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AIMR's Member Magazine for
Investment Professionals

March/April 2004

Risky BUSINESS

**Defying the throes of financial risk
takes sheer grit, unwavering skill,
and a little bit of luck**

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A man in a dark suit is rappelling down a thick rope from a very high floor of a modern skyscraper. He is holding a black briefcase in his left hand and a black umbrella in his right hand. The background shows the repetitive grid of windows of the building and a blurred city street with cars below. The overall color palette is dominated by blues and greys, with the man's suit providing a dark contrast.

Risky

BY CHRISTOPHER WRIGHT

Unexplained meltdowns. Position blowups. Rogue traders. Elegant models that turn to dust and roil markets. Such is the world of risk management. Yet, despite the availability of sophisticated statistical risk models, managing risk requires more than mathematical wizardry. One must go beyond the models to fully grasp the essential aims of risk management and understand its limitations.

This article traces the historical development of risk management from the 1950s forward. In this way, we will gain a full appreciation for where we are in the story and for where risk management is headed in the future.

Hold on to your security blanket; this is no ordinary bedtime story.

BUSINESS

THE STORY OF RISK MANAGEMENT PAST, PRESENT, AND FUTURE

PAST IS PROLOGUE

Our story starts out harmlessly enough with the advent of modern portfolio theory in the 1950s when Markowitz, Tobin, and Sharpe concluded that there is no reward without risk and systematically tied portfolio risk to interactions between portfolio components for the first time. Diversification and hedging grew out of their work with pricing risky assets (CAPM), asset correlations, and volatility (beta). Standard deviation, which could be easily applied to stocks and bonds, became the primary measure of risk.

The publication of the Black-Scholes options pricing model in 1973 was a watershed event in the history of risk management. Shortly after the first options exchange opened its doors in Chicago, MIT professors Myron Scholes and Fischer Black developed a mathematical formula for the fair pricing of options based in part on the current price and average volatility of a stock. Financial managers could use the formula to create risk-free positions (e.g., building on the idea of using put options to cancel out the risks of holding equities). Large losses were now theoretically impossible.

The model was further developed by Robert Merton, who showed that it could be used more broadly. The model was subsequently adopted in commercial loan credit-scoring and in valuing debt, deposit insurance, oil exploration leases, and other contracts depending on the uncertain future value of an asset.

The Black-Scholes options pricing model is the bedrock of the modern practice of risk management. “The field of financial risk management really began to take off when risk became quantifiable,” says Leslie Rahl, founder and president of Capital Market Risk Advisors, Inc. The Black-Scholes model contributed substantially to the growth of the derivatives markets and the practice of risk management in the ensuing decades. Hedging risk with futures, options, and swaps entered the mainstream.

The Black-Scholes model depends on the share price, which changes constantly. Thus, the option price the model produces quickly goes out of date. A way was needed to instantly recalculate option values in order to eliminate risk continuously. In work credited to various people, the problem was solved, and dynamic hedging was born.

Dynamic hedging is the continuous, computer-driven modification of portfolio positions to maintain hedges in

the face of changing market prices. Also known as portfolio insurance, dynamic hedging is a method for synthetically replicating put options.

Which brings us to the stock market crash of 1987, a significant event in the history of risk management. The Dow Jones Industrial Average went down 508 points in one day, or 22.6 percent (and a total of 769 points or 31 percent in four days) — a 20-standard deviation event. “Dynamic hedging products sold like hotcakes in 1985 and ’86, but the October ’87 crash showed that it doesn’t always work,” says MIT financial engineering professor Andrew Lo, PhD.

“When people went to cash out of stocks and [get] into bonds, herd behavior made stocks fall faster, and investors were down 20 to 25 percent before they could get out,” says Lo. “It’s a funny kind of insurance that works when you don’t need it and doesn’t work when you do.” The ensuing debate about portfolio insurance really changed minds about risk management.

The 1990s saw a series of spectacular financial disasters. Take the case of Metallgesellschaft in 1993 when it incurred a US\$1.3 billion loss in oil futures. Or several more famous cases. In 1994, Orange County’s positions in leveraged derivatives betting on low interest rates caused US\$1.7 billion in losses and pushed the county into bankruptcy.

Rogue trader Nick Leeson brought down Barings Bank in 1995 when he lost US\$1.4 billion in unauthorized futures and options trading. Barings went bankrupt and was later sold to ING. Sumitomo Corporation lost US\$2.6 billion in copper futures trading in the years running up to 1996.

A TURNING POINT

One of the most significant turning points in the history of risk management, according to Lo, was the collapse of Long-Term Capital Management (LTCM) in 1998. Myron Scholes and Robert Merton, who shared a 1997 Nobel Prize for their work in options pricing, reentered the stage among the principals of LTCM, a billion dollar US hedge fund earning 40 percent returns in leveraged fixed income arbitrage, straddles, and futures.

Dazzled by such luminaries of modern finance, other market participants gave LTCM preferential treatment — extending unlimited credit and exempting LTCM from margin requirements. (The halo effect was also an ingredient in the Enron story.)

Most of LTCM's activities involved arbitrage between Treasuries and more complex instruments with credit and liquidity premiums. When Russia declared a debt moratorium in August 1998, LTCM's counterparties began demanding more collateral to cover widening spreads. LTCM lost US\$550 million in a single day — something LTCM's models showed could only occur once every 800 trillion years.

It was feared that a default by LTCM would spark a mass close-out in derivatives markets and cause mark-to-market values to spiral downward. There was also concern that an unknown number of other firms had begun to imitate LTCM and that a market meltdown was in the offing. With nothing less than the fate of the entire global financial system thought to hang in the balance, Alan Greenspan, chairman of the US Federal Reserve Board, and others arranged for a bail-out. A consortium provided US\$3.6 billion in additional capital to reassure markets, and LTCM's positions were gradually liquidated over the next two years.

By the time it was over, LTCM's partners had lost US\$1.1 billion. The question is obvious: How could such smart people get it so wrong?

LESSONS LEARNED

The 1987 crash ... Orange County ... Barings Bank ... LTCM. What lessons have been learned from this sordid history?

“Those four events taught us totally different lessons and, hopefully, risk managers have integrated them into their thinking,” says Rahl. “It is highly unlikely that the future will resemble the past, but the important point is that, given the frequency of supposedly once-in-a-lifetime events, any approach to risk management will have to emphasize stress testing and ‘what if’ analysis.”

A recurring feature in the blowups of the 1990s was the amassing of positions by junior personnel or subsidiaries without the knowledge or comprehension of senior management. Risk managers took note and began to place emphasis on the risk management process — asking the right questions, curbing incentives to take unwise risks (moral hazard), and focusing on other facets of adequate supervision.

“LTCM also gave people a new appreciation for liquidity risk — the inability to unwind positions and get out when you need to,” Lo says.

Another lesson of LTCM has to do with the cascade effect of herd behavior. Attracted by outsized profits, other large financial institutions had begun to replicate LTCM's methods and positions with implications for the entire global financial system. While the stakes may not have been as high in the 1987 crash, herd behavior and liquidity risk figured in that crisis as well.

Perhaps the final lesson of LTCM is humility — even the smartest people can fail to devise models that adequately capture market complexities (model risk).

THE PRESENT — VAR

Where do things stand today? Standard deviation is no longer the risk measurement tool of choice. Standard deviation is driven equally by the upside when what people really care about and consider risky are surprises to the downside. New measures have been developed focusing on downside surprises. One of these, shortfall, measures the probability of falling below a prespecified benchmark return.

But, by far, the primary tool in use today to examine the downside is value at risk (VAR). According to Professor Lo, new risk measures were needed after options portfolios became common in the 1970s. Options have complex payoff structures unlike stocks and bonds. The nonlinear risks posed by options gave rise to the need for new risk analytics. The main tools in use today — VAR, stress tests, and scenario analysis — grew out of the derivatives industry, which developed significantly in the 1970s.

VAR was next widely adopted among banks and bank regulators as the basis for bank capital requirements, Rahl says. VAR was also being used in the broker-dealer community and was beginning to be discovered on the buy side prior to LTCM, she says. VAR spread out from there to mutual funds and nonfinancial corporations.

VAR is the maximum amount a portfolio can lose over a specified holding period at a given confidence interval.

Concern about tail events has led firms to supplement VAR with stress testing and scenario analysis, which ask how portfolios would perform under more extreme sets of assumptions ...



Illustrations: Robert Megawick

It results in a statement such as “the most this portfolio can lose over the next 24 hours is US\$1 million with a 95 percent probability.” There are three basic methods used to compute VAR: correlations, historical data, and the Monte Carlo method.

Historical patterns are not always a reliable guide to the future, especially in times of market turbulence. Maybe the next 10 years will not look like the last 10 years. This has led to greater use of the Monte Carlo method, which relies on predictive math and computer simulations to compensate for deficiencies in historical loss data. Monte Carlo programs easily run through a large number of complex scenarios derived from a range of values for interest rates and other macro factors.

A variation for calculating VAR, which is particularly favored by hedge funds, uses Principal Component Analysis (PCA). PCA attempts to reduce the data needed to calculate VAR by combining redundant variables into artificial super-variables (“principal components”), which account for most of the variance in a large number of risk factors. The calculation uses the smaller set of principal components, which are themselves uncorrelated.

One advantage of VAR is that it can be used to disaggregate total risk and uncover the main threats to portfolio value, which may stem from interest rates, macroeconomic conditions, or other factors. VAR is touted as a tool that can uncover such hidden concentrations of risk.

VAR has weaknesses. Different firms calculate VAR differently; there is no gold standard for the tool. Also, VAR only looks at asset prices and does not account for all risk to the portfolio. Notably, operational risk (about which more is said below) is left out of the equation.

VAR is fine 95 percent of the time, but what about the other 5 percent? Studies of historical data show that the risk of major market moves is orders of magnitude higher than normal distribution tables would suggest. One published rule of thumb holds that any financial market can expect at least one daily price move of four standard deviations or more every year. Risk managers are advised not simply to disregard the statistical outliers but to remember that return distributions can and do break out of the normal range and show fat tails to the downside.

Concern about tail events has led firms to supplement VAR with stress testing and scenario analysis, which ask how portfolios would perform under more extreme sets of assumptions concerning interest rates, currency movements, commodity prices, and the like. LTCM made financial managers aware of the need for stress testing, says Rahl. Reportedly, LTCM didn’t stress test enough and didn’t ask what would happen if the Russian ruble collapsed.

In scenario analysis, risk managers consider worst-case scenarios to anticipate extreme conditions and ask, “What if there’s a crisis?” It is said that “all correlations go to one in a crisis” — that markets all go down together in extreme conditions. As such, diversification as a risk management tool has its limits. Planning an exit strategy to address liquidity risk is something that would have helped LTCM. Risk managers also look for hidden risk factors such as credit downgrades that can cause disproportionate losses or even make a position blow up if the factor value changes slightly.

MEASURING FAT TAILS

Several additional measures of downside tail risk have been developed. Semivariance resembles shortfall but penalizes outliers more by squaring the tracking errors, thus capturing tail risk more effectively. Monte Carlo has been adapted to model expected return distributions with fat tails and run “bimodal” scenarios to predict performance under normal and crisis conditions.

Finally, Extreme Value Theory (EVT) purports to predict the chances of events that have never occurred. EVT has been used to forecast possible losses from extreme events — including catastrophic operational losses — in various contexts (finance, insurance, capital allocation, environmental monitoring, etc.).

One current debate is whether the risk of tail events is quantifiable, whether it is really possible to price the infinitesimal odds of very rare events and factor them as ordinary operating losses. To Lo, “It’s a bit like asking what are the

Fat Cats with Fat Tails?

BANKS AND THE NEW BASEL II CAPITAL ACCORD

A new framework for bank capital requirements, known as the New Basel Capital Accord (Basel II), is undergoing final revisions and is expected to be in place in large internationally active banks by 2007.

Basel II is the product of the Basel Committee on Banking Supervision (BCBS), which is composed of bank regulators and reports to the central bank Governors of the Group of Ten industrialized countries.

The committee's pronouncements do not have the force of law. Implementation is proceeding by way of rulemaking in the United States and legislation in the EU. Reportedly, the US Federal Reserve Board expects Basel II to apply initially in the United States to the 10 largest internationally active banks and also to another 10 that voluntarily opt in, bringing two-thirds of the total assets of all US banks under Basel II when it takes effect.

The case for Basel II is that current regulations fail to account for variations in the risk exposure of individual institutions, resulting in anomalies. Banks lending to AAA-rated companies have the same minimum capital requirements under the current one-size-fits-all approach as banks with BBB-rated firms in their loan portfolio.

"Not all institutions engage in equally risky activities," says Shyam Venkat, a partner at PricewaterhouseCoopers. Venkat leads the firm's financial risk management practice for the financial services sector. "Why subject the more conservative institutions or those that do a better job of managing their risks to the same capital requirements?" he asks.

The new accord makes a capital charge for operational risk explicit for the first time. Operational risk is the possibility of loss arising from "inadequate or failed internal processes, people and systems, or external events," which varies from bank to bank. Fraud might be the primary risk for a bank in the credit card business. Complex derivatives might be more of a factor for a full-service institution offering structured transactions.

Operational risk measurement is relatively new and underdeveloped compared to other sectors of risk management. But historical loss data — the key to developing operational risk measurement — is rapidly piling up and statistical analysis is proceeding apace at many banks. "The measurement of operational risk is in its infancy, but I am confident that these measures are already directionally cor-

rect and provide reasonable estimates of actual risk," says Joseph Sabatini, managing director and head of corporate operational risk at JP Morgan Chase.

Basel II lays out a menu of choices for calculating capital charges associated with credit risk and operational risk. A bank has some discretion in choosing the approach it deems most appropriate. The more sophisticated approaches rely on the bank's internal risk models. With respect to credit risk, a bank's own assessment of risk can provide inputs to the committee's capital ratio formulas, which will stay on the books. In contrast, a floor for operational risk may only be in place for the first two years.

The expectation of the banking industry is that the floor will be removed and that banks will be allowed to determine their own capital set-asides for operational risk if their internal models meet Basel II standards for, among other things, depth and breadth of historical loss data.

Some observers worry that banks are susceptible to low-frequency, high-severity tail events arising from operational risk that cannot be tamed by centralized controls. "Someone who doubts the accuracy of operational risk statistical analysis today is absolutely correct, but is missing the point," says Sabatini. "A measure that's off by a few degrees still provides the basis for improving risk management." In other words, a rough measure is better than no measure at all.

It has been estimated that a large bank will need to spend upwards of US\$100 million to comply with Basel II. Some in the industry argue that competitive pressure is forcing banks to develop risk management capabilities anyway, but an unidentified banker was explicit in a July 2003 media report about wanting a payoff — i.e., lower capital requirements — from this huge investment.

Smaller US banks complain that Basel II will give an unfair competitive advantage to larger banks that can afford to implement sophisticated risk-evaluation systems. Smaller banks, it is argued, will be stuck with Basel II's standardized menu choices, resulting in higher capital charges.

The ACB (America's Community Bankers) wants a simpler internal ratings system that can be used by smaller banks. Venkat agrees that the cost of implementing Basel II is a problem for smaller banks. "You don't need a Bentley to drive a short distance every day," he says. //

typical grazing habits of albino spotted tigers. If you haven't seen too many of them, you can't really study their properties."

Or, as a controversial FDIC staff study on the new Basel II Capital Accord (see story, p. 28) put it in December 2003: "No one knows how to measure the hundred year-flood plain for a large complex bank. Measuring the risk of extreme tail events in ever-changing bank loss distributions will always be an inexact science. Placing exclusive reliance on banks' statistical estimates of the likelihood of these tail events is not an acceptable way to protect the deposit insurance funds or, ultimately, the taxpayer."

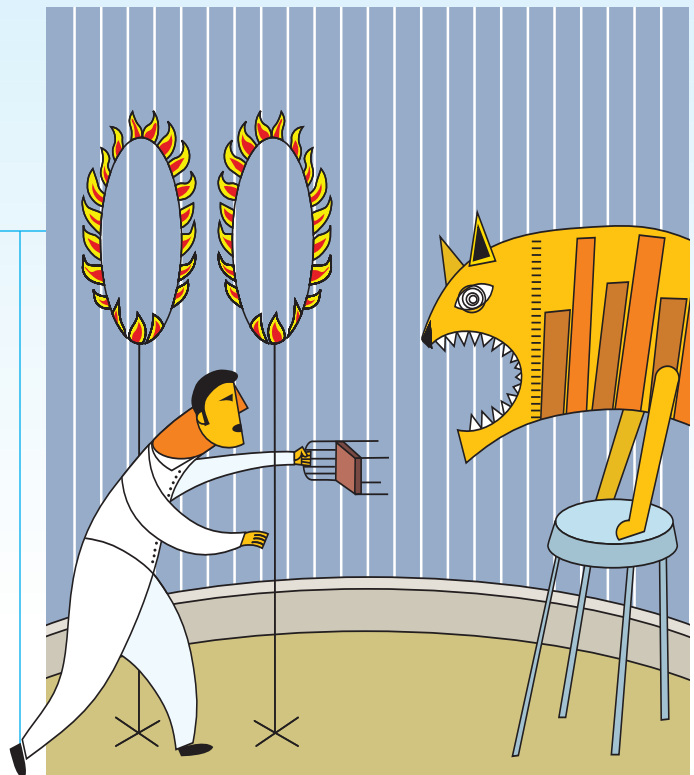
Lo continues: "We have successfully modeled fat tail distributions and can estimate them statistically, but we don't yet know what economic forces produce them." The greatest benefits to be gained from rare events, he says, lie not in mathematical modeling but in simply acknowledging that rare events exist and changing portfolio management practices accordingly.

Of course, this is easier said than done because human beings tend to dismiss the possibility of catastrophe out of hand. "We don't think about the chances of getting hit by a bus on a daily basis, but they are not always trivial," says Lo. "We act as if the true chances of low probability events are zero but they can kill you financially."

People do move back into a flood plain after flood waters have receded, and Professor Lo worries that "now we have the dog that didn't bark" — the lack of any major blowup in the hedge fund world over the past few years has caused many investors to forget the important lessons of 1998, making hedge funds more popular than ever.

The best that can be done with respect to the pricing of tail event probabilities is to pool them and treat them as a portfolio, says Shyam Venkat, a PricewaterhouseCoopers partner who leads its financial risk management practice for the financial services sector.

"Pricing low-frequency, high-severity events as one-offs is prohibitively expensive," Venkat continues. "But institutions attempt to rationalize taking on tail risks by adopting a portfolio approach and considering them as a basket of



things that won't all happen at once." The limitations of this approach become obvious during times of market stress — when a number of risks come home to roost at the same time and 'all correlations go to one,' as discussed above.

There is a split of opinion after LTCM as to where the greatest gains in risk management are to be made. "The solution," Robert Merton said in a 1999 *New York Times Magazine* interview, "is not to go back to the old, simple methods. That never works. You can't go back. The world has changed. And the solution is greater complexity." Others dismiss the efficacy of more complex valuation methods and want more government regulation, starting with additional public disclosure of risks by financial institutions. A third school of thought says it is time to recognize that risk management is an art, not a science, and to emphasize the managerial and judgmental aspects of risk management.

As CMRA's Rahl puts it, "It's tempting to want a single number to express risk, but risk is a very complex being that doesn't lend itself to a single number." Process transparency is a more important risk tool than an actual number, she says: "Hedge funds and other financial firms need to communicate with investors to assure them of the robustness and consistency of the risk management process."

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but risk is a very complex being that doesn't lend itself to a single number."**

Leslie Rahl, Founder and President, Capital Market Risk Advisors, Inc.

THE FUTURE — WHERE IS RISK MANAGEMENT HEADED?

Intriguing research is opening up new frontiers in risk management. Academics are looking into credit and liquidity risk and new ways of estimating default probabilities. They are also trying to develop more sophisticated statistical techniques for unstable correlations that would model how markets act in tandem in a crisis. Lo calls this “phase-locking behavior” and likens it to the phenomenon of fireflies flashing on and off in unison.

Myron Scholes and others are working in chaos theory to explain why “once-in-a-lifetime” events such as Orange County or LTCM seem to keep happening every three or four years. Lo has abandoned this line of research for now, finding markets much more complex than physical phenomena such as turbulence.

Where is the field of risk management headed? It has been predicted that financial innovation will continue to the point where financial managers have the ability to quantify nearly all risk and are engaged in stripping out all layers of risk until investors end up with precisely the risks they are most willing and able to bear.

In this vision of the boundless “unbundling and repackaging of risk,” some debt and equity instruments might become obsolete. Equity securities, currently a bundle of aggregated risks (market risk, specific risk, etc.), could give way to layered risk-linked contracts with specific payouts.

Rahl agrees that this is the future. “We’ve been living this vision incrementally since the early 1980s,” she says. “I don’t see it stopping.”

Lo finds the vision compelling and cites total return swaps as an early example where parties have cut up and redistributed risk. However, he sees some hurdles to overcome before investors — not to mention regulators — become comfortable with the total unbundling of risk. LTCM called into question the wisdom of relying purely on mathematical models. “The numbers are one thing, but how do you really tell if your counterparty is reliable enough to bet your pension fund on a five-year swap?” he asks.

It has also been predicted that some of the best financial



firms 20 years from now will derive their revenue from intellectual property associated with the unbundling and repackaging of risk rather than from monetary capital. Rahl agrees that intellectual property will provide new revenue sources for financial firms but argues that monetary capital will always play a part. “People need it, so firms providing capital will still exist, although they might take new forms,” she says. “If traditional firms no longer provide capital, somebody else will.”

Lo also buys the intellectual property argument, to some extent. However, he says that firms will not invest as heavily in this area as others predict because legal protection for intellectual property is uncertain. Merrill Lynch may have successfully defended its cash management account and collected royalties as a result, but financial patents are still few and far between. The issue for Lo is that the primary means of protecting new financial risk products is through trade secrets, which are considerably more porous.

Another prediction is that the risk unbundling process will usher in a new era in which capital markets are nearly perfect and the global economy enjoys unprecedented efficiency and stability. “Well, yes and no,” Rahl says. The valuation issue will remain. “I’m reminded by the signs I see driving around Connecticut: ‘We buy junk; we sell antiques.’ Clearly, value is in the eye of the beholder,” she says.

“The world is too complex,” Rahl continues. “There are different economies, different currencies, and different

“The models give some guidance but don’t provide absolute bounds of certainty. There are always tail events that surprise you.”

Shyam Venkat, Partner, PricewaterhouseCoopers

“People have forgotten the lessons of systemic risk that LTCM taught, and, with everyone using value at risk as their risk measure, we could be on the precipice of another crisis.”

Andrew Lo, PhD, Financial Engineering Professor, MIT

supply-and-demand needs. I'm not sure you can achieve equilibrium across all these forces. Markets are connected in some ways but isolated and regional in others. Arbitrage will continue because it's hard to remove all the arbitrage possibilities when they are driven by different factors.”

Lo is also a skeptic. “Markets are an evolving ecology,” he says. “New risks arise all the time.”

THE LIMITS OF RISK MANAGEMENT

What claim can be made for risk management when it reaches its inherent potential?

There are loose statements in the literature about normalizing, evaluating, and taming risk, but no responsible commentator claims that risk management can completely eliminate all risk. “Dealing with any manifestation of risk is still as much art as science because risk is unpredictable by definition,” Venkat says. “The models give some guidance but don't provide absolute bounds of certainty. There are always tail events that surprise you.”

Absolute certainty and security aside, many commentators are confident that risk management will prove even more beneficial in the future than it is today. “We will have a full appreciation of how much risk we're taking to make a certain amount of money,” says Rahl. “We will be able to view all investment decisions on a risk-adjusted basis — defining risk broadly to include reputational risk, legal risk, Spitzer risk, etc.”

Venkat believes that risk management will continue to evolve and ultimately result in better decision making across all facets of a business. “The risk element will be baked into strategic decisions and explicitly considered in, for example, deciding which new business to go after,” he says. As time goes on, constituents will want to know more about a firm's internal risk management practices before deciding whether to invest. “Risk management will apply more broadly in the future and the process will continue to adapt to include new manifestations of risk that arise all the time,” he says.

The field of operational risk management is relatively new and underdeveloped, but, even so, practitioners believe that it is already improving bank management and daily operations. “The value proposition is quite compelling,” says Joseph Sabatini, managing director and head of corporate operational risk for JP Morgan Chase.

As the field of operational risk develops, Sabatini says, “banks will understand operational risk more systematically and will be able to reduce their loss experience, lower the relative amount of capital required to support this risk class,

and raise overall productivity by standardizing and leveraging firm-wide risk management processes where appropriate.”

Lo sounds a more skeptical note about the inherent possibilities of risk management. “We will be able to associate the right bundles of risk with the right people who will hold them at the right time,” he says, but the numbers don't always tell the whole story. He cites a distinction between risk and uncertainty made by economist Frank Knight, who worked in the 1930s. “What was the probability in the 1990s that the Internet would succeed?” Lo asks. “That's not something you can measure.”

Some observers go beyond saying that risk management can't possibly account for everything. They claim that risk management can in some instances make things *more* dangerous. Peter Bernstein wrote in 1995 (after Orange County), “An explosive demand for novel forms of containing risk is developing, some of which, I fear, may in the end make markets more risky rather than less.”

Reportedly, some bankers believe that the new Basel II Capital Accord (see story, p. 28) is dangerous because it could increase systemic risk by tightening credit in times of recession when credit ratings are falling. Deterioration in corporate credit ratings could require banks with corporate lending exposure to increase retained capital by 300 percent, according to a Deutsche Bank estimate.

An ING Barings representative was quoted in December 2003 as saying that Basel II is already making bankers more cautious, and is causing them to curtail lending in troubled economies such as that seen in Germany. More German companies are expected to issue high yield bonds as a result.

Lo zeroes in on the universal acceptance of VAR, the main measurement of risk in use today. “VAR has made markets *more* unstable because now there's a new common variable we will all respond to when there are fluctuations,” he says. “It's like everybody in the boat moving to the left at the same time.” Risk management has unintended consequences, he says. “People have forgotten the lessons of systemic risk that LTCM taught, and, with everyone using value at risk as their risk measure, we could be on the precipice of another crisis.”

The one true path to developing a fuller appreciation of risk, according to Lo, is to experience more blowups. “What doesn't kill us will make us stronger,” he says. Sweet dreams ... **!**

Christopher Wright is a freelance writer in the Washington, DC, USA, area.