Probability, Gambling and the Origins of Risk Management

By Dan Cooper and Brian Grinder

The Chevalier de Méré, a 17th century gambler and dabbler in mathematics, once asked Blaise Pascal a question that began a revolution in the way people think about the future. Many historians trace the origins of modern risk management back to de Méré's question. De Méré probably had no intention of starting a revolution; his interest in mathematics sprang primarily from the realization that it could make him a better gambler. The question, which he evidently posed to several mathematicians, had to do with solving "The Problem of Points."

"The Problem of Points" was first discussed in print by none other than Luca Pacioli, of double entry accounting fame, in 1494. The problem is this: Suppose two gamblers have agreed to toss a fair coin until one of them has won a specified number of tosses. Each player bets the same amount on the game, and they agree that the first player to win three tosses gets the stakes. The game commences with the first player winning twice and the second player winning once. The gamblers are ready to toss the coin again, but unfortunately, the game comes to an abrupt halt and cannot be finished (maybe the police show up to raid the illegal gaming facility they are frequenting or perhaps a loan shark suddenly appears to collect money from one of the players). The question posed by de Méré was not how to best escape the pursuers, but how to split the pot between the two participants.

The answer to this seemingly simple question had eluded both gamblers and mathematicians for at least 200 years. Many thought it was impossible to arrive at a solution. Keith Devlin writes: "…before the Middle Ages, no one suspected it was possible to quantify the likelihood of some future event such as the outcome of the roll of a dice. Events that were not in some way predetermined were thought to be beyond rational analysis. The future was a matter determined by God…and there is nothing anyone can do about it other than pray and show allegiance to whatever deity you believe controls your destiny."

Pascal was a complicated man probably best described by the subtitle of historian Donald Adamson's biography as a *Mathematician, Physicist and Thinker about God*. Adamson contends, "Never again has an interest in mathematics and an interest in the religion of the Gospel been combined in one person to such a high degree." This apparent dichotomy has especially puzzled Americans who, because of a strongly held belief in the separation of church and state, tend to push religious issues out of the public square. Peter Bernstein, unable to reconcile these two sides of Pascal, simply dismisses his religious life as zealotry that eventually led him to convictions that were "essentially anti-intellectual."

Religious issues aside, Pascal tried to solve "The Problem of Points" but couldn't decide if he should consider all possible outcomes in arriving at the solution. For instance, if the final two tosses are either Heads Heads or Heads Tails, the outcome is the same, player one wins on the fourth toss, there is no need for the fifth toss and the game ends. To resolve the issue, he turned to Pierre de Fermat, one of the foremost mathematicians in the world. Fermat took a strictly algebraic approach to the problem and in a series of letters (the two never met face to face) convinced Pascal that, in order to solve the problem correctly, all possible outcomes must be considered. For the first time in history it was possible to correctly determine the distribution of the stakes. (For our example, player one should be given 75% and player two should get the remaining 25%. See Kaplan and Kaplan, pp. 25–30 for a detailed explanation.)

Adamson has described this accomplishment as releasing "the sciences from the straitjacket of absolute certainty, [and] establishing instead the concept of a stochastic universe." But how could the answer to a gambler's question by a couple of mathematicians who saw it merely as an interesting intellectual exercise be such a tremendous accomplishment? The answer lies in the ability to predict the future based on likely outcomes alone. The future was no longer the exclusive domain of the divine will or of fate; it could actually be predicted with mathematics by mere mortals! No, the future could not be predicted with certainty, but a reasonable estimate could now be made of future uncertain events.

As with most new ideas, this one caught on slowly; early applications of probability theory seemed either unpractical or frivolous. Pascal used probability theory in his famous wager about the existence of God but never really pursued it into other areas such as managing risk. Abraham de Moivre used his knowledge of probability and mathematics to accurately predict the date of his own death at the age of 87. Apparently de Moivre noticed that he was sleeping a little longer each night

and used that fact to predict the day he would simply not awake (November 27, 1754). The first practical application of probability theory was in the study of mortality rates. During the same decade that Pascal and Fermat were struggling with "The Problem of Points," John Graunt was busy compiling statistics on London's mortality rates. This information was later used by Christiaan Huygens who applied probability theory to Graunt's data in an attempt to calculate life expectancies, and the stage was set for the introduction of insurance as a risk management tool.

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In hindsight, probability theory has obvious application to the field of insurance, but its close association with gambling thwarted such application for decades. In 18th century London, it was possible to buy policies to insure against such things as adultery or losing the lottery. Insurance was also used to bet on the outcome of certain battles or on the life span of celebrities. According to Lorraine Daston, "Both insurance offices and their customers were for the most part betting on the future not planning for it." Daston also notes that insurance contracts were sometimes used to disguise usurious loans and contends that the early insurance industry "was not simply astatistical; it was antistatistical." The link between insurance and gambling would not be broken until well into the 19th century and would greatly hinder the use of probability and statistics in the development of financial risk management as attempts to quantify risk would not be made until the middle of the 20th century.

The tortuously slow development of risk management began in the lowly gambling halls of Europe but eventually led to an extremely sophisticated industry that today manages billions of dollars in assets. At its origins, Pascal and Fermat assumed that the game under consideration was fair: the coin didn't have heads on both sides and the dice wasn't loaded.[1] Part of the role of today's risk manager is to recognize when the game isn't fair, and part of the risk they must assess is the possibility of corruption. An anonymous risk manager recently wrote, "In January 2007 the world looked almost riskless…it was the most benign risk environment we had seen in 20 years." This outlook, apparently shared by scores of risk managers, led to a lackadaisical approach to risk management which, in spite of all its sophistication, failed to appreciate the ever-present temptation in the financial markets to make dishonest gains.

Financial economist Robert Shiller acknowledges that financial innovations can lead to "secret dealings, deception and even fraud," but he argues that, "New technology, with all its power, is always dangerous, and accidents happen as our society learns how to control it. In the early age of steam, many people were killed by boiler explosions, in the early age of air travel, by airplane crashes." He goes on to assert that such accidents were dramatically reduced through technological advances and is convinced that we will eventually be able to tame the financial innovations that have been so disruptive as of late. But, as the 911 terrorists so clearly demonstrated, there will always be those who will abuse technology, and we must constantly be on the lookout for them. Likewise, there will always be unscrupulous participants in the financial markets in search of an easy dollar. Corruption and irresponsible behavior, of course, is not limited to financial innovations. The recent rash of old fashioned Ponzi schemes that have been uncovered in both large metropolitan areas such as New York City and small rural outposts such as Grand Island, Nebraska have left investors from every walk of life with huge losses.

The recent market turbulence can be blamed on a number of factors, but it is clear that much of the downturn could have been avoided if a certain level of integrity had been maintained. Since totally honest markets are as unlikely as perfectly efficient markets, risk managers cannot simply depend on sophisticated formulas or the opinions of ratings agencies. Probability theory has been a powerful tool for risk managers, but it must be accompanied by an understanding of the corrupting power of money. Perhaps we can learn something from Pascal's interest in religion and morality after all. FH

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Sources

Adamson, Donald. *Blaise Pascal: Mathematician, Physicist and Thinker about God.* New York: St. Martin's Press, 1995.

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Anonymous. "Confessions of a Risk Manager; A Personal View of the Crisis." *The Economist* 388, (August 9, 2008): 72–73.

Bernstein, Peter L. *Against the Gods: The Remarkable Story of Risk*. New York: John Wiley & Sons, 1996.

Brenner, Reuven and Gabrielle A. Brenner. *Gambling and Speculation: A Theory, a History, and a Future of some Human Decisions*. Cambridge [England]: Cambridge University Press, 1990.

Daston, Lorraine J. "The Domestication of Risk: Mathematical Probability and Insurance 1650–1830." In *The Probabilistic Revolution Volume 1: Ideas in History*, edited by Lorenz Kruger, Lorraine J. Daston and Michael Heidelberger. Vol. 1, 237–260. Cambridge, Massachusetts: MIT Press, 1987.

David, F. N. *Games, Gods, and Gambling: A History of Probability and Statistical Ideas*. Mineola, N.Y.: Dover Publications, 1998.

DeGroot, Morris H. *Probability and Statistics*. Reading, MA: Addison-Wesley Pub. Co., 1986.

Devlin, Keith J. *The Unfinished Game : Pascal, Fermat, and the Seventeenth-Century Letter that made the World Modern*. Basic Ideas. New York: Basic Books, 2008. Kaplan, Michael and Ellen Kaplan. *Chances Are: Adventures in Probability*. New York: Viking, 2006.

Ross, John Frederic. *The Polar Bear Strategy: Reflections on Risk in Modern Life*. Reading, MA: Perseus Books, 1999.

Shiller, Robert J. *The New Financial Order: Risk in the 21st Century*. Princeton University Press, 2003.

Note

1 This does not mean that gaming systems or financial systems don't have inefficiencies that can be exploited. For instance in 1873, John Jaggers hired several clerks to record in secret the results of every spin on the roulette wheels at the Beaux-Arts Casino in Monte Carlo for a week. He analyzed this data, found that one of the roulette wheels was out of true, and used this information to win about $325,000 at that wheel over the next several days.

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had weakened depository institutions and to provide a new channel for the interregional movement of mortgage credit. During this early period modern securitization relied on the public GSEs, however, to insure and control the fundamental credit risks associated with mortgage lending.

When I examined the history of securitization in 1995 it appeared that private label securitization was set to reshape the market for jumbo residential and commercial mortgage just as GSE-sponsored securitization had transformed the conformable residential market. I observed at that time that history suggested caution—not because modern, private-label securitization would fail, but because rating agencies, underwriters and investors would demand complex, intricate and costly safeguards to make sure that it did not. I questioned, in other words, if the benefits of private securitization would be exhausted by the costs that would be imposed to guard against the failures that history has shown can arise in these structures.

It did not seem possible in 1995 that privately-sponsored securitization would venture so aggressively into the subprime mortgage market, that GSEs would support and follow that initiative or that mortgage credit risk would become so mispriced within inadequately capitalized securitization structures. But now we once again must respond to failure and its consequences; in doing so history suggests that we consider two issues carefully. First, do we now know enough to create a regulatory framework within which private securitization structures can become stable and cost-effective intermediaries? If we do not, how can we best integrate public and private facilities to realize the benefits of mortgage securitization? FH

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Sources

Bogue, Allan. *Money at Interest*. Cornell University Press, 1955.

Brewer, H. Peers. "Eastern Money and Western Mortgages in the 1870s," *Business History Review*, 1975.

Mappin, W.F. "Farm Mortgages and the Small Farmer." Political Science Quarterly 4, 434–451, 1889.

Miller, Glenn H. *Financing the Boom in Kansas, 1879 to 1888*. Unpublished thesis, University of Kansas, 1954.

Snowden, Kenneth. "Mortgage Securitization in the United States: Twentieth Century Developments in Historical Perspective." In *Anglo-American Financial Systems: Institutions and Markets in the Twentieth Century*, edited by M. Bordo and R. Sylla, pp. 261–298. New York: New York University, 1995.