

A Deterministic Scenario Approach to Risk Management

Thomas Hull¹

Presented at
2010 Enterprise Risk Management Symposium
Society of Actuaries
April 12-15, 2010

Copyright 2010 by the Society of Actuaries.

All rights reserved by the Society of Actuaries. Permission is granted to make brief excerpts for a published review. Permission is also granted to make limited numbers of copies of items in this monograph for personal, internal, classroom or other instructional use, on condition that the foregoing copyright notice is used so as to give reasonable notice of the Society's copyright. This consent for free limited copying without prior consent of the Society does not extend to making copies for general distribution, for advertising or promotional purposes, for inclusion in new collective works or for resale.

¹ Thomas Hull, FSA, is also a member of the Swiss Association of Actuaries with over 20 years of experience in the insurance industry. Prior to joining Deloitte in Switzerland, he worked for large U.S. and international financial services organizations in several roles, including ALM, product development and marketing. As a consultant, he has advised clients in solvency and risk management, stochastic valuation models and market-consistent embedded value calculation.

Abstract

Techniques used in risk management have grown in mathematical and technical sophistication over recent years, leading to a quality of analysis on known and calibrated risks.

The current credit crisis has shown, however, that overreliance on historical data and analytical models may not provide sufficient data to analyze very high-impact events and might actually lead to overconfidence. In addition, the process of building models has a tendency to focus developers on preconceived risk constellations and the impact of specific events, whether singularly or in combinations determined through correlation matrices.

Scenario analysis and stress tests based on consideration of shock events and their possible repercussions can provide useful information to management and regulators on a company's resiliency through a chain of events, as well as support the consideration of a firm's operations as an integral part of a wider financial system. By careful selection, construction and analysis of scenarios unfolding over a period of time, a more holistic picture of the firm's risk position can be created. Additionally, because such scenarios have at their heart a story-line, the communication process with key stakeholders is less abstract than discussions focused on distributions, tails and other mathematical constructs.

Finally, we also discuss how scenario analysis and stress testing can be used to define a company's risk appetite, which is at the core of a well-embedded ERM framework. The theoretical approach discussed will be supported through the presentation of the construction and analysis of an event-chain scenario deriving from recent global financial developments.

There is no shortage of literature on the (in)ability of human beings to assess risk properly. Collectively we have short-term memories along with a disinclination to forego short-term gains when we perceive risks to be distant or unlikely. The literature of how people view risk depending on context, group size and numerous other factors is extensive. Quantitative models have proven to be extremely useful in helping us quantify risks, understand observed phenomena, explore the sources and impacts of financial risk, and develop tools and methods for managing risks. At their best, models remove a great deal of bias and subjectivity from risk analysis as well as give us a measurement tool.

Capturing Risk in Our Models

Over 40 years ago, William Brainard and James Tobin wrote the following about using computer simulations to study market phenomena:

“We fully realize, of course, that this procedure cannot tell us anything about the real world. You can’t get something for nothing. We realize further that lessons derived or illustrated by simulations of our particular structure will not be very convincing or even interesting to people who believe that the model bears no resemblance to the processes which generate actual statistical data.”²

Despite advances in our understanding of financial markets, two points have not changed. First, the understanding of the real world will always be limited by the required simplifications of modeling. Brainard and Tobin may go too far in asserting we learn nothing about the real world, but the underlying point that we are creating a simplified and partial picture remains. An analogy from our school years comes from introductory physics, where we examine force and acceleration without accounting for complications like air resistance. Indeed, our understanding is greatly improved, but we would be deeply mistaken to assume observed phenomena adhere to descriptions resulting from our model calculations! The second point addresses the fact that the assumptions inherent in building our models may not be accepted by others. Indeed, with today’s complex models, stakeholders may not even be aware of the subjectivity behind a model’s calculations and parameterizations. Thus, improper or incomplete communication reduces the efficacy of the models as risk management tools.

What was Missing?

The well-known failures of Long-Term Capital Management and recently AIG Financial Products are often cited as demonstrating the limitations of quantitative modeling, because the models omitted relevant factors. The preconceptions of how the world works appear to have limited the imagination of those basing their decisions on the model.

“It is hard for us, without being flippant, to even see a scenario within any kind of realm of reason that would see us losing one dollar in any of those transactions.”

— Joseph J. Cassano, a former AIG executive, August 2007

Cassano’s statement also demonstrates that there was more than failure of models behind the events at AIG. The human failure to recognize the limitations of the chosen analysis, whether a result of hubris, greed or a lack of intellectual rigor, likely blocked effective communication about the limitations of the quantitative analysis. Many prominent business executives, regulators and academics are looking beyond the models and asking what went wrong. (For an example, see “The Financial Crisis and the Systemic Failure of

² Brainard, William C., and Tobin, James. “Pitfalls in Financial Model Building.” *The American Economic Review* 58(2), Papers and Proceedings of the Eightieth Annual Meeting of the American Economic Association (May 1968).

Academic Economics” by Thomas Lux et al.) After the fact, Cassano’s statement appears either absurd, monumentally egotistical—or both. However, the troubles of many financial institutions (including in particular insurers issuing unit-linked policies with guarantees) came about in an environment where these organizations had chief risk officers (CROs), risk committees and long combined experience in financial services in addition to their sophisticated models. How could these institutions have been better prepared, and what should top the risk agenda now?

An Inconvenient Financial Truth

There will be another global economic crisis.

The causes, warnings and effects of the next crisis will, in the absence of stunning failures by business and government, be different from those observed over the last two years. Global financial markets are vibrant, evolving new instruments and developing new interconnections at a dizzying pace. Complexity grows, particularly as firms in various sectors seek ever more sophisticated ways to compete and increase profitability. This evolution creates lags in the sophistication and construction of our models and in our ability to comprehend fully the financial system.

Certainly we should improve our models, our business process and our oversight systems, and seek to understand how we missed the drivers of the credit crisis. Repeated mistakes are by far the worst kind because we have the information to avoid them. In addition to understanding the specifics of our recent troubles, we must try to assess the nature of the lapses, in order to improve the process while avoiding repeating the past.

While events such as the credit crisis rightly lead us to take a critical view of financial models and risk management processes and techniques, we are not likely to avoid unpleasant surprises. We must strive to understand the data we have and make careful observations so we may identify as many risks as possible. Quantitative models are an integral tool in promoting our understanding of the world, and allow us to measure the financial impact of events in a meaningful way. Yet the increasing sophistication and complexity of our models makes it harder to use the output or results directly in communicating our findings about risk to nontechnical audiences. Indeed, even technically astute audiences who are not well-versed in the specifics of a particular model will struggle to use the results to drive decisions and actions. These considerations help define the placement, duties and personality requirements for a risk manager.

A Model for Risk Management

In the wake of the current credit crisis, many politicians and corporate leaders speak of avoiding or minimizing risk, but in truth corporations must *manage* risk to ensure appropriate investor returns and the continued existence of the company. A changed emphasis from avoidance to management focuses participants on the upsides of risk as well as the need for action rather than reaction. In an ideal situation the risk manager guides the organization to walk the talk: in common Solvency II language, to embed a risk culture in the organization. This requires support from the top, but does not define the particular structure or staffing of risk management itself. Such a role requires the capability to understand the analytics that go into measuring risk combined with superb communication skills and a great deal of persistence. The following steps outline an approach for taking an organization through a risk management cycle for the first time.

Define the Opportunity

Too many equate risk management with compliance. Compliance, while certainly very important, may be viewed as a minimum standard in this context. Defined for applicability across multiple organizations or industries, compliance at most companies does not address specificities enough sufficiently to serve as a basis for management action. The risk management process should protect the organization in alignment with the strategy, help define the culture, and support daily operations. Excellence in risk management is a competitive advantage.

Assess the Current Situation

An analysis incorporating multiple viewpoints mitigates the danger of one person or a few people taking a biased view and missing key exposures. Leadership needs to consider the “as is” situation, understanding organizational strengths, weaknesses, constraints and vision for the future. This in turn informs the development of the risk tolerance and risk appetite. The CRO must consider the existing structure and culture before embarking on changes in the risk framework. Part of the challenge lies in focusing on the key risks. Some of these can be identified through financial modeling techniques; others may not lend themselves to this approach. A method using deterministic scenarios for the assessment follows, and illustrates one way to engage more key managers in the risk assessment process.

Communicate the Results of the Analysis

The risk manager must help craft the message about risk management to various stakeholders such as internal management, employees as a whole, regulators, ratings agencies and investors.

Using Deterministic Scenarios

There is no shortage of forecasts about the future development of the world economy, though subjectively it appears the caveats given to such forecasts are more prominent and frequent than is the case in less stressful times. Basic business planning most often involves applying the developed strategy to the best estimate view of the future, exploiting known strengths to maximize potential. Deterministic scenarios, by contrast, allow the application of a “what if” mind-set to explore the impact of possible future events in ways not achievable in

quantitative models or in a basic business plan. Indeed, the process of developing extreme scenarios and considering their impact on multiple aspects of company operation provides feedback about the risk profile of the company and the resiliency of current strategy. Crystallizing the sources of, and sensitivities to, risk allows formation of a clearer picture of the company's opportunities and flexibility.

A deterministic scenario begins with a narrative. This narrative should make clear the view of the beginning situation and strive to identify the inherent relevant assumptions. Even a narrative beginning "at present" will have embedded a specific interpretation of the current state, and it is important this be made explicit while also documenting start values for key metrics that could include yield curves, interest and equity volatility, etc. Since scenario development and analysis will likely unfold over a period of weeks, clear documentation of the initial state will aid when impacts and possible reactions are deconstructed. It must be clear to all participants from the outset that such scenarios are not forecasts, and their design should lead to significant business impacts with a goal of defining corporate limits, financially and operationally. They needn't be catastrophic, but a rosy view of the future is of minimal value. Key influencers in the management group should assist in developing a narrative that, while extreme, holds together logically. Buy-in from a group of respected participants can inhibit any larger group analysis from descending into debates on the appropriateness of the scenario, keeping focus on the analysis of the impact.

A Sample Scenario Narrative

The end of 2009 has brought a dramatic increase in equity markets, though earlier record highs have not been reached. Spreads have narrowed and volatility has decreased, though both are still high by historical standards. Life insurers are generally able to earn sufficient spreads on traditional business to meet margins, though the options on unit-linked policies are still in the money placing continued strain on capital. Lapse rates on variable products with guarantees have not declined as much as some models for financially rational behavior would have suggested, perhaps due to consumer's need for liquidity in still-tight credit markets.

In the first half of 2010 equity markets undergo a dramatic downward correction. Equity volatility remains high for 2010 and thereafter reaches historically low levels, with equity prices remaining stagnant. As a result of governments globally attempting to reignite the recovery, interest rates are dropped rapidly to low levels. As deflationary pressures grow, the long end of the curves also drops drastically. Banks generally are still wary, and credit does not flow as governments have hoped.

Nascent improvements in certain industries and export nations are dealt a severe blow during the setback to economic activity, and despite plummeting prices for oil, gas and metals, government takeovers in the airline industry are widespread after 2010. Exporting countries are hit by the slowdown, and the combination of unsustainable economic stimulus and plummeting demand drive China into recession. Elsewhere growth in the BRICs (Brazil, Russia, India and China) is flat. Sovereign default reappears, as several economies are unable to service existing debt in the new environment.

In the life insurance industry, guarantees are in the money, and the investment environment means new money does not generally earn enough to cover guarantee costs, leading to defaults or forced changes to contracts.

Key Metrics

A table of the initial state and the development of key factors for analysis helps ensure a focused discussion and defines the parameters for the required quantitative analysis. Note that these key factors are chosen with a consideration of life insurance in mind, and will likely differ depending on industry. Model-based estimates of the changes described in the table should illustrate the impacts on chosen key metrics—for example, surplus, required capital and reserves. The quantification need only consist of rough estimates sufficient to provide rigor to discussions, indicating the direction and magnitude of changes in the chosen results.

Year	DJIA BOY	Equity Volatility	Lapse	U.S. Treasuries					
				1	2	3	5	10	30
1	10,600	14	7%	0.34	0.94	1.49	2.51	3.76	4.63
2	7,950	22	7%	0.20	0.50	0.80	1.50	2.30	2.60
3	8,030	12	6%	0.00	0.25	0.45	1.00	1.50	1.20
4	7,870	12	5%	0.00	0.25	0.30	0.70	0.90	1.20
5	7,920	14	6%	0.00	0.25	0.30	0.50	0.80	1.20

Applying the Method

The scenario in the given example might serve to support a conversation around capital management with the appropriate management participants. While a randomly generated scenario could also be used for this purpose, the narrative structure can help the consideration of evolving strategy in an interactive manner, with newly emerging information driving an adaptive strategy. A model does not allow an analysis to pause and reflect on what has happened and what might happen. A participative discussion of the pros and cons of various courses of action should highlight for all participants the danger of delaying action as weighed against a need to maintain flexibility. In this way it becomes dramatically clearer that a strategy of hoping for the best in year one, say by not hedging against further interest rate deterioration, could well be disastrous.

Objections that it is obviously a bad strategy to hope for the best should be weighed against evidence such as the fact that several companies assume long-term equity returns will converge to an average. For a simplified consideration of the implications of the long-term return assumption, assume a 10-year time horizon for equity returns and a long-term average return of 10 percent per annum. The invested amount of \$100 grows to \$259 in a decade. Should the first year involve a market correction of 50 percent, stocks would have to return 20 percent per year for the subsequent nine years in order to return \$259. Making heavy bets this will occur exposes a company dependent on the outcome to some serious problems if the initial assumption is faulty.

In a similar manner, any strategy focusing solely on one scenario can limit flexibility. Low interest rates may continue, may normalize, or may presage an inflationary period. Only by considering the need for maneuvering room can a company effectively prepare for an uncertain future.

The presented deterministic scenario and accompanying metrics can also be expanded for a different or wider conversation, perhaps incorporating sales and distribution strategy. What will customers demand in such a situation? How might competitors react? Which businesses might be expected to flourish, and which might be curtailed sharply? While care must be taken to avoid overly elaborate scenarios, small expansions of a base case against carefully selected measurement criteria drive development of truly wide-reaching risk management approaches and engage the wider organization in the process.

Beyond the Math

The skill and effort required to apply deterministic scenario analysis as a risk management tool should not be underestimated. High level executive support and participation are required, and the risk manager must be a skilled communicator. A careful balance between realism and sufficient simplicity must be maintained to ensure engagement with manageable time commitment in an accessible exercise.

Yet as a company becomes accustomed to the process, scenario analysis can be used as the basis for developing a holistic risk-aware strategy incorporating input from across the organization. Key participants will have input to the assumptions underlying a deterministic scenario, and a narrow focus allows a broad understanding of approach. Because scenarios have at their heart a story line, the communication process with participants is less abstract than discussions focused on distributions, tails and other mathematical concepts. Guided and applied appropriately, deterministic scenario analysis provides a powerful additional tool in building a robust risk-aware organization.

The author gratefully acknowledges the support of Dr. Philipp Keller who introduced him to the world of deterministic scenario analysis. Among numerous other achievements, Dr. Keller developed the Swiss Solvency Test. He is vice chairman of the IAA Solvency Subcommittee, an expert for the International Risk Governance Council in Geneva and an expert in Monetary and Capital Markets with the International Monetary Fund.