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CRYSTAL BALL

Smart Decision-Making in the Era of Financial Challenges

How Monte Carlo Modeling Can Help Manage Risk, Improve Forecasting and Drive Growth in Turbulent Times

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JOHN CHARNES

SENIOR VICE PRESIDENT IN ENTERPRISE STRESS TESTING

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Introduction

People, businesses and nations seem fated to view much of their financial history in terms of "if only." When it comes to finances, fair warning is literally worth its weight in gold. But such foresight is valuable only when there are the will, the means, and the capability to apply it. Today, the consequences of profound financial and monetary miscalculations continue to mount. Our challenges are to regain confidence and achieve clarity on alternatives so we can move into recovery and address the damage to infrastructure and individual companies. Today, we confront a more challenging landscape than we have faced in recent memory. For myriad reasons, traditional planning did not serve us well. Managers face new levels of accountability and keen public scrutiny in their decision-making.

In response to this severe downturn, Oracle Corporation has now enabled planners to apply the principles of Monte Carlo modeling to Enterprise Performance Management (EPM) and Business Intelligence (BI) applications. Oracle Crystal Ball integrates smoothly with the latest release of Oracle Strategic Finance to focus the power of Monte Carlo simulation and optimization on managing risk. Managers can access data from EPM applications—such as Planning and Essbase—in Excel and directly apply Crystal Ball to model risks and predict outcomes. This robust, intelligent, prebuilt engine is a vital resource for understanding the financial impact of alternative corporate strategies in challenging times.

The Road Ahead: Decision-Making in Times of Turmoil and Opportunity

The U.S. financial infrastructure is currently enduring a profound test and will emerge changed in ways we can only speculate about in this early phase of recovery. As we move through upheavals, we can create better decision-making strategies and build systems that are inoculated against the consequences of our own fallibility. Frank Buytendijk, author of Performance Leadership, (McGraw- Hill, 2008) calls this process "future-proofing" your strategy.

What some call selective ignorance, others a thoughtless herd mentality, and yet others criminal negligence continues to wreak damage. A financial crisis so severe that it can ruin major institutions such as Lehmann Brothers reveals a critical need for better decision-making resources. One major lesson is that "what-if" risk analysis is weak and unreliable for confronting issues of great magnitude.

"The single biggest risk for any organization – or nation – is the lack of a validating risk analysis method itself."

DOUGLAS HUBBARD

AUTHOR AND OWNER

HUBBARD DECISION RESEARCH

Amid a perfect storm of economic shocks and setbacks, the Monte Carlo method is a reliable compass for charting a wise financial course. For decades, Monte Carlo has been identifying "silver bullets" for leading companies. The model, whether used by large corporations to gauge global decisions and strategy, or by internal operating units to determine tactics, far surpasses traditional analysis in accuracy and insight.

The Perils of the Past: Basing Financial Decisions on "Best Story Wins"

Human nature often impels people to base their financial decisions on wishful thinking or on a cherished economic philosophy, rather than on realistic analysis. People unconsciously weight their reasoning in favor of a desirable outcome and set themselves up for major loss. However, it isn't a mere truism that failure is a better teacher than success; we are certainly well-positioned at this time to learn from our errors and protect ourselves through legislation and better business tools.

Success can be illusory and short-lived. It feeds complacency, conflates luck with wisdom, and creates vested interests that frustrate needed change.

Failure, on the other hand, delivers harsh lessons for avoiding the same pitfalls and drives the search for improvement. (When prolonged, of course, failure causes fear and timidity and weakens confidence for taking the necessary risks, resulting in stagnation). Embedded in the pain of today's situation is an abundance of valuable information.

According to author and analyst John Charnes, "If there is a bright side to the untoward events in the financial sector, we know that we now have a history of really bad things happening that will be a part of the data that people use to parameterize models in the future. When people put together models where extremely bad events happen and continue to happen, it gives them more credibility and helps to inform risk management techniques going forward."

How the Monte Carlo Method Drives Productive Risk-Taking

The ability of Monte Carlo modeling to reflect all outcomes—particularly those dismissed as too unlikely to consider—makes it an objective and vital resource. Monte Carlo is founded upon stochastic analysis, which offers the ability to create thousands of "what-if" scenarios. These allow evaluation of variables and values according to probability distributions. Since the Monte Carlo method can calculate an unlimited number of possible outcomes, we gain a comprehensive, realistic picture.

One caution that stochastic analysis vividly illuminates is to be wary of rare events—and particularly wary of rare but inevitable events. In his first book, Fooled by Randomness: The Hidden Role of Chance in Life and in the Markets, author Nassim Nicholas Taleb tackled cherished notions that place people in the cross-hairs of once-in-a-generation happenings. Taleb points out that because people are often unaware of randomness, they overestimate causality and find explanations where there are none. They tend to learn only from "winners" and ignore the lessons taught by losing. People seem irrationally wedded to counter-intuitive financial behavior that garners only incremental returns and can be wiped out by one catastrophic event.

"An unlikely event that is catastrophic in scale doesn't even have to be reported, according to FASB rules."

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Based on mathematics, the Monte Carlo model evades such hopeful traps. Remote possibilities, as we are painfully learning, are not remote when they are happening to us. If real life were as well-behaved as a neat deterministic analysis, the world would be comfortably predictable, and people could plan confidently, decade after decade. But in our universe, improbability shapes and controls outcomes to a huge degree (i.e., the asteroid that wiped out the dinosaurs). So the better a decision-making system reflects the likelihood of the extremely unlikely, the greater its value.

Patrick Leach, Senior Consultant and author of Why Can't You Just Give Me the Number?, an executive's guide to the use of probabilistic thinking in managing risk and decision-making, notes that a company attempting to calculate a certain figure, such as how many barrels of oil a field is likely to produce, would first input data for various parameters. It would then run an algorithm that uses these inputs to generate outputs of interest, including total amount of oil produced.

When the exact values for input parameters are unknown or uncertain, however, is where Monte Carlo proves its value. Crystal Ball, for example, accommodates uncertainty by generating a range of possible values and a probability distribution associated with that range. The program then chooses a value for each parameter from the ranges given, according to the probability distributions, repeats this process as many times as needed—even into the hundreds—and then rank-orders output values from the smallest to the largest to calculates statistics based on this list. Because values are chosen randomly and the process is repeated many times, the output is statistically significant— a major improvement on a subjective "reasonably certain" result.

"People are Systematically Overconfident in Almost Everything They Do"

"I'm pretty good at making forecasts" people say, "if memory serves me." And it usually doesn't. Author Douglas Hubbard notes that when managers declare themselves "90 percent confident," they actually have a 67 percent chance of being correct. A one-in-three chance of being wrong adds up to extreme overconfidence. Hubbard notes that people compound this inaccuracy by selectively forgetting when they are mistaken.

Yet another quirk of human nature, according to Hubbard, is that "the more time that passes without a catastrophic event, such as a major market crash or market turmoil, the more risk-tolerant people become." For every year that the market is reasonably stable, regulators become that much more lenient about enforcing constraints on risky activities such as investing on margin. They relax reserve requirements based on all-too-human reasons: nobody wants to stand in the way of growth, miss out on profit, or be perceived as out-of-step.

Hubbard points out other problems, such as the inconsistency of human estimates of risks (they change risk estimates even for identical scenarios for no apparent reason), and the ambiguity and errors of popular non-quantitative methods of risk assessment. Finally, the application of empirical methods so that quantitative models can take real-world observations into account are too rarely considered. Taken together, these problems mean that most risk assessments will be seriously flawed.

Hubbard recommends that managers use proven "calibrated probability assessment" training to improve subjective assessments of risks. Figures generated can be used in Monte Carlo simulation. Sensitivity analysis will determine where objective empirical measures should replace initial subjective estimates.

The Value of Simulations: Predicting Worst-Case Scenarios and Mitigating Outcomes

The events of September 11, 2001, the tsunami of 2004, and the recent financial crisis are all worst-case scenarios with massive, lasting impacts on local, national, and international economies. Potential worst-case scenarios deserve extra attention because they result in the greatest casualties, damages, and financial loss. Not planning for such scenarios makes recovery incalculably longer and harder. The more information we can acquire about the potential of such events to happen, the better we can overcome our wishful denial and prepare for it. If not safety, there's at least shelter in knowledge.

It's natural to want to know the mathematical probability of a worst-case scenario over a given time frame. But when earnings forecasts—even in relatively stable times—can be wildly inaccurate, how can the probability and scope of such a worst-case scenario be identified—then communicated and responded to? The answer is that simulations about historically extreme (i.e., 99th percentile) events themselves offer profound insight into our exposure and chances for deflecting crisis.

According to Huybert Groenendaal, Ph.D., MBA, and F. J. Zagmutt, BVSc, MV, MPVM of EpiX Analytics in their 2006 Risk Management Magazine article, "Financial Planning for Worst-case Scenarios," the most dangerous thing we can do is not to think about them. "Right now, we are living proof that worst-case scenarios are not only possible, they are a certainty." While any particular disaster is itself unlikely, the cumulative probability of any one of them happening is 100 percent. (It may be extremely difficult to predict the lottery winner, but it is not difficult to predict that there will be a winner). Modeling software based on the Monte Carlo method lets us anticipate the future, even if we cannot predict it—and preparing for worst-case scenarios makes surviving them far more likely.

Behavioral Finance and the Brittleness of Linear Planning

Linear planning is based on fixed inputs put through a process to yield a fixed output. This makes such planning "brittle," in that dramatic and rapid change causes it to shatter easily, destroying its usefulness. If any of its fixed assumptions fails, the entire plan can collapse. To create robust plans that remain accurate and useful under pressure, people need to move from a deterministic, fixed-input model to a stochastic process that accommodates variability and uncertainty.

A program such as Oracle Crystal Ball, based on the Monte Carlo method, calculates the probability of one's achieving any given strategic goal and offers the ability to develop plans that reflect realistic financial risk and reward. Monte Carlo helps decision-makers think about investment and long-term planning, for instance, as a continuum of probabilities rather than a certainty. So they grow accustomed to responding to change rather than hoping it won't happen.

The Process of Financial Planning: Reaching the Future Intact

John Charnes believes that the very process of arriving at a good model can be as useful and informative as running the model itself. "One of the biggest benefits of building a simulation model is that you have to study the inputs so carefully and understand the problem so well you may not even have to run the model!" Reflecting extreme, 99th percentile events in a simulation helps one obtain sharp insight into actual risk exposure. Informed financial decision- making also demands that one address the realities of limited information and inexact equations. The steps of stochastic analysis comprise:

» **Develop a model of the problem.** Essbase or Excel are both excellent general purpose, model-building tools. Oracle's Strategic Finance is a versatile prebuilt model, allowing the analyst to spend more time thinking and less time reinventing the wheel.

- **Assign ranges of values to the inputs.** Access data from EPM applications and directly apply Crystal Ball to model risks.
- **Calculate the ranges/probabilities of the outputs.** Automate "what if" analyses to evaluate thousands of outputs and their probabilities as Monte Carlo simulations.
- **Analyze and share results.** Oracle EPM Workspace enables sharing of Crystal Ball workbooks and analysis across the enterprise.

Lowering the Lifeboats: Predicting, Identifying and Acting on Worst-Case Scenarios

Huybert Groenendaal, managing partner of EpiX Analytics, suggests that we must "be creative and think outside the box to identify potential worst-case scenarios." In the casino business, for example, a "predictable" risk would consist of a patron on a lucky streak or a file clerk who forgets to send in required paperwork and thus puts the gaming license at risk. An out-of-the-box risk would be a disgruntled customer planting dynamite on the support pillars of the lobby.

In his influential work, The Black Swan: the Impact of the Highly Improbable, Nassim Nicholas Taleb notes that while many risks can be anticipated using historical data or events, the worst risks for a business to deal with are often those that have not yet happened. It can be argued that we are today experiencing an economic "Black Swan"—an implausible "outlier" event with a disproportionate and lasting effect on the way we live and do business. The recent downturn certainly meets Taleb's three qualifications of rarity, extreme impact and retrospective predictability. In his book, Taleb notes that, "ever since we left the Pleistocene, some ten millennia ago, the effect of these Black Swans has been increasing. It started accelerating during the industrial revolution, as the world started getting more complicated, while ordinary events, the ones we study and discuss and try to predict from reading the newspapers, have become increasingly inconsequential."

Douglas Hubbard: The Strengths of Monte Carlo Analysis

According to Douglas Hubbard, author of How to Measure Anything: Finding the Value of Intangibles in Business and The Failure of Risk Management: What is Broken and How Do We Fix It?, the frequency of rare catastrophic events is actually much higher than most models assume. "If I fill a bucket with dice and roll them, this activity will yield what we know as a normal distribution. But most of the risks we worry about modeling for in the financial world do not behave this way. Financial markets behave more like earthquakes, forest fires, and tsunamis. Their interrelated components mean that the whole system can be stressed. The failure of one component causes the failure of many other things. Hubbard argues in his book that the single biggest risk for any organization—or nation—is the lack of a validating risk analysis method itself, which Hubbard calls Meta-Risk. "It doesn't matter the kind of precautions or analysis of financial volatility if they are mis-assessing risk to begin with."

Hubbard notes that the best and most mature industries use Monte Carlo analysis, particularly when the stakes are very high. "A major factor in the recent financial crisis was failure to employ risk-evaluation tools such as Oracle Crystal Ball.

Actuaries use the Monte Carlo method in insurance, as do nuclear power plants, aerospace projects, and the oil industry to calculate the benefits of exploratory drilling." Where the correct information is extremely valuable, it's worth conducting a survey to obtain it. However in 9 of 10 cases, you can make the optimal decision with the limited information you have: rarely does more information lead to a different and better answer.

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Common Mode Failure—complementing the Black Swan effect

There are fundamental problems in the risk analysis used by most organizations for which Hubbard uses the title Common Mode Failure. "You run risk analysis on a system and one component fails, which causes the failure of a number of other components. One example of a common mode failure would be a nuclear power plant routing systems through a single room—which room then catches fire. Most risk analysis is fundamentally flawed. It creates a placebo effect. People act on it with high confidence, which is especially prevalent where they don't think of the problem as quantitative. They think, 'At least we're doing something,' and that is not necessarily good. There should be a Hippocratic Oath for a analyst as in medicine: first, do no harm."

Hubbard's solution is for more organizations to adopt Monte Carlo simulation with structural cause-and-effect models. "There is currently no place in options theory or modern portfolio theory to talk about the referred effect on the housing market. Soft, unscientific risk evaluation methods are being applied, and we know those methods don't work. The people who develop them may have domain expertise, such as being a pathologist for the CDC assessing the risk of a flu pandemic. He might understand his subject area, the flu, but he goes on to develop a risk evaluation method too, when he is not qualified to do that, and Monte Carlo actually is what is needed.

People with domain expertise assume that because they are experts in security, terrorism, space travel or IT portfolio management, they are also qualified to come up with a risk scoring method. In fact, none of them are so qualified—and they actually add error. In oil exploration, for example, they do a lot of good Monte Carlo modeling, but when a CEO reports to shareholders, he has to come up with an exact number, whereas a range would be much more realistic and useful in expressing uncertainty. "They just don't understand that the truth lies on one point in a range of uncertainties."

Hubbard believes that organizations need to change internally, "and we have to start higher up with regulatory bodies. The Financial Accounting Standards Board (FASB) rules on how you account for contingent losses—that sounds like risk to me, and nothing is quantified in numbers. They only look at probabilities, so that an unlikely event that is catastrophic in scale doesn't even have to be reported, according to FASB rules. Enron should have had a probability range for its balance sheet. But accountants wanted an exact number, whether right or wrong, so they don't run distributions to come up with numbers for balance sheets. As Warren Buffett says, it's better to be approximately right than precisely wrong."

Hubbard believes all agencies—CDC, FAA, EPA, NASA and others—should be running stochastic probabilities. "NASA's manned space launch risk analysis is insufficient, in my opinion. When it comes to risk and decision analysis, they come up with a simple score where there is no evidence it improves decisions. I'm begging agencies not to develop and promote methods with no scientific record of working, but to use a Monte Carlo-based method instead."

John Charnes: How Monte Carlo Leads to Ever-Richer Models

Author and executive John Charnes believes that when people are able to put together models in which extremely bad things happen and continue to happen, it builds credibility and helps to inform risk management techniques

going forward. “That’s little consolation to somebody whose business is in trouble, but the bright side is that this process leads us to richer models and better solutions in the future. The recent [financial] situation was considered too unlikely by many to really worry about,” says Charnes. “It would have been hard to forecast what is going on now because it’s an extreme ‘tail event’ on a distribution curve. But using the Monte Carlo method, people normally explore the variation around your estimates, which gives you the entire distribution of possible results based on some set of assumptions that can also be probabilistic. “It gives you an idea of how bad things could be. The current events that we’ve been experiencing could have shown up on someone’s Crystal Ball model as an “outlier tail event” that might have been discarded as too extreme a few years ago. But it can happen, and now it has.”

The Monte Carlo method applies to larger and smaller entities

Charnes believes that a program such as Oracle Crystal Ball turns a spreadsheet from a static data organizer into a dynamic analysis tool. Charnes currently uses Monte Carlo simulation to perform credit risk analysis and develops an initial model to do proof of concept.

“The institution I work for is one of the largest in the world, so that tens of thousands of loans need to be analyzed every day, which would overwhelm a spreadsheet. A company this large needs its own dedicated systems and software to handle large-scale transactions.” A medium-sized company is ideal for doing Monte Carlo simulations via a spreadsheet—but even very large companies can use Excel-based Monte Carlo analysis for departmental-size projects. The great thing about Crystal Ball is that it sits on top of Excel, a familiar interface, so the training is virtually done already.”

With regard to the reliability of information used to build a simulation, Charnes reiterates that “any model is vulnerable to GIGO (Garbage in/Garbage out).

“But if people do a good job of thinking through the inputs, then the output will be a reasonable representation of future possibilities. Could our recent financial crisis have been included or in some way represented in a Crystal Ball model of 2006? “I would hope it would have been there,” says Charnes.

Conclusion

In a time of major crisis, such as we are experiencing today, people become frightened, confused, and hesitant. They may make decisions based on emotion; or on precedents that are no longer relevant—or they may make no decision at all. At such times, Monte Carlo modeling is a beacon of financial sanity and reliability. The need to quantify risk and support courageous decision-making is critical, and the right course may not be obvious under extreme conditions.

Traditional methods of financial planning typically present overly optimistic results, ignore unpleasant scenarios, or wishfully focus only on precedent. The Monte Carlo method’s stochastic analysis empowers a user to stress-test any number of potential outcomes to reveal outliers and worst-case scenarios, so that steps can be taken to prevent or mitigate profound loss.

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