The New Religion of Risk Management

by Peter L. Bernstein

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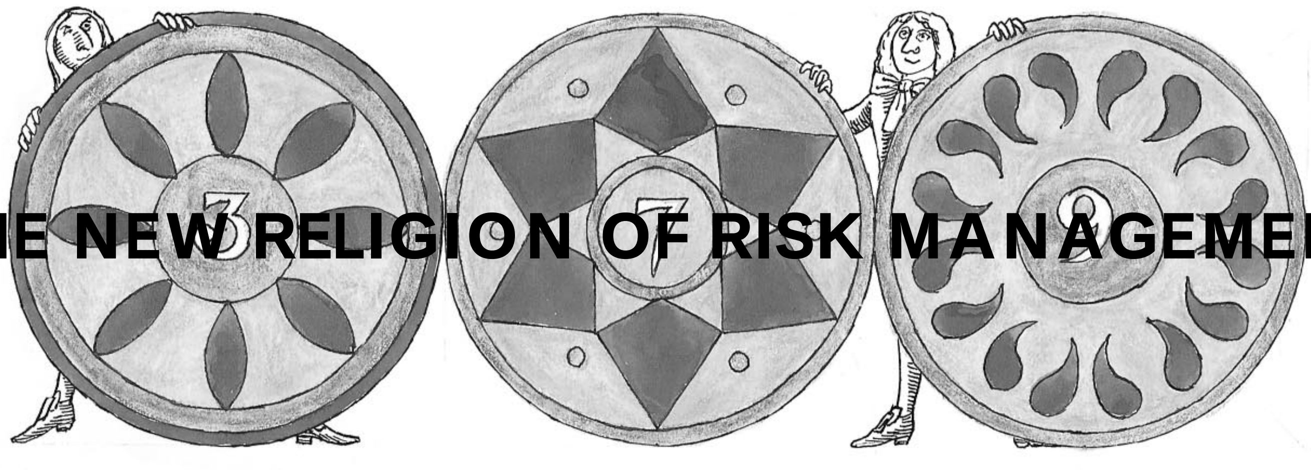
Have we replaced old-world superstitions with a dangerous reliance on numbers?

THE NEW RELIGION OF RISK MANAGEMENT



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The notion that the future rests on more than just a whim of the gods is a revolutionary idea. It is also a very young idea. A mere 350 years separate today's risk-assessment and hedging techniques from decisions guided by superstition, blind faith, and instinct.

More than any other development, the quantification of risk defines the boundary between modern times and the rest of history. The speed, power, movement, and instant communication that characterize our age would have been inconceivable before science replaced superstition as a bulwark against risks of all kinds.

Yet is today's sophisticated approach to risk management and decision making an unalloyed blessing? This question goes far beyond the well-publicized hazards of derivatives. What have we gained by the transformation from superstition to the supercomputer? What does it mean that the elaborate apparatus of probability analysis has supplanted hunches, intuition, and incantations, not only in business and finance but also in areas such as forecasting the weather or predicting the winner of the next race at the track?

I first shall describe how modern probability theory came about, because it is important to recognize how novel the approach is. I then shall discuss at greater length what we have gained and lost by replacing old superstitions with a new faith in numbers. We must consider the possibility that the whole process of breaking free from the Fates has turned us into slaves of a new kind of religion, a creed that is just as implacable, confining, and arbitrary as the old.

The history of risk management begins in the Renaissance, when the human imagination broke loose from the constraints of the past and exposed long-held fundamental beliefs to inquiry and challenge. It was a time of religious turmoil, budding capitalism, and an unbridled enthusiasm for science and the future.

Against this backdrop, the Chevalier de Méré, a French nobleman with a taste for both gambling and mathematics, challenged the famed mathematician Blaise Pascal to solve a puzzle about how to divide the stakes of an incomplete game of chance between two players, one of whom is ahead. The issue appears simple enough, but it had been a puzzle ever since it was set forth by Lucas Pacioli, an Italian monk, some 200 years earlier.[1] Pascal turned to mathematician Pierre de Fermat for help, and the outcome of the joint project – what could be considered a seventeenth-century version of the game of Trivial Pursuit – was the discovery of the theory of probability.[2]

With their solution, Pascal and Fermat created the first practical art of the modern world. Their audacious intellectual leap allowed people for the first time to make forecasts and decisions with the help of numbers. In one fell swoop, the instruments of risk management that had served from the beginning of human history – the stars, the snake dances, the human sacrifices, and the genuflections – were rendered obsolete. The modern investor's mantra, the trade-off between risk and reward, could now become the centerpiece of the decision-making process.

Pascal and Fermat made their breakthrough during a wave of innovation and exploration so powerful

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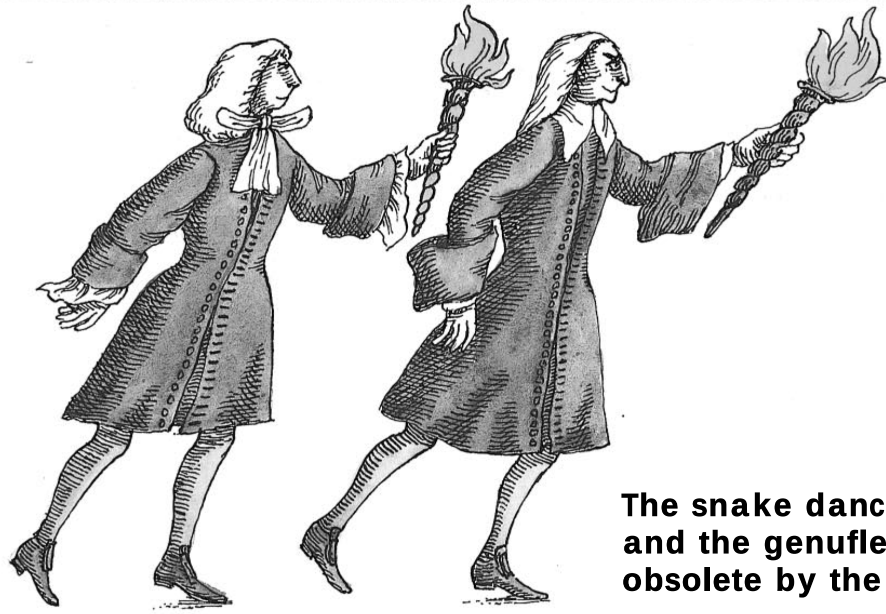
DRAWINGS BY EDWARD GOREY



The snake dances, the human sacrifices, and the genuflections were rendered obsolete by the theory of probability.

that it has been unmatched even in our own era. By 1654, the round earth was an established fact, huge new lands had been discovered, artillery was pounding medieval castles to powder, printing with movable type had ceased to be a novelty, wealth was pouring into Europe, the Amsterdam stock exchange was flourishing, and the population of London had been estimated for the first time.

Those developments had profound philosophical consequences that put mysticism on the run. By the middle of the seventeenth century, Martin Luther had said his piece and halos had disappeared from most portraits of the Trinity and the saints. English anatomist William Harvey had dared to overthrow the medical teachings of the ancients to discover the circulatory system of the blood – and Rembrandt had painted the *Anatomy Lesson*.

Breaking free from the Fates may have made us slaves of a new religion.

As the years rolled by, the mathematicians converted probability from a toy for gamblers into a powerful instrument for organizing and interpreting information. In 1703, Gottfried Wilhelm Leibniz commented to Swiss mathematician Jakob Bernoulli that "nature [had] established patterns originating in the return of events, but only for the most part," thereby provoking Bernoulli to invent the law of large numbers and the process of statistical inference. By 1725, the development of mortality tables had become a competitive sport among mathematicians, and the English government was financing itself through the sale of life annuities. By the middle of the eighteenth century, marine insurance was a flourishing and sophisticated business in London.

In 1730, the French mathematician Abraham De Moivre suggested the structure of the normal distribution and discovered standard deviation, the measurement of risk, and a much richer menu of the myriad uses of sampling. Eight years later, Daniel Bernoulli, Jakob's nephew, defined *expected utility*. Even more important, he propounded the idea that "the utility resulting from any small increase in wealth will be inversely proportionate to the quantity of goods previously possessed." With that innocent-sounding assertion, Bernoulli combined measurement and gut into one quantitative concept, hit upon the idea of risk aversion, and laid the groundwork for the basic principles of portfolio management in our own time. Bayes' theorem of 1754 – a striking advance that demonstrated how to make better-informed decisions by mathematically blending new information into old – came almost exactly 100 years after the collaboration between Pascal and Fermat.

All the risk-management tools we employ today, from the strict rationality of game theory to the challenges of chaos theory, stem from the developments between 1654 and 1754, with only two exceptions: the discovery of regression to the mean in 1875 by Francis Galton, an English amateur statistician, and the application of quantified diversification to portfolio management in 1952 by U.S. finance theorist Harry Markowitz. Both of those advances, however, built on the original work in probability.

As one ingenious idea has piled on top of another, the development of quantitative techniques for managing risk has enhanced our quality of life and set the accelerating tempo of modern times. These methods allow people to take more risks than they otherwise would – a benefit to society, which cannot progress without risk takers.

Without the laws of probability, no great bridges would span our widest rivers, polio would still be crippling children, and no airplanes would fly. Without life insurance, young families would have to turn to charity if their breadwinner were to die in the prime of life. And without health insurance, many more people would die before their time. Without fire insurance, only the wealthiest could afford to own homes. Without the ability to sell their crops at a price fixed before the crops are harvested, farmers would provide us with less food to eat. If there had been no liquid capital markets allowing savers to diversify their risks, the spirit of enterprise would have been stifled. The great capital-intensive industries of our age, such as the railroads and electric power, would, Soviet-style, have been inefficient creatures of the state – or, worse, might not have developed at all. Thousands of our most productive companies would never have come into existence. Economic growth would have moved forward at a snail's pace, and living standards would have been primitive compared with what we now take for granted.

Our lives teem with numbers, but numbers are only tools and have no soul.

But nothing good comes for free. The mathematically driven devices of modernism contain the seeds of a dehumanizing technology that offsets the positive features of risk management. Our lives teem with numbers, but numbers are only tools; they have no soul. At the center of the whole process is the computer, which consumes numbers like a voracious monster whose existence depends on ever greater quantities of digits to crunch, digest, and spew back out. The result is a culture that threatens to become so complex and frequently so arcane as to constitute a new religion.

I see three dangers in these trends: the exposure to discontinuity, the arrogance of quantifying the unquantifiable, and the threat of increasing risk instead of managing it. Taken together, these three dangers can be lethal.

The great English statistician Maurice Kendall wrote that "humanity did not take control of society out of the realm of Divine Providence...to put it at the mercy of the laws of chance." Albert Einstein would have agreed. In a letter to his fellow physicist Max Born, Einstein declared, "You believe in a God who plays dice, and I in complete law and order in a world which objectively exists." Einstein's choice of the word *complete* indicates that he had few worries about things like discontinuities or paradigm shifts.

In the messy real world of daily life, however, God has denied human beings complete knowledge of the laws that Einstein was convinced would define the order of the "objectively existing" world. Furthermore, although Einstein may have been correct that God does not play with dice *in nature*, the outcomes of most of the risks we take, as well as of all the risks we create, depend on the decisions of other human beings – especially in business and finance.

The English journalist G.K. Chesterton had the picture more clearly in mind when he wrote, "The real trouble with this world of ours is not that it is an unreasonable world, nor that it is a reasonable one. The commonest kind of trouble is that it is nearly reasonable, but not quite. Life is not an illogicality; yet it is a trap for logicians. It looks just a little more mathematical and regular than it is; its exactitude is obvious, but its inexactitude is hidden; its wildness lies in wait."

We all have memories of occasions when the wildness broke loose. Many of us can recall the moment in the late 1950s when bonds first yielded more than stocks, blowing apart a relationship sanctified by more than 80 years of history.[3] Others will remember the early 1970s, when long-term interest rates rose above 5% for the first time since the Civil War and then dared to *remain* above 5%. That wildness was followed shortly by another, even more frightening paradigm shift, when the price of oil broke loose from the long-standing grasp of the Texas Railroad Commission, which had regulated world oil prices since the early 1930s by controlling U.S. oil production.

Diversification is not a guarantee against loss, only against losing everything at once.

The amazing stability of key relationships over so many years depleted the capacity of people to imagine anything different. Worse, nothing suggested that they even should try to imagine something different.

Consequently, the calamities may not have been unpredictable, but they had become unthinkable. Now, consider this: If no one was able even to imagine that stock yields would remain below bond yields for decades, that bonds are in fact risk investments, and that OPEC could dominate the world energy scene, *how could we have expected a computer to imagine wildness like that?* How can we instruct a computer to model events that have never occurred, that exist beyond the realm of human imagination? How can we program into the computer concepts that we cannot even program into ourselves?

Clearly, we cannot put future data into the computer, because we do not know the future data. Instead, we program past data – the only available fuel for our models. Therein lies the logician's trap: Past data from real life are untrustworthy because they compose a sequence rather than the set of independent observations that the laws of probability demand. As Paul Samuelson has pointed out, history provides us with only one sample of the economy and the capital markets, not with thousands of separate, autonomous, and stochastic numbers. Even though many economic and financial variables have approximately normal distributions, the picture is never perfect. Resemblance to truth is not the same thing as truth. Those outliers and imperfections are where the wildness lurks.

It is hubris to believe that we can put reliable and stable numbers on the impact of a politician's power, on the probability of a takeover boom like the one that occurred in the 1980s, on the return on the stock market over the next 2, 20, or 50 years, or on subjective factors like utility and risk aversion. It is equally silly to limit our deliberations only to those variables that do lend themselves to quantification, excluding all serious consideration of the unquantifiable. It is irrational to confuse probability with timing and to assume that an event with low probability is therefore not imminent. Such confusion, however, is by no means unusual. And it surely is naïve to define discontinuity as anomaly instead of as normality; only the shape and the timing of the disturbances are hidden from us, not their inevitability.

Finally, the science of risk management is capable of creating new risks even as it brings old risks under control. Our faith in risk management encourages us to take risks we otherwise would not take. On most counts, that is beneficial. But we should be wary of increasing the total amount of risk in the system. Research shows that the security of seat belts encourages drivers to behave more aggressively, with the result that the number of accidents rises even as the seriousness of injury in any one accident may diminish. Derivative instruments designed as hedges have become vehicles for high-speed sleigh rides that no manager likes to contemplate. The introduction of portfolio insurance in the late 1970s encouraged a higher level of equity exposure than had prevailed before that invention. I have concerns about a similar process at work today among conservative institutional investors who use broad diversification to justify their large exposure in untested areas. Diversification is not a guarantee against loss, only against losing everything at once.

Yet nothing is more soothing and authoritative than the screen of the computer, with its imposing arrays of numbers, luminous color schemes, and artfully composed charts. That is not the worst of it. As we sit and stare at the data and the graphs, we are so absorbed in what we are doing that we tend to forget we are operating a gadget whose mind is at rest. Computers exist to answer questions, not to ask them.

Whenever we allow ourselves to ignore that truth, the computer becomes the ally rather than the enemy of our conceptual errors. Those who live by the numbers may find that the mathematically inspired techniques of modernism have sown the seeds of a destructive technology in which computers have become mere replacements for the snake dances, the bloodlettings, the genuflections, and the visits to the oracles and witches that characterized risk management and decision making in days of yore.

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1. Pacioli is a friend to all readers of this article. It was he who first introduced a systematic version of double-entry bookkeeping.

2. Pascal was a passionately religious man. He made it clear that the mathematical solution was only one of many ways to distribute the stakes, but to the players, who had trustingly parted with their money to place their bets in the pot, the mathematical approach was the only fair or moral solution.

3. From 1871 to 1958, stock yields exceeded bond yields by an average of 1.3 percentage points, with only three transitory reversals of which the last was in 1929. There is every reason to believe that stocks yielded more than bonds before 1871, the starting point for the most reliable historical data on the stock market. Since 1958, bond yields have exceeded stock yields by an average of 3.5 percentage points.

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