

# Analysis

PERSPECTIVE

## SPRING

### Computing **Economic Capital** via Portfolio Simulation

By Joseph L. Breeden, Ph.D.

**The Basel II Accord** offers benefits to financial services institutions that develop internal ratings-based (IRB) models for setting economic capital. Those institutions that do not may face rather substantial penalties in the form of increased capital requirements in the future.

continued



Although Basel II creates a strong incentive for IRB models, it offers scant advice on how these should be created. Retail portfolios have historically received much less attention than commercial portfolios for modeling total risk in part due to the inherent complexities of modeling retail portfolios. Portfolio-level forecasts of unexpected losses are unable to capture changes in portfolio mix, economic climate, originations quality, portfolio maturation, and more. Because of these shortcomings, it is clear that few if any existing models will meet the stringent requirements for IRB models under Basel II.

Another commonly discussed approach is to use account-level bureau scores to assess portfolio risk. Although these scores have excellent performance characteristics as rank-order models, precisely calibrating them to future loss rates carries the same problems described above. In other words, scores accurately reflect risk, but not necessarily the future magnitude of such risk.

Dual-time Dynamics (DtD) was developed by Strategic Analytics to explicitly address these issues. DtD quantifies the account maturation process, changes in originations quality, management impacts, seasonality, and response to the economic environment for retail port-

folios. With DtD, we know that the portfolio maturation process, seasonality, and marketing plans (originations quality and management impacts) are statistically predictable using the proper nonlinear algorithms. The great unknown is the future economic environment. Because our process has quantified the past outside (or "exogenous") environment for the portfolio, a natural solution is to use Monte Carlo Simulation to generate a very large number of future exogenous curves representing the portfolio's response to future macroeconomic changes. Importantly, our version of Monte Carlo Simulation is conducted preserving the dominant structures in the exogenous curve: auto-correlation (trend-length), distribution of changes, and seasonality. To properly capture these effects, SA utilizes a more sophisticated version of Monte Carlo Simulation than typically encountered (see inset below).

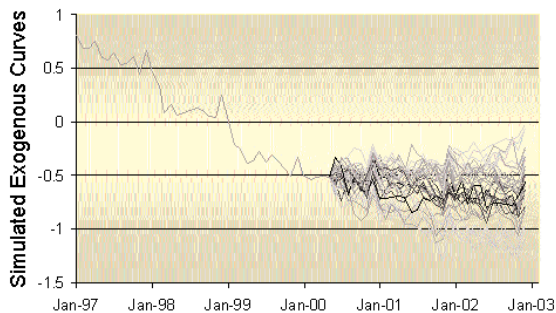
After generating many possible future exogenous curves, forecasts of future revenue and losses are generated via the simulation engine in LookAhead™. These forecasts are collected to create probability distributions of revenue and losses. From these distributions, levels of expected and unexpected losses

**AUTO-CORRELATION MEASURES THE DEGREE** to which today is dependent upon yesterday. Financial markets are said to follow a random walk, e.g., there is no relationship between yesterday's move and today's, but consumer portfolios are strongly auto-correlated: today's results are heavily dependent upon yesterday's. Non-normal, or non-Gaussian distributions are also common in consumer and other financial portfolios, so re-creating the true distribution of changes is also critical when utilizing Monte Carlo Simulation. **THERE ARE MANY INSTANCES IN MODERN FINANCE** where these issues are recognized, for example, options traders know that the Black-Scholes formula must be adjusted to reflect more accurately the distribution of future returns. More spectacularly, the failure of Long Term Capital Management can be partly attributed to misestimates of cross-correlation and incorrect assumptions about the statistical distribution of price changes.

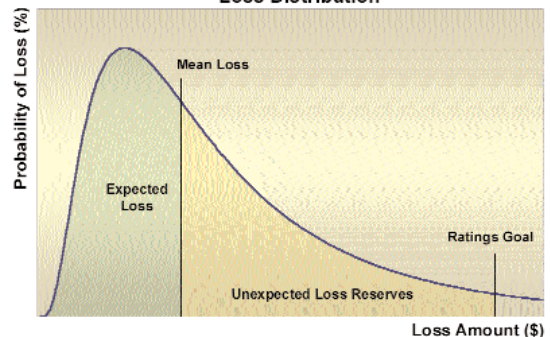
folios. By replacing the past macroeconomic environment with a scenario for the future environment, this approach leads naturally to robust, scenario-based forecasts. DtD runs without need of account-level information, operating instead on segment-level data.

can be set easily, and economic capital computed. Dual-time Dynamics provides a high-precision approach to predicting future losses while capturing the spirit of economic capital—preparing for the unexpected. ●

Monte Carlo Scenario Creation



Loss Distribution



# LookAhead™: Breakthrough in Scenario-Based Portfolio Forecasting

**How will your portfolio react to a change in new account marketing plans—to a burst or decline in seasonal spending?**

If the economic outlook impacts payment behaviors—what will happen to collections queues?

**How will changes to several "moving parts" affect the P&L—and how quickly?**

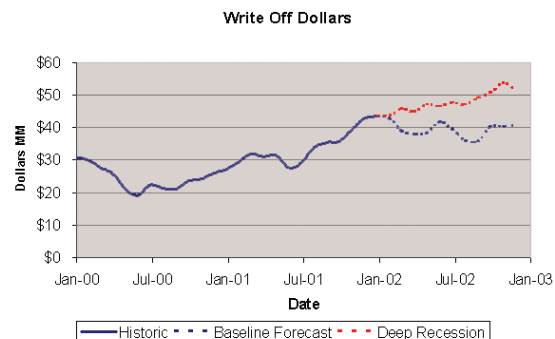
**LookAhead™, a scenario-based simulation tool** powered by SA's Dual-time-Dynamics (DtD) technology, is designed to provide answers to these kinds of questions and many more like them. Moreover, once LookAhead is configured to your portfolio's specifics—your way of describing the key credit variables, customer segmentation and the projections that matter to you—the answers come in minutes, at your desktop. Armed with a forward-looking view, you can direct the course of change with sound, solid projections reflecting the full range of your assumptions and business outlook.

**Several key features distinguish LookAhead from "home-grown" forecasting tools and processes:**

**1) DtD enables unparalleled accuracy** in forecasting behaviors such as attrition, utilization, and delinquency with its unique ability to distinguish account maturation characteristics from reaction to outside impacts. Forecasts therefore combine inherent, "baked in" behaviors with those that are subject to change based upon the scenario. No other tool of its kind brings this level of sophistication and accuracy.

**2) LookAhead's scenario-based simulation capability** allows unmatched flexibility in sizing up your portfolio's future. Begin with a baseline forecast—a steady state projection. Then construct scenarios describing proposed (or hypothesized) changes—LookAhead supports scenar-

ios imported from spreadsheets or intuitive visual scenario changes on the fly. In minutes, you will understand the impact of policy changes and behavioral shifts, not after days or weeks of staff-intensive crunching.



**3) LookAhead's client-specific configuration** invites the incorporation of new portfolios, new segmentation schemes and business rules. It also ensures a regular and fresh link to the business data required to produce your forecasts. In short, LookAhead grows with you as your business changes and complexity grows. With full and ongoing support by Strategic Analytics, your LookAhead license ensures that you have access to the latest in forecasting advances. ●

Combining advanced analytics with flexibility, configurability, and support puts LookAhead far ahead of the pack. For a personal look at LookAhead, please contact **David Franklin at 505.438.9501 (x 102)** or write us at [sales@strategicanalytics.com](mailto:sales@strategicanalytics.com).



Michael Smith

# MICHAEL SMITH

**J**UST AS THE FLOOR PLAN, finishes and "feel" of a new building reflect the skill of its designer, the function and feel of SA software reflects the work of Michael Smith, Chief Software Architect since joining the company in 1999. In the same way that a well-designed building has a much better chance of serving its purpose, adapting to new uses and standing the test of time, so Mike translates the analytic visions and insights of the company into components that create valued and robust tools for our clients.

**It's a complex task**, especially in the environment of a relatively young company—but more so, because he is developing technology with exceptionally broad applicability. This uncertainty and breadth drive requirements that

**“** We design software so that varying aspects of the solution are contained in fairly independent components—that way, changes to a single component do not impact others

are fluid, diverse and dynamic: attributes that many in his role would shy away from. Yet these challenges are exactly what attracted Mike to SA and to it, he brings a rich technical background, an interest in all facets of the business of both SA and its clients with a steady, calm determination to do the job right.

#### **ROLE AT SA:**

Translates analytic concepts into versatile software components, allowing efficient and reliable delivery to clients.

#### **BACKGROUND:**

Modeling of biological and physical systems—including the human auditory system. Developed distributed intelligence systems for command and control of military operations. Later applied development skills to the creation of an advanced crisis simulator—allowing senior bank managers the ability to try their hands at managing through economic crisis. Advocate for software reuse and early adopter of Java and XML.

#### **SOFTWARE DEVELOPMENT PHILOSOPHY:**

"We work hard to determine how we can maximize the value of our tools for clients. This can result in a rather fluid set of requirements...we design software so that varying aspects of the solution are contained in fairly independent components—that way, changes to a single component do not impact others."

#### **TEAM PHILOSOPHY:**

According to Mike, one of SA's strengths is how the company confronts challenges. "There is considerable sharing of opinions...finding the best solution is more important to us than who finds the solution."

#### **HOBBIES:**

A lacrosse player in college and later in clubs—the game's appeal is its fast-paced, dynamic nature. "Defense and offense can change instantly, and success depends on quick changes to strategy and communication." The qualities of the game map directly to Mike's professional interests. "I'm drawn to work environments that are challenging in their content, and dynamic in their execution." Mike is also an accomplished cook, bringing a natural curiosity about the scientific aspect to his efforts. "I'm finding there are dynamics to bread dough that are not fully understood at this time." ●

# Tools from Nonlinear Dynamical Systems Theory Offer New Methods

**I**n grade school we are all warned not to compare apples with oranges. The size of two objects can't be compared unless we measure each in some common unit. Comparing the speed of two runners requires that each be measured in elapsed time over a set course. But even quantities measured with the same units can be difficult to compare if the measurements are taken at different times and under different circumstances.

Is it really possible to compare Roger Bannister's 1954 world record performance, running the mile in 3:59.4 minutes, with Eamon Coghlan's 1983 time of 3:49.78? The two runs were completed under very different circumstances (Bannister's was outdoor, while Coghlan's was indoor), under different training conditions, and with different expectations. How is it possible to compare data that are recorded at different times, subject to different environmental conditions?

Comparing the performance of consumer portfolios that evolve over different time periods and that are subject to different economic and management conditions offer many of the same challenges. Classical equations offer one possible solution to some of these comparison problems. Equations governing weather patterns, called the Navier-Stokes equations of fluid turbulence, are widely agreed upon, but the exact initial conditions that correspond to actual weather patterns are not known, and small errors between the model and reality are amplified exponentially. For instance, it is widely acknowledged that the state-of-the-art in weather prediction is a seven-day forecast. Experts using sophisticated models and data from places like the National Center for Atmospheric Research greatly outperform chance in their weather projections out to one week. On the 8th day, they are better off flipping a coin for prediction. Therefore, knowing the equations that theoretically guide a process is an important first step, but how do you measure and set initial conditions accurately so that you end up with a good long-range forecast?

Some help to this question arrived late in the last century. The modern era of dynamical systems theory began in 1890 with the work of the French mathematician Henri Poincaré who was primarily concerned with predicting the motion of planets. Focusing on the so-called 3-body problem, his concern was the analysis of the earth-moon-sun system under mutual gravitational attraction. The equations for this system were well known at the time and are relatively simple to write down. Their solutions, Poincaré discovered, were highly sensitive to changes in the initial conditions. Small changes in them, as in the equations governing weather systems, are exponentially amplified, a phenomenon now called the Butterfly Effect. Poincaré discovered chaos theory, and a new era in scientific inquiry was opened. Novel techniques for mining data and estimating initial conditions are being developed from this new field driving exciting practical applications.

The Genesis Discovery Mission, launched in August 2001, was sent along a trajectory to Mars that was designed to take advantage of the dynamical structure of the gravitational fields produced by the planets, something that would not have been possible without the use of nonlinear dynamics tools developed in the last 20 years.

Techniques from nonlinear dynamics have also had a profound impact on the field of time-series analysis. They have given us a way to understand these time-series and make meaningful comparisons between them allowing us to create new forecasting strategies. To return to our original question, how can one

## PAUL K. NEWTON

Professor of Engineering and Applied Mathematics, University of Southern California



### > PAUL NEWTON RECEIVED HIS B.S. DEGREE

(*cum laude*) from Harvard University majoring in applied mathematics and physics, and his Ph.D. degree in applied mathematics from Brown University. He has been a Professor of Mathematics at the University of Illinois, Urbana-Champaign where he was also a member of the Center for Complex Systems Research, and has held visiting appointments at Stanford University, Brown University, and the Institute for Theoretical Physics at UC Santa Barbara. He is the author of the book *The N-Vortex Problem: Analytical Techniques*, published by Springer-Verlag, as well as over 50 journal articles on various topics in nonlinear and chaotic dynamics, nonlinear partial differential equations, and turbulent fluid flows. He serves on the editorial boards of the *Journal of Nonlinear Science* and Springer-Verlag's *Texts in Applied Mathematics*.



compare financial data that is collected over different periods of time?

The problem of comparing consumer portfolio data is very much like trying to compare data collected on two different graduating classes from a university. Most alumni offices send out surveys to their graduates every five years in order to collect data such as salary information, and more subjective data, such as the "level of personal satisfaction" achieved. Suppose the Class of 1981 has an average annual salary of \$100,000 while the average annual salary from the more recent Class of 1991 is only \$50,000. From this data, it is not at all easy to determine which of these classes has a "more successful" student body, even if you were willing to accept average salaries as a measure of success. The Class of 1981 has been out longer, has more experience; hence their salaries should be higher. To compare more directly, we would need to compare the average salaries of the two classes the same number of years after graduation. But this too is difficult. Economic conditions were booming when the Class of 1981 graduated and were not as favorable to the Class of 1991. Shouldn't this be factored in?

One solution to this kind of problem being pioneered by Strategic Analytics is the use of sophisticated data discovery and decomposition techniques that break down a signal

into components between which fair comparisons can be made. In the context of consumer portfolio performances, the key components are the maturation effects found in a portfolio and the exogenous impacts coming primarily from the outside environment. By measuring these effects at the component level, we can begin to measure them and make meaningful comparisons among them. Back to our alumni satisfaction example, using these techniques we can adjust satisfaction responses for

**Techniques from nonlinear dynamics have also had a profound impact on the field of time-series analysis and are beginning to be used to analyze data both from the financial markets and from complex weather patterns.**

the economic (exogenous) conditions at graduation, thereby arriving at a "pure" measure of satisfaction normalized for the environment.

There are many new areas that the field of nonlinear dynamics has influenced over the past ten years, with the analysis of time-series being one of the most exciting and promising. When coupled with solid business experience and in-depth domain knowledge, we can expect new breakthroughs in modeling and prediction for business processes. ●

## Readers Note:



This issue marks the first anniversary of **Signals**, **Strategic Analytics' corporate newsletter** which targets a select group of credit, risk management, and information technology professionals. As we enter our second year of publication, your feedback helps guide the content of future issues. We're particularly pleased to receive reactions to our technical content, guest articles, case studies, and overall readability. Please help shape future Signals by emailing your comments to: [signals@strategicanalytics.com](mailto:signals@strategicanalytics.com). In addition, you may make any address changes or unsubscribe using the same email address.

Signals is published quarterly by Strategic Analytics Inc. for our clients, investors, and partners. To provide feedback, change an address, or request a subscription, please write:

8

[signals@strategicanalytics.com](mailto:signals@strategicanalytics.com)

\*

Strategic Analytics 3900 Paseo Del Sol  
Santa Fe, New Mexico 87507

(

505 438 9501

CONTENTS COPYRIGHT 2002 BY STRATEGIC ANALYTICS INC. ALL RIGHTS RESERVED. PRODUCT AND COMPANY NAMES ARE TRADEMARKS OR REGISTERED TRADEMARKS OF THEIR RESPECTIVE HOLDERS. PRINTED IN USA.

## Signals

**Editorial Director**  
Patrick Culhane

**Designer**  
Heidi Volpe

**Copy Editor**  
Barbara Riley