strengths and weaknesses of the stress tests, which are then discussed with recommendations.

INTRODUCTION

Portfolio stress-testing may be used when attempting to identify and quantify risks that are not particularly well captured by more conventional measures, particularly relating to the impact on a portfolio of difficult market conditions. This paper discusses portfolio stress-testing using historical and artificial scenarios, after commencing with a definition and classification of stress-testing methods. Four approaches are explored, two historical and two hypothetical stress tests. Examples are included and the advantages and disadvantages discussed.

DEFINITION OF PORTFOLIO STRESS-TESTING

Portfolio managers associate a number of activities with stress-testing, including looking at the potential downside risk of portfolios, or methods to see what response might be expected under difficult ('stressed') conditions. Although stress-testing cannot be guaranteed to identify actual impacts on a portfolio of future events, it is another tool in the portfolio or risk manager's armoury. Stress tests are designed to determine how a portfolio might respond to adverse developments, so that weak spots can be detected early and preventative action taken, typically focusing on key risks such as market risk, credit risk and liquidity risk[1].

Consider the following definition of portfolio stress-testing [1]:

- A method of the *quantification of potential future extreme, adverse* outcomes in a portfolio of financial instruments.
- A *palliative* for the anxiety that is experienced by managers with significant risk exposures.

This definition highlights some key points. Quantitative estimates of stress test outcomes are required, in monetary terms, but stress tests do not necessarily provide statistical estimates of outcome likelihoods. The scenarios indicate potential future outcomes under extreme conditions; a scenario is not a stress test unless the outcome is *adverse*[2]. Portfolio investment scenarios that do not anticipate adverse outcomes are not stress tests. For an example see [2].

Stress-testing only identifies potential problems, without resolving them. Thus stress-testing may be palliative (reducing pain but not offering a cure) by reassuring a practitioner if no outstanding issues are detected, but leaving unresolved questions as to what to do about problems that have been identified, or even whether the selected stressed scenarios are sufficient to identify all key portfolio weaknesses.

CLASSIFICATION OF PORTFOLIO STRESS-TESTING

Stress-testing covers a wide range of methodologies, and various terms are used in the literature rather loosely [3], thus a full classification may be difficult. The classification below frames the current discussion and may help other practitioners. Often historical events provide a source of stressed conditions; however, practitioners are free to imagine any damaging situation and attempt to quantify its portfolio impact[3]. A key distinction is between historical scenarios (re-enactments of particular market events with a defined start and end date) and artificial scenarios (invented to capture a particular concern and often involving assumptions), see Figure 1. Thereafter, classification divisions may become more judgmental. This classification follows aspects of [1] by splitting artificial scenarios into hypothetical and algorithmic scenarios. The main types of stress tests are described in Table 1, together with advantages and disadvantages.

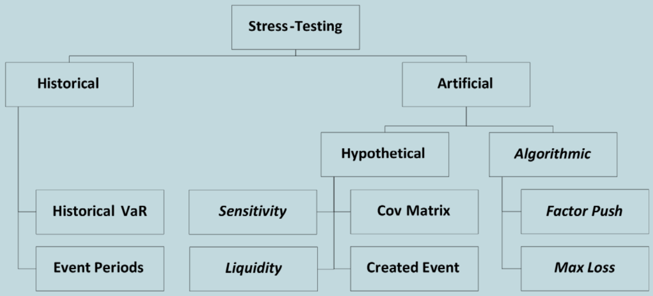

Figure 1: Stress-testing classification. The stress test examples in this paper do not include the italicised types

Historical stress-testing's strength is that assets actually behaved in the way captured by the scenario, adding credibility. Although, if markets have changed since the historical scenario period, perhaps due to regulation changes, or other reasons, such response may no longer be possible. Also, historical events can be 'messy'; numerous knock-on effects and proxy shocks can make it hard to isolate individual aspects for application to a particular portfolio.

Artificial stress tests raise the question as to whether the proposed scenario is even possible; it can be difficult to make artificial stress tests realistic. How can the designer possibly include all responses, direct and indirect, to portfolio assets? However, artificial stress tests

1. *For definitions of types of risk see [7], [3].*
2. *Should a proposed scenario that is expected to have an adverse outcome turn out actually to have a benign outcome, this would demonstrate that the scenario is of little concern.*
3. *Since many stressed scenarios will be motivated by consideration of past events, those interested in stress-testing might be well advised to take a keen interest in historical market crashes, ranging from the classics ([8], [13], [10], [9]) to more contemporary events [11], [12].*

Approach	Summary	Description	Advantages	Disadvantages
Historical	Replay crisis event	Re-enactment of a particular historical market event of significance. Scenario shocks. It must be reasonable since it actually occurred	• It actually happened that way	• Proxy shocks may be numerous • No probabilistic interpretation • No guarantee of 'worst case'
Hypothetical	• Covariance matrix • Create event • Sensitivity analysis	Modify covariance matrix to reflect higher asset correlations. Specify hypothetical shocks to market factors (often historical events can be a guide). Definition of a systemic liquidity event. Shock specific identified risk factors while neglecting correlation. Explore a mixture	• Relatively easy • Very flexible • Can be detailed	• Empirical support mixed • No guarantee of 'worst case' • Limited risk information
Algorithmic	• Factor push • Maximum loss	Attempt to systematically identify the worst outcome within a defined feasible envelope. Push each risk factor a number of standard deviations in a direction that results in losses. Identify the set of changes in market risk factors that results in the greatest loss	• Minimal qualitative elements • Attempts to identify 'worst case' in feasible set	• No guarantee of 'worst case' • Ignores correlations • Assumes data from normal periods are relevant • Computationally intensive

Table 1: Stress test types with advantages and disadvantages.

can attempt to include the impact of changes (or anticipated changes) on markets, perhaps due to regulatory developments, new currencies and so on. An artificial test can also isolate specific concerns in a portfolio.

IMPLEMENTING PORTFOLIO STRESS-TESTING

Stress-testing tends to be an ad hoc practical activity rather than theoretically based [3]. A balance between art and science is required, with the identification and imagining of dangerous scenarios followed by efforts to examine their impacts on a portfolio. The definition of stress test scenarios requires judgment, even if implementation of the selected scenarios can become more scientific. Selection of scenarios will depend on various assumptions, which should be broadly regarded as 'unlikely but plausible' [3].

The judgmental aspects of defining stressed scenarios means involvement of stakeholders (including portfolio managers) is essential, with unequivocal support by senior management. This will likely be better achieved if stress-testing is an integral part of portfolio management rather than an add-on. Indeed, a portfolio manager's input is likely to be critical in identifying issues of concern, as well as determining the appropriate severity of a stressed scenario, which requires a balance between being challenging but possible. Stress-testing should not be seen as an inconvenience, but as a reassurance to managers of the quality of their investment decisions.

Robust stress-testing may also be seen from a corporate social responsibility perspective. By making investment outcomes more robust, clients should benefit and management reputation should be enhanced.

Implementing stress-testing can be seen as a four-step process [4]:

1. **Risk identification**: historical events or anticipated concerns
2. **Definition of stressed scenarios**: involvement of stakeholders, support of senior management, integration within investment decision-making
3. **Execution of stress-test scenarios**: derivation of portfolio value
4. **Analysis of results**: commentary in periodic reporting.

The definition of stress test scenarios cannot be regarded as a 'once and forever' activity. Existing scenarios should be constantly reviewed, re-evaluated and possibly adjusted to maintain their usefulness, with a policy established to review stressed scenarios periodically to assist in establishing good discipline and to learn from experience[4].

HISTORICAL STRESS-TESTING USING VAR

Historical scenarios comprise a period with defined start and end dates that span an interval when the asset or portfolio of interest performed poorly. The asset price behaviours over the period are applied to the current portfolio to see how it would respond.

Under stressed conditions, parametric Value-at-Risk (VaR) might be inadequate due to the assumption of normally (or log-normally) distributed returns, making historical VaR more appropriate. Historical VaR takes actual period returns over some interval, assigning an equal probability to each [1], so can be seen as a scenario analysis. Further, one could add selected 'stressed period' returns, equally-weighted with the non-stressed returns and recalculate the VaR, thereby creating a stress test with a stressed historical VaR.

4. Indeed, approaches for defining and maintaining a library of stressed scenarios could be seen as a large topic in its own right, which is beyond the scope of the current article.

An example illustrates the process. Suppose for some asset, the 95% historical weekly VaR is calculated over two years to current date (104 weekly returns). The historical VaR calculation comprises sorting returns into ascending order and identifying the 5% lower quantile return. With 104 returns, the 5% limit would be the rank 5.2 lowest return[5]. Suppose a four-week period in 1987 has been identified with a severe impact on the returns of our asset. The four additional weekly returns for the stressed period can be added to the current returns already collected[6]. The new total of 108 weekly returns is re-sorted with the 5% lower quantile being the rank 5.4 lowest return[7]. The resulting value would be the 95% weekly historical stressed VaR under the scenario.

The addition of a small number of stressed-period returns has only slightly altered the 5% lower quantile rank (5.2 to 5.4), but since the stressed period, returns might reasonably be expected to comprise returns lower (or amongst the lowest), compared with the 104 weekly returns to current date. The resulting stressed VaR can be considerably worse.

This identifies some strengths and weaknesses of the historical VaR stress test. Recent returns were blended with a small sample of historical returns from some stressed period that otherwise would have been excluded. Instead of using a distribution of weekly returns over the period two years to current date, we have arbitrarily added a further four weekly returns from some period when the asset performed poorly. In the example, the stressed period was much shorter than the usual period analysed, and thus had little effect on the rank used in the ordered returns to calculate historical VaR. Broadly, if the stressed-period returns are all higher than the non-stressed historical VaR, the stressed VaR will be little different from the non-stressed VaR. Equally, if the stressed-period returns are all rather lower than the non-stressed VaR, then the value of the stressed historical VaR will be largely determined by the stressed-period returns. Naturally, for a longer stressed-period merged with a shorter non-stressed current historical VaR, the result will not be so clear-cut.

Historical VaR uses a fixed period to date. One criticism is that any market event prior to the start of that period will be completely excluded. The above adjusts the historical VaR to include the impact of a selected crisis period that would otherwise lie outside the VaR window, addressing this criticism. Additionally, the historical VaR uses actual returns, and therefore has a return distribution of arbitrary shape[8]. By adding crisis period returns, which would likely lie deep in the negative tail of the distribution, it is probable that the resulting distribution would be more negatively skewed than otherwise, which would seem desirable for a stressed VaR analysis. However, this analysis has not replicated the entire returns distribution for the stressed period. Also, by using the distribution quantile, no path-dependency has been included and no underlying economic analysis has been conducted.

HISTORICAL STRESS-TESTING USING EVENT PERIODS

Here, a different process is used to apply the asset price behaviours from a historical period of poor performance to the current portfolio. For an individual market index, a crisis period might seem well-defined, however, in reality, historical scenarios may play out over extended periods due to market linkages and feedback. For a portfolio of varied instruments, defining a start and end date may be harder. This is illustrated in Figure 2, with two approaches identified.

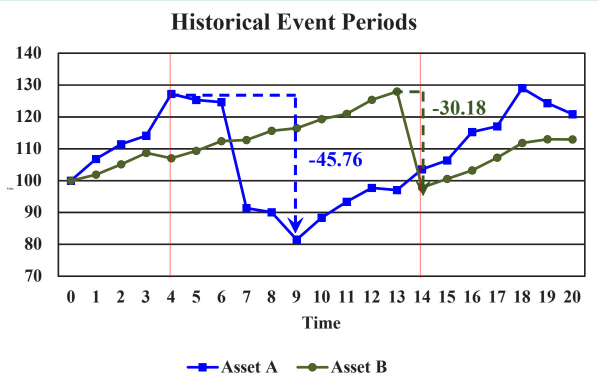

Figure 2(a): The price histories of two assets are shown, Asset A and Asset B. The historical scenario lies between the two vertical lines from time periods 4–14. Asset A has a maximum value of 127.21 and a minimum of 81.45, resulting in a peak-to-trough fall of -45.76. Asset B has a maximum of 127.99 and a minimum of 97.81 with a peak-to-trough fall of -30.18.

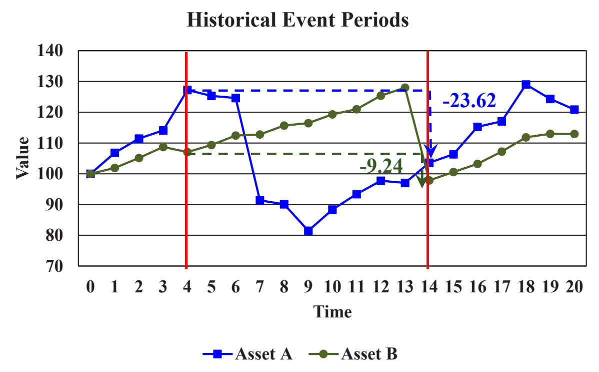

Figure 2(b): Price histories of Assets A and B. At the start of the scenario period, Asset A has a value of 127.21, with a value of 103.59 at the end. Over the period, Asset A declines by -23.62. Asset B starts at 107.05 and ends at 97.81, so declines by -9.24 over the period.

The two key approaches [1] are either to apply maximum peak-to-trough movements in asset prices simultaneously (Figure 2a), in which case falls of 45.75 in Asset A and 30.18 in Asset B are used as occurring at the same time, or else to use actual movements over the full period (Figure 2b), resulting in falls of 23.62 in Asset A and 9.24 in Asset B. In the case of Figure 2(b), the recovery in A reduces the impact, as does the initial increase in B.

The simultaneous use of peak-to-trough movements captures the largest moves in each asset, but ignores any delay between them. Putting these shocks together may not make economic sense. Alternatively, using the movements over the entire period may be weaker if we have difficulty defining the event window. The positive price movements in both A and B during part of the event window have decreased the magnitudes, making the resulting stress test less demanding. However, retaining the relative time behaviours of the assets makes the shocks economically meaningful. On balance, the approach using the actual movements over

5. The fractional rank being obtained, by linear interpolation, say, as a weighted sum of 0.8 of the 5th worst weekly return and 0.2 of the 6th worst weekly return.
6. The stressed period returns would be expected to lie in a time period not included in the usual non-stressed historical VaR calculation.
7. Again, linear interpolation could be used to obtain the fractional rank return as a weighted sum of 0.6 of the 5th worst weekly return and 0.4 of the 6th worst weekly return.
8. No assumption of normally or log-normally distributed returns.

the entire period is probably preferred, since it results in a more plausible scenario, although it may remain more vulnerable to correct identification of suitable start and end dates and neglect impacts within the window.

HYPOTHETICAL STRESS-TESTING USING THE VARIANCE-COVARIANCE MATRIX

Volatility and VaR are often used to quantify risk, with de-correlated assets to achieve diversification, thus reducing a portfolio's volatility and parametric VaR. Accepting the intuition that correlations often increase during market crashes[9], to stress-test diversification we may increase correlations to quantify the impact this would have on portfolio volatility and VaR.

For a multi-asset portfolio, we construct $n \times n$ volatility matrix **v** with the volatilities of the *n* assets down the leading diagonal. Using correlation matrix **R**, we obtain the variance-covariance matrix **S=vRv**. The asset weight vector $\vec{w}$ gives the portfolio variance $\vec{w}^{\top}\mathbf{S}\vec{w}=\sigma^2$, and portfolio parametric $VaR_{\%} = \left|-N\sigma\delta t^{1/2}\right|$, where *N* is the number of standard deviations for the confidence level we require. We can increase both individual asset volatilities and correlations to reflect some stressed scenario.

Consider a four-asset portfolio, with assets A–D, weights $w_A=0.25$, $w_B=0.40$, $w_C=0.30$, $w_D=0.05$ and annual volatilities $\sigma_A=9.78\%$, $\sigma_B=3.76\%$, $\sigma_C=11.17\%$, $\sigma_D=14.84\%$. Now suppose a non-stressed correlation matrix:

$$\boldsymbol{R} = \begin{bmatrix} 1 & -0.21 & 0.87 & 0.59 \\ -0.21 & 1 & -0.16 & 0.05 \\ 0.87 & -0.16 & 1 & 0.73 \\ 0.59 & 0.05 & 0.73 & 1 \end{bmatrix}$$

This leads to a portfolio volatility of 6.08%pa, and a 95% monthly parametric VaR of 2.89%[10].

Now stress-test by increasing the volatilities to $\sigma'_A=14\%$, $\sigma'_B=5\%$, $\sigma'_C=16\%$, $\sigma'_D=23\%$ and correlations to:

$$\boldsymbol{R}' = \begin{bmatrix} 1 & 0 & 0.91 & 0.79 \\ 0 & 1 & 0.17 & 0.16 \\ 0.91 & 0.17 & 1 & 0.87 \\ 0.79 & 0.16 & 0.87 & 1 \end{bmatrix}$$

We obtain a stressed portfolio volatility of 9.55%pa and stressed 95% monthly parametric VaR of 4.54%. In fact, common practice would suggest applying a multiplier of 4 to the portfolio volatility [1], increasing the VaR to 18.14%[11].

However, we are not at liberty to modify the correlation matrix arbitrarily. Some combinations of correlations can result in implausible stressed returns and variance-covariance matrices that are not positive semi-definite, meaning that negative variances can arise. This can be circumvented by taking a correlation matrix from a stressed historical period, but it makes the stress test more like a historical scenario, and may not explore the asset correlations of primary concern. Alternatively, mathematical techniques can be used to construct the correlation matrix appropriately. Two such approaches are discussed here.

If return histories on portfolio assets are available, the correlation matrix can be revised following Finger [1], [5]. Correlations are adjusted by modifying selected return vectors period-by-period, and must be rescaled if the original asset variances are to be unchanged. Consequently, not only are targeted correlations changed, but also other correlations in the same matrix rows and columns. Numpacharoen and Bunwong (N&B) [6] propose an alternative, whereby the correlation matrix is adjusted directly. Cholesky decomposition ensures that a positive semi-definite correlation matrix is obtained, correlations are represented using trigonometrical functions and changes made in correlative angles. This ensures correlations lie within $-1 \le \rho_{ij} \le +1$ and the resulting adjusted correlation matrix has the necessary mathematical properties.

These two approaches are not expected to give the same adjusted correlation matrix, for example [6], with initial and target correlation matrices of:

$$\boldsymbol{R}_{Initial} = \begin{bmatrix} 1 & -0.3 & 0.3 \\ -0.3 & 1 & 0.3 \\ 0.3 & 0.3 & 1 \end{bmatrix}; \hat{\boldsymbol{R}}_{Target} = \begin{bmatrix} 1 & -0.3 & \mathbf{0.85} \\ -0.3 & 1 & 0.3 \\ \mathbf{0.85} & 0.3 & 1 \end{bmatrix}.$$

Adjusted correlation matrices are generated:

$$\hat{\boldsymbol{R}}_{Finger} = \begin{bmatrix} 1 & -0.14 & 0.85 \\ -0.14 & 1 & 0.14 \\ 0.85 & 0.14 & 1 \end{bmatrix} \text{ and } \hat{\boldsymbol{R}}_{N\&B} = \begin{bmatrix} 1 & -0.3 & 0.85 \\ -0.3 & 1 & -0.04 \\ 0.85 & -0.04 & 1 \end{bmatrix}.$$

It is not entirely clear which method should be preferred. Finger's approach has intuitive appeal, since returns are adjusted towards an average to increase correlation. However, a goal-seek algorithm is required and, for a large multi-asset portfolio, a long history of returns has to be adjusted (potentially including rescaling for volatilities), which might become cumbersome. In some cases, a suitable asset return history may not be available. In this case, N&B's approach seems practical, since only the correlation matrix is required, although the mathematical sophistication may discourage some practitioners. Although N&B's method ensures the resulting correlation matrix has the correct properties, there is no guarantee of economic validity. In practical terms, choice between the two methods may be dictated by availability of asset returns for Finger [5], and access to a Cholesky decomposition algorithm (and level of intellectual comfort) for N&B [6].

HYPOTHETICAL STRESS-TESTING USING CREATED EVENTS

A hypothetical created event stress test is an invented scenario which attempts to capture a particular concern. One, several or many factors that may impact the portfolio are selected and deliberately tweaked to assess portfolio response. The practitioner has almost complete freedom in identifying relevant factors to shock, revealing a weakness of the approach, since it can be difficult to create economically meaningful stressed scenarios. An envelope approach can be used [3], which helps ensure a degree of consistency and makes it easier to include important factors, although may not guarantee economic consistency[12].

Figure 3 illustrates the stress-envelope approach. Stress factors are identified and, for each, the worst possible shock determined. Individual scenarios are based on envelope values. Generally, not all of the factors will be used, and the stressed scenario levels chosen will be somewhat lower than the envelope maximums. Multiple stressed scenarios will reflect differing concerns. Nothing in this process ensures the economic consistency of individual scenarios thus created, so there is no guarantee that the scenarios created are realistic, possible or extreme enough.

9. A number of academic studies debate this point, a discussion can be found in [1].
10. N=1.645, δt=1/12, so $VaR_{\%}=|-1.645\times6.08\times\sqrt{(1/12)}|=2.89\%$.
11. Calculated as $VaR_{\%}=|-1.645\times4\times9.55\times\sqrt{(1/12)}|=18.14\%$.
12. In an ideal world, one would have a complete global market model to which shocks could be applied and from which the responses of all portfolio assets could be obtained. Since such a model does not exist, practitioners constructing a hypothetical scenario should try to make it as realistic as they reasonably can.

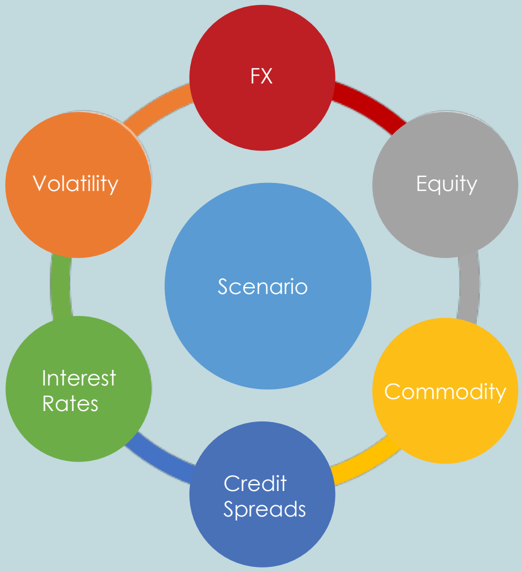

Figure 3: Illustration of stress-envelope

Following [3], an example illustrates the process. Consider an envelope of four factors as follows[13]:

1. European equities fall by 25%
2. World ex-Europe equities fall by 20%
3. A parallel downward shift in the yield curve of 200bp
4. Foreign exchange rates: EUR weakens relative to USD by 10%.

Based on this envelope, one scenario is created as:

- European equities fall by 20%
- World ex-Europe equities fall by 15%
- A parallel downward shift in the yield curve of 50bp.

Only a subset of factors has been selected and, in each case, the size of the factor shock is not greater than that of the envelope. A judgment must be made whether the shocks selected are economically feasible.

Implementing the stress test involves determining the impact on the portfolio of the maximum shock for each factor individually, and then pro-rating these for the overall impact, as shown in Table 2. While the linear interpolation used to evaluate the impact of factors may appear simplistic, [3] argues that it is actually conservative.

An advantage is flexibility to assess the impact of any imagined scenario. However, its weakness is that there is no guarantee that the events created are realistic, possible or extreme enough. Elements such as portfolio diversification and correlation are ignored. Historical events may be used as a guide in creating such scenarios, which would support credibility. However, the advantage of the created event is that an historical event can be modified to incorporate new aspects, such as changes to regulations, developments in markets, geopolitics and so forth, giving an opportunity to add real value.

SUMMARY AND DISCUSSION

Following a definition of portfolio stress-testing and a classification of stress-testing types, examples of four kinds of stress tests have been presented: two historical and two artificial. Table 1 lists advantages and disadvantages of the main types, while Table 3 captures key differences between the approaches.

The selection of a stress-testing methodology will depend on the requirements of the practitioner (consider Table 3). With concern to how an historical event might impact the current portfolio, a historical stress test would be required, although history may be used as a guide in generating hypothetical correlation matrices or created events. But if the objective is to address concerns over new market developments, regulations and so forth, hypothetical stress tests may be more appropriate.

There are other considerations. If a stressed-VaR measure is desired, then a choice between parametric or historical returns distributions may lead to either historical VaR or hypothetical variance-covariance matrix approaches. When testing the diversification benefits of a portfolio, then historical event-periods could be used, although hypothetical variance-covariance matrix testing comes into its own when explicitly exploring correlations and volatilities.

Should economically meaningful scenarios be the primary consideration, then the historical methods are likely to be preferred (although note 'new market developments' in Table 3). However, historical event-period scenarios may not be appropriate if maximum-peak-to-trough price movements are used, and the variance-covariance matrix scenarios could be based on historical correlations and volatilities, making them economically realistic.

Regarding flexibility in scenario creation, historical stress tests are limited to historical events, while hypothetical methods allow more freedom. For the ability to isolate specific concerns, historical events tend to be 'messy' with many knock-on effects, while the hypothetical methods permit a focus on individual portfolio aspects. Similarly, to explore extreme events, the historical methods only permit this if suitable events lie within the historical record, while the hypothetical methods permit the option of pushing factors further.

Factor	Maximum stress envelope shocks	Maximum stress envelope values	Scenario shocks	Scenario shock weights	Scenario values
Europe equities	-25%	-€1000	-20%	20/25 = 0.8	-€800
World ex-Europe equities	-20%	- €800	-15%	15/20 = 0.75	-€600
A parallel downward shift in the yield curve	-200bp	+ €200	-50bp	50/200 = 0.25	+€50
Foreign exchange rates	-10%	+€150	Not used	Not used	€0
				Total	-€1350

Table 2: Illustration of hypothetical created-event stress test

13. In reality, one would expect the envelope to contain many more than four factors, however this is sufficient to illustrate the example.

Aspect	Historical VaR	Historical event-period	Hypothetical variance-covariance	Hypothetical created event
Historical basis	Yes	Yes	Maybe as a guide	Maybe as a guide
New market developments	No	No	Maybe	Yes
Returns distribution	Historical returns	-	Parametric	-
Diversification	-	Actual period movements: Yes Max-peak-to-trough: No	Yes	-
Economically meaningful	Yes	Actual period movements: Yes Max-peak-to-trough: No	Can be if correlation realistic	No
Flexibility in scenario creation	Any historical event	Any historical event	Yes, in terms of correlation and volatility	Yes
Ability to isolate specific concerns	No	No	Yes	Yes
Possibility to explore 'extreme' cases	Only if historical events	Only if historical events, although max-peak-to trough a possibility	Yes, in terms of correlation and volatility	Yes
Data availability	Historical data required	Historical data required	Full asset returns or just correlation matrix	No

Table 3: Key aspects of stress tests.

A practical consideration may be data availability. The historical scenarios that can be replicated will be limited by data availability on each asset, so for less recent events this could be a significant issue. Potentially, the hypothetical variance-covariance matrix test can get away with only the current portfolio correlation matrix, while hypothetical created events probably have the least demanding data requirements of all, being essentially limited to the current portfolio.

Thus, in practice, the choice of stress-testing method used for a portfolio would depend on the objectives and requirements of those setting the stress-testing programme, as well as the resources and data available.

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