

Back-to-basics

The truth is in the colours

In this second paper of a three-part series, Paul Smetanin discusses the importance of generating relevant profit and loss scenarios and the advantages of colour-coding those risks in presentations to management. This discussion follows on from August's paper, *Devising a Market Risk Framework*

The ability to generate a rich source of profit and loss scenarios is fundamental to the successful performance of an independent market risk management process. Scenario generating capability, however, doesn't in itself complete the market risk framework. It is when scenario generating capability is coupled with scenario grading tools that the criteria governing a market risk management framework can be completely satisfied.

This paper introduces the concept of risk barometer techniques as a means of communicating the relevance of risk scenarios, thereby turning risk data into risk information. Such techniques assist an organisation's risk-based intellectual capital in analysing scenario results, equipping the risk manager with the tools to extend beyond risk measurement into risk management, by delivering useful information and instigating timely risk-mitigating actions.

Scenario analysis

Scenarios for risk management can be defined as a description of the evolution of the state-of-the-world over time (Aziz, Dembo, Rosen, Zerbs, 2000). More specifically, a scenario is a risk manager's view of a future possible state-of-the-world that describes the effects of the variability of risk factors on the value of the organisation's financial claims over time.

Scenario analysis can be defined as the study of scenarios to determine relevant future states-of-the-world. These are used for understanding the value consequences of uncertainty, which is then used as a basis for risk assessment and management. In this context, scenario analysis is designed to completely map future uncertainty in a changing financial and economic environment. When mapping future uncertainty, several sources of change must be integrated in a way that allows the user to understand:

- Risk** – what is the risk exposure?
- Causality** – where does the risk come from, how could it eventuate?
- Relevance and context** – why is the scenario likely to occur in the current environment?

Consequence – what is the cost to the organisation if the scenario were to occur?

Best action – what risk-mitigating action is required and when?

By answering these questions, the risk manager constructs the profile of risk across several sources of uncertainty. Sources of uncertainty for the market risk manager include market, credit and liquidity risk factors. The challenge of constructing relevant scenarios lies in figuring out how to appropriately combine these sources of risk in a meaningful way.

Scenarios and risk framework criteria

The criteria that need to be satisfied by a market risk framework are detailed in *Devising a Market Risk Framework*, *AsiaRisk* August 2000, pages 27-31. Using these criteria as a benchmark, the mathematical process of scenario generation on its own has difficulty in delivering risk management information to the organisation. It does little to deliver relevance, comparability over time, effective representation, accountability and execution.

Part of the challenge of being a market risk manager is to consider the various measures of risk and assess which aspects of the business are a cause for concern. This process involves quantitative and qualitative assessments of risk. That is, the mathematical aspects of daily risk management combine with the experience and intuition of the risk manager. Scenarios are plain statements of fact, on their own they lack context and relevance. They allow the ascertainment of "what" risk is and "how" it could eventuate. However, the "why" of the risk scenario is a point of concern is largely absent, thereby cutting short the risk profile.

Independent risk management should support senior management's understanding of the risks taken and the decision-making process. Simply reporting scenario results does not ensure that such information will be understood or contribute to the decision-making process. There is a need for a consistent and systematic means of adding relevance and context to

scenario information. The risk manager will then have a mechanism to communicate and deliver risk information in a way that will assist in "managing the expectations" of loss at the senior management level and the instigation of risk-mitigating decisions.

Risk barometer techniques

A solution to providing context and relevance to scenario information can be found in scenario grading techniques, known as risk barometers. Such techniques aid the identification of those risk scenarios that cause concern by combining quantitative and qualitative views of risk. These views of risk are then delivered as a colour grade that signifies the relevance of a scenario to the decision process.

Scenarios are not forecasts, given they are merely statements of fact lacking predictive content. However, risk managers perform scenario analysis because the technique helps form opinions as to which scenarios are a cause of concern. For the risk manager, a "cause for concern" is the simultaneous occurrence of a material risk as measured and the consideration that it is likely to occur. "Likely" is not used in the statistical sense, but instead as a risk assessment that states it shouldn't come as a surprise if the scenario substantially or completely occurs.

Risk barometers are intended to be an indicator of how static risk measures combine with information on current market environment dynamics in a relevant way. The value of risk barometer results is not in any predictive ability to measure changes in market variables, but instead as a warning that current risk measures and market conditions may evolve into a foreseeable loss consequence.

In this way, a risk barometer reduces the dependence of the decision process on assigned estimated probabilities by providing, as a complement, opinion-based sources of information that borrow from an assessment of current market circumstances and experience. Although the scenario may have an estimated probability assigned to it that may initially negate its

consideration in the risk management process (given it is beyond a given confidence interval), risk barometer techniques may reassign relevance to the scenario due to particular market dynamics that are not incorporated in the probability density function (PDF).

For example, a single risk factor PDF may estimate with 99% confidence that a loss will not exceed \$20m. In assigning that probability, the PDF is solely a function of its inputs and assumptions when making statistical inferences. However, if that single risk factor is the dollar/yen exchange rate, which is precariously close to breaking through a significant historical resistance level (which in this case would be against the interests of the organisation), the actual probability of a loss greater than \$20m may not be 1%, but greater. In such circumstances, the risk manager may choose to report the scenario as a 99% confidence outcome, but grade the scenario appropriately to warrant management's attention.

Such examples are common in markets where liquidity fluctuates greatly, such as the Asian currency and debt markets or where markets are at risk of external shocks, rendering key risk measures blind (eg. when central bank monetary policy adjustments occur).

Figure 1 illustrates a process that could be followed from generating scenarios through to taking risk-mitigating action. Scenarios generate statements of risk that the risk manager is required to assess in light of assigned estimated probabilities and other non-statistical views of likelihood. The result is statements of concern that are considered in light of what the organisational value consequences may be¹. Ultimately, if the consequence of loss is too great then risk-mitigating action should be taken.

Risk barometer process

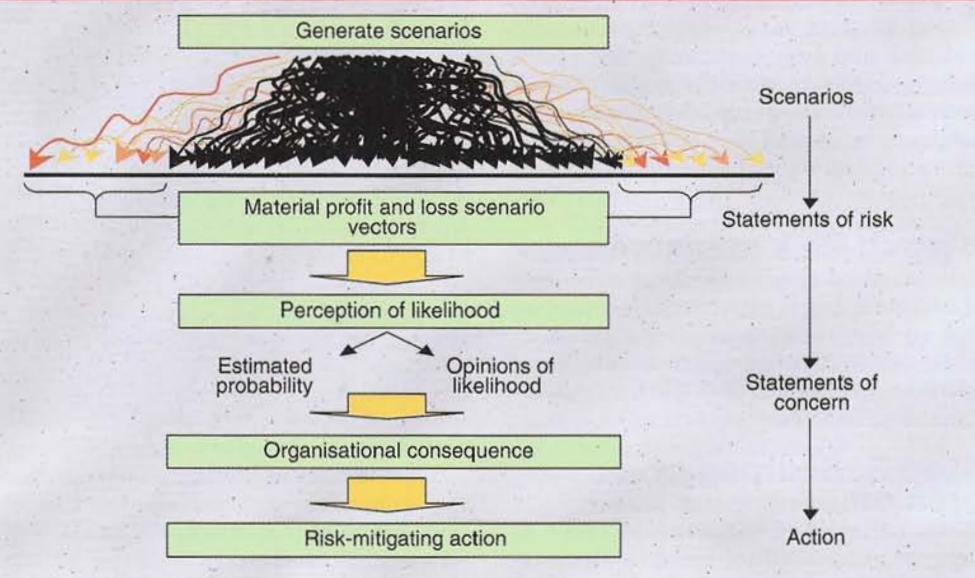
Figure 2 explains the broad interactions of a barometer approach to providing context and relevance to risk data. Barometer processes are a complex interaction between quantitative estimates, risk measures, risk tolerances and the experiences and opinions of key staff. These factors all combine to declare a grade or colour code for a particular scenario. Depending on the organisation's approach to risk management, the grade may have policy consequences or requests for further business and risk dialogue to discuss the organisation's tolerance for loss.

Step 1: Market turbulence

Risk can be defined as the probability that the actual and expected return to a position diverge. In terms of the asset return distribution, the expected return is the location of the distribution and the risk determines the dispersion about the expected return. Value-at-risk (VAR) merely attributes an estimated probability to an

¹Organisational value consequences may not be limited to the measure of the scenario loss, but could be much greater due to loss of strategic position, loss of shareholder and share price support, etc.

1. Risk barometer techniques



event occurring at a predetermined location in the tail of the distribution. The risk of extreme or unusual events is not included in the VAR measure because such events are likely to occur beyond the predetermined location in the tail of the distribution. Thus in atypical or turbulent market conditions, the VAR measure is prone to significantly underestimate the institution's exposure to risk.

A trading period may be described as being turbulent if the probability of an extreme event occurring is high, relative to standard trading conditions. In periods of turbulence the usual market linkages break down. Prices tend to be discontinuous and thus prone to jumps. Volatility tends to be high and correlations tend to move closer to ± 1 .

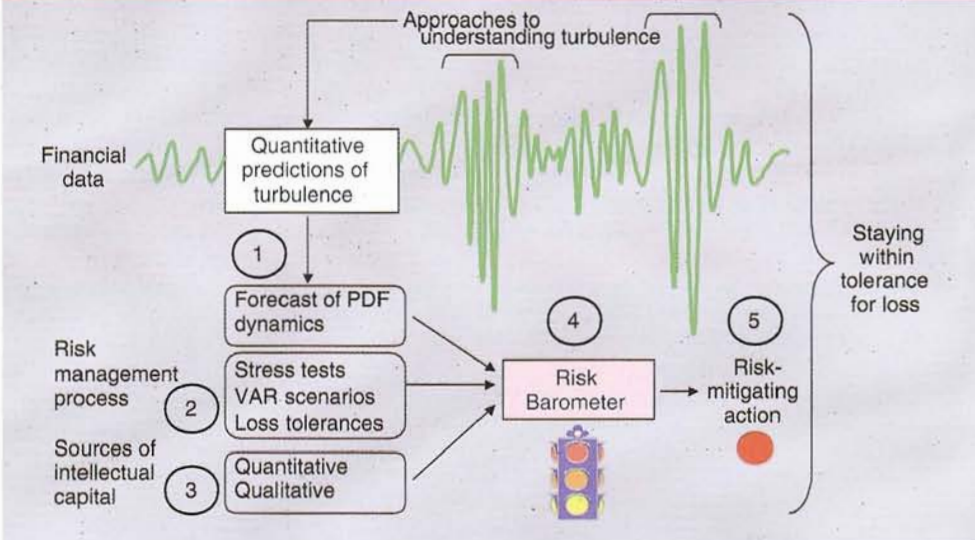
The major factors underlying turbulence are most likely to be associated with extreme volume and an absence of any real breadth, depth and liquidity in markets. In the case of a traded

market position, turbulence would give rise to large and unforeseen gains or losses in the trading book. As a result, market turbulence can have serious consequences for the reliability of PDF-based risk measures.

Market turbulence is closely associated to the concepts of volatility clustering, pooling and persistence. Volatility clustering describes the tendency of large returns (gains or losses) to follow large returns, and small returns to follow small returns. Volatility clustering represents serial correlation in the variance of returns. Volatility pooling refers to the tendency for volatility clusters to occur across assets and markets and can be described as the tendency for peaks in volatility to be highly correlated with each other. Persistence in volatility occurs when there is evidence of significant and extended periods of turbulence (and/or calm) in the returns data.

For a risk manager, the occurrence of turbulence is problematic for VAR estimates, since

2. Risk barometer process



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these estimates are based on normal trading conditions. Furthermore, if the asset displays pooling, clustering and persistence in volatility, then the likelihood of a large market-related risk loss increases dramatically. By understanding conditions of relative market tranquility and turbulence, in combination with other sources of "market intelligence," risk scenarios can be put into some context for the management process.

Step 2: Risk measures

Risk measures provide the barometer with a view of which risk factors are relevant. The usual inputs are VAR scenarios, stress tests and pre-selected historical events. Loss tolerances are a management input that describes the organisation's aversion to risk-based losses.

Step 3: Sources of opinion

A key role of the risk barometer process is to bring the various sources of market-based intellectual capital into the decision process. This may be already done via other means, but a risk barometer allows several sources of valued opinions of risk to be included in the decision making process in a consistent and systematic way. As a result, less is left to chance as the organisation capitalises, harmonises and maximises the value of experience of its key staff. The inclusion of such opinions and experiences can be as simple as key staff responding to periodic market-based questionnaires.

Step 4: Barometer interactions

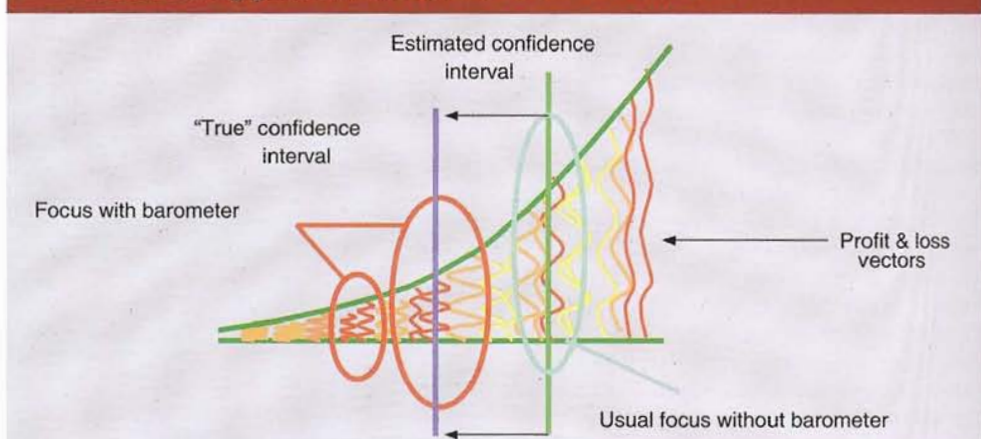
The combining of risk barometer inputs is as complex as the risk-mitigating decision process. Approaches can range from the intuitive and judgemental to the mathematics of neural networks, Bayesian lattices or multifactor models. The key is the generation and existence of the information. The debate will invariably centre around how an organisation seeks to combine it.

Step 5: Barometer results

Scenarios are graded by the colours of red, amber and yellow. The choice of colours is deliberate, seeking the most familiar colour for the required reaction. The colour green is not appropriate as the technique is primarily devised to generate concern in a corporate governance context. However, in a business performance context, the colour green could be used to denote market risk positions with higher chances of profitability than loss.

Colour-coding can infer several conclusions about the risks the organisation takes. In its simplest form, colour-coding could be an indication that attention to the scenario is deserved. In this way, red, amber and yellow codes are viewed as degrees of risk. In the more complex implementation, as already suggested, colour-coding could assign a view that the accuracy of an estimated probability is in question, and that the true probability of an event

3. Practical application of the risk barometer



occurring is much higher².

When the colour code pertains to the accuracy and reliability of density estimates, it reports upon the interaction of estimated probabilities with opinions of where the actual or true probabilities may exist. It seeks to raise the question – are deviations from the "true" probability large and important? There are potentially large benefits to exploiting management experience in quantifying the accuracy and relevance of the probability estimates. The risk barometer provides a formal forum for these considerations.

When questioning the accuracy of density estimates, the colour code classification may be formalised as follows:

- **Red:** The scenario outcome is material and the estimated probability is considered to be smaller than the true probability, and the difference is considered to be large, therefore requiring some further consideration. That is, under usual conditions the risk is small, but in the current market environment the true probability of the consequence is higher. Red codes interpreted as those scenarios that do not represent uncertainty, but instead represent significant risk.

- **Amber:** The scenario outcome is material and the estimated probability is considered to be smaller than the true probability. However, the difference is not sufficiently large to consider the scenario a real risk. Instead, the scenario is considered a concern. Thus the amber classification indicates a potential risk.

- **Yellow:** The scenario outcome is material with the estimated probability considered to be near or equal to the true probability of the event occurring. Such outcomes may be thought of as merely uncertain events.

Without the benefit of a risk barometer collecting various views of market conditions, the VAR-centric risk manager may only consider the scenarios at or around the VAR confidence

interval in the management of loss expectations (see figure 3). However, if all scenarios are colour-coded to question their estimated probabilities or raise the concern of the eventuation of scenarios, and there exists a concentration of red scenarios outside the VAR confidence interval, the true confidence interval may exist further out in the tails of the density function. In this case, the risk manager may be compelled to raise certain red scenarios, which lie outside the estimated confidence interval, as relevant risk considerations for senior management.

Utility of barometer techniques

Barometer techniques are designed to assign current relevance to what are generally considered as static, backward-looking risk measures. This is achieved by providing forward looking views of market dynamics, derived from an organisation's risk-based intellectual capital. This "information" is then well placed to contribute to the decision-making process. Such techniques, however, are not only relevant for market risk, but are also relevant in the measurement and management of other sources of risk, such as credit, operational and liquidity risk. In fact, barometer techniques will support any variable-based management decision process. For example, asset and liability management, specific transaction approval, project investment decisions, net present value decision processes, etc.

The key benefits of barometer techniques include:

- Market expertise and the domain knowledge of key sources of the organisation's risk-based intellectual capital are delivered to management in a relevant, systematic and consistent way.

- Adds quality control to the risk process. Risk managers are likely to have to validate their choice of colour code at the request of the business or management. This should increase the transparency of the risk process, instigating greater accountability for the generation of risk measures. This is more desirable than keeping the process hidden in the daily risk assessment process and limited to the intuition of the risk manager at the time of assessment. Furthermore, barometer results could be subject to certain

²The ex-ante estimated probability of an event may differ from the true probability of an event due to:

1. A mis-specification of the model of the underlying data generating process
2. An unusual evolution of the data after the estimates and forecasts are produced, ie an extreme event
3. Discrete time variation in the conditional moments of the distributions

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back-testing regimes that are designed to review and understand any errors in judgement that occur from the use of barometer technology and the validity of opinions provided by certain "market experts"³.

□ Colour-coding is an emotive trigger that, if used appropriately, should raise questions on the timely consideration by management of the consequences to the organisation if a scenario were to occur.

□ Provides a systematic and consistent approach to questioning the assumptions of the organisation's key risk measures.

□ Barometer techniques can significantly increase the usefulness and contribution of stress testing in the decision-making process. Stress testing runs the risk of marginalisation, given that stress scenarios are by their very nature large and improbable. As a result "corporate numbness" may be created when stress tests are generated and reviewed day-in, day-out. It is difficult for management, however, to grow numb to stress tests when they are suddenly graded as red or amber. Imagine the impact of reviewing stress

is two asymmetric forecast errors in the use of the barometer as an indicator of market conditions. (1) Incorrectly grade a scenario RED, subsequent conditions are normal; or (2) Incorrectly grade a scenario YELLOW, subsequent conditions are turbulent and should have been graded as RED or AMBER. In this case back testing techniques can be used as a quality control mechanism to ensure that the avoidance of type 2 errors does not lead to an increase in type 1 errors

test numbers for the past couple of months with yellow coding and then all of a sudden it turns amber or red. It generates questions.

□ Provides a means of generating information on both positive and negative outcomes. The use of the barometer is not just limited to the negative aspects of risk management for corporate governance. It can be also used to discover positive performance or the taking of clever risk. As a performance tool, for example, barometer outcomes can be used to weight profit outcomes in the same way as volatility is used in a Sharpe Ratio.

Conclusion

The value of an independent market risk management process is in its ability to "deliver" risk management information and instigate risk-mitigating action at the appropriate time. Risk measures are usually static statements of what may happen and suffer exposure to assumptions of historical dependence, input and method mis-specification and mis-interpretation.

Scenarios form the basis of a market risk framework that will satisfy aspects of executability, utility, accountability, extensibility, cultural development, adaptability and endurance. However, it is not until relevance is attached to certain scenario outcomes that management is able to appropriately assign concern and mitigating action over certain market outcomes.

For those organisations using scenario

simulation frameworks as the basis of market risk management in the absence of barometer techniques, relevance is likely to be attached by dialogue and behaviour around certain risk reports. This is completely appropriate. However, the benefit of the barometer approach is that it presents a framework in which the participants of the business and risk process are reminded of the risk challenges that face them every day. Barometer techniques allow the various opinions of risk to be blended and delivered in a systematic and consistent way with the aim of creating transparent and appropriate risk-mitigating action.

In this way, barometer techniques are designed to assist risk managers in articulating their views of the future, fine tune their powers of persuasion and contribute to the process of instigating risk-mitigating decisions. ■

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REFERENCES

Dembo, Aziz, Rosen, Zerbs, 2000

Mark-to-Future, a framework for measuring risk and

Algorithmics Inc. Publication

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