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SURVEY - MASTERING RISK -10: Why risk management is not rocket science

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Why risk management is not rocket science

Summary

In 1996 and 1997 the hedge fund run by Long-Term Capital Management (LTCM) had an unbroken run of success and established an unrivalled reputation in managing financial risk, says René Stulz. In August 1998, however, Russia defaulted on its debt, setting off a chain of unheard-of market movements that proved disastrous for LTCM. Some say the moral of the story is that risk management is flawed, since the fund's partners were experts in the discipline on Wall Street and in academia. Here the author offers a different interpretation of events.

The collapse of the hedge fund managed by Long-Term Capital Management (LTCM) in 1998 was a stunning event. Roughly half the LTCM partners had finance doctorates, most of them from Massachusetts Institute of Technology (MIT). Two of its partners, Robert Merton and Myron Scholes, had won the Nobel prize for research of which the cornerstone was a technique to hedge derivative risk. LTCM also included a group of traders with considerable experience in the markets and the leader of this dream team was a trader with an awesome reputation. Yet in a matter of months the fund lost more than Dollars 4bn and LTCM was accused of seriously endangering the world financial system. Many have argued that this collapse demonstrates that modern financial risk management techniques do not work. Before turning to this issue, it is useful to review the history of LTCM up to and including the collapse.

Where did LTCM come from?

In the 1980s and early 1990s, Salomon Brothers made billions of dollars through its proprietary trading. Most of those profits came from its bond arbitrage group led by John Meriwether. This group was created to take advantage of misvaluations of securities with correlated risks by taking a short position in the overpriced security and a long position in the underpriced one, hedging those risks that could be hedged (see box on page 4).

To understand this approach, suppose the group decided that the yield on a particular US agency bond was too high compared with US Treasury bonds (yields in fixed income markets are inversely related to the price of a security). Certain agency bonds benefit from various guarantees from the US government. Yet such bonds trade at a higher yield than comparable government bonds. The group would purchase the agency bond and sell short government bonds with the view that eventually the yields would converge - hence the term "convergence trade" to denote such a position.

Because of government guarantees, the main risk of the bonds is interest rate risk, but the position would have little interest rate risk because of the offsetting bond positions. The position would generate cash because of the difference between the coupon received and the coupon to be paid on the short position. Further, any narrowing of the spread between the yields of the agency bonds and the Treasury bonds would create a capital gain.

Eventually, Salomon Brothers was embroiled in a scandal when an employee was charged with manipulating auctions for Treasury bonds. Several senior managers at Salomon left the institution in 1991, including Meriwether. Two years later, Meriwether founded Long-Term Capital Management (LTCM) to manage a hedge fund, the Long-Term Capital Portfolio. Hedge funds are unregulated, managed pools of money. LTCM was organised to pursue the strategies that the arbitrage group at Salomon Brothers had implemented and very quickly several members of this group joined LTCM, along with future Nobel Laureates Robert Merton and Myron Scholes.

A short history of LTCM

The fund began trading in February of 1994 and had stellar returns in its first two years - its investors earned 43 per cent in 1995 and 41 per cent in 1996. In 1997, the fund did substantially less well, earning 17 per cent. By December 1997, the fund's equity had grown to more than Dollars 7bn. LTCM decided that it did not need so much equity in the fund and returned Dollars 2.7bn to its investors.

At the beginning of 1998, the fund had capital of about Dollars 4.7bn. Each dollar of capital was used to borrow funds, which brought the total assets of the fund roughly to

Dollars 125bn. The fund had derivatives positions in excess of Dollars 1,250bn of notional value. These positions were artificially high because LTCM's strategy was to get out of certain derivatives positions by taking new, off-setting positions rather than by terminating the existing contracts before maturity. In the summer of 1998, the fund had positions in a wide variety of markets: Danish mortgages, US Treasury bonds, Russian bonds, US stocks, mortgage bonds, Latin American bonds, UK bonds and US swaps. Under normal circumstances, these positions were mostly uncorrelated - the fund took advantage of diversification to reduce its risk in addition to hedging positions.

LTCM wanted the volatility of the fund to be roughly 20 per cent on an annualised basis. Before April 1998, its volatility was consistently below its target, averaging 11.5 per cent; the fund's volatility was very stable. After the fund's capital was reduced, its volatility was still substantially lower than 20 per cent. With capital of Dollars 4.7bn, a monthly Value-at-Risk (VaR) of 5 per cent corresponding to a volatility of 20 per cent is Dollars 448m. In other words, the fund was expected to lose in excess of Dollars 448m in one month out of 20 at its target volatility.

On August 17, Russia defaulted on its domestic debt. This started a period of dramatic market movements that led to large losses for the fund. On August 21 1998, it lost Dollars 551m, mostly in positions that had nothing to do with Russia, but many were adversely affected by it indirectly as discussed below. The loss on August 21 was more than 10 times the target daily volatility of the fund - computer spreadsheets return a probability of zero for such an event if returns follow the normal distribution.

By early September, the fund's investors had seen their investments reduced to half their January levels, and the fund was running out of capital. Meeting under the auspices of the Federal Reserve Bank of New York on September 23, the heads of 14 leading banks and investment houses decided to invest Dollars 3.65bn in the fund and obtained a 90 per cent stake in LTCM. This was not a public money bail-out, since no public money was used. Rather, it was the equivalent of pre-packaged bankruptcy: the fund was restructured to avoid default.

In December 1999, the fund was dissolved. The above-mentioned banks and investment institutions made a profit of 10 per cent on their investment. The fund had about 100 investors who were not part of the management company. Out of these 100 investors, 88 made a profit on their investment. The typical investor's average annual return was 18 per cent.

The limits of financial engineering

The entire strategy of LTCM had been based on its ability to manage risk. It had shown until 1998 that it was masterful at doing so. Until then, it never made a loss two months in a row and its worst monthly loss was 3.85 per cent. Its ability to manage risk enabled the fund to economise on equity capital, so that investors could earn more. It looked like a money machine. Yet, despite the considerable successes of modern finance, the partners knew that risks cannot be measured exactly and controlled perfectly and were well aware of the limitations of the models they were using.

LTCM was full of individuals who had made contributions to the pricing of derivatives - some of them path-breaking. Models developed in financial economics are tremendously useful but, like models in any science, they also have limitations. For instance, any trader mechanically applying the formula for the pricing of options would lose his shirt quickly. Practitioners and academics have developed many adjustments to the Black-Scholes formula. However, adjustments that work well for a period of time may suddenly fail. For example, the mistakes one would have made using the Black-Scholes formula changed after the crash of 1987.

Most of the time and for most applications, the limitations of these models are not consequential. Nevertheless, problems that have little impact on an institution with limited leverage can become dramatically magnified in a highly leveraged institution. Imperfections in pricing models could, for example, lead a trader to conclude that there are profit opportunities in the markets when there are none.

Consider the yield spread between debt-rated Baa bonds (bonds with some speculative characteristics) and Treasury bonds. Since 1926, Baa spreads have ranged from roughly 50 basis points to almost 800 basis points. Finance academics have found it difficult to explain spreads of several hundred basis points for Baa debt using characteristics of issuing companies. One way of looking at such large spreads is to say that they represent mispricing that can be exploited to create almost risk-free profits. Another way is to say that the models are missing something important - in other words, part or all of these spreads is more akin to an insurance premium that compensates holders of bonds for the risk they take.

Investors who believe in the mispricing theory may make large profits from exploiting large spreads for a while even if the mispricing theory is false. Eventually, though, if investors are being compensated for taking risks, their bets will make losses. This is no different from a business that makes its profits by selling earthquake insurance as long as there are no earthquakes. If the bets are highly leveraged, losses can be crippling. What looked like a free lunch can become a very expensive one.

Too much faith in black boxes?

Although LTCM's problems have received most of the attention, the loss in equity value of large banks over the last two weeks of August 1998 make its losses look less dramatic. On August 21, when LTCM lost half a billion dollars, Citicorp's equity fell by more than Dollars 2bn. From August 26 to September 4, the market value of the equity of Bankers Trust, Chase Manhattan, Citicorp and J.P. Morgan fell by a combined Dollars 43bn or 29 per cent. Clearly, the risk management systems of LTCM were not the only ones that had problems on these days. It is, however, important to be clear about where the systems went wrong.

Systems did not fail to predict that large losses were possible. A daily VaR that measures the maximum loss at the confidence level of 99 per cent will be exceeded one day out of 100 on average if it is estimated accurately. Risk managers knew that there was some possibility of devaluation in Russia or of capital outflows in Brazil.

However, the systems did not anticipate and were not prepared for the vicious circle of losses that developed as positions could not be unwound without creating further losses, which themselves forced further unwinding of positions. This vicious circle had two critical consequences. First, it made one-day VaR measures irrelevant because these measures are based on the presumption that positions can be undone rapidly at low cost. Second, as losses forced the unwinding of positions, the crisis spread to unrelated positions, thereby making the returns of unrelated positions highly correlated.

Any risk management system relies on forecasts of the distribution of returns of the portfolio or institution whose risk is managed. In normal times, forecasting the distribution of returns is much easier - the world just keeps repeating itself with no dramatic surprises. Crisis periods are different - the past becomes much less useful in forecasting the future, volatility often grows dramatically and correlations become much closer to one.

All this happened in August 1998. The previously uncorrelated positions of LTCM suddenly became highly correlated. By the time models based on the past adjust to these changes, it is no longer possible to reduce risk cheaply. The fundamental assumption of many risk management models is that bad draws occur randomly - the fact that there was a large loss today means nothing about the probability of a large loss tomorrow. Unfortunately, in August 1998, events that risk models said had an infinitesimal probability of happening were happening several times a week.

Wrong assumptions?

Between the time LTCM was created and 1998, the financial world changed dramatically, partly due to LTCM, partly due to regulatory actions. These changes explain much of what happened to LTCM.

LTCM was a spectacular financial innovation. The way it was structured was a marvel of financial engineering. Unfortunately for the partners, the world is a competitive place. It is hard to keep good ideas hidden. The enormous profits LTCM made early focused the attention of the financial sector on LTCM. This adversely affected LTCM for three reasons. First, it created a large number of imitators. Second, it put pressure on LTCM to keep pursuing high profits in an environment where this was no longer possible, leading it to create positions in which outsiders would not think it had a competitive advantage. Third, it made markets less liquid for LTCM.

Consider the impact of imitators on LTCM's strategies. Suppose that LTCM finds that yields are too high on a security. It goes and buys the security, while hedging the risk. When imitators do the same, the price of the security rises, eliminating the profit opportunity LTCM had first identified. This effect both reduced the size of the trades that LTCM could make and decreased the profits on those trades.

In 1997, the fund's investors earned 17 per cent, less than half what they earned the year before. Traditional positions exploiting yield spreads were becoming less profitable. To increase returns, LTCM reduced the fund's capital and went into areas that seem questionable: it took positions in Russian bonds; made volatility bets; and took positions in takeover stocks.

The partners may have had sound reasons for these positions. However, these positions seem a long way from fixed-income strategies exploiting apparently excessive spreads. For these new positions, one could find lots of other investors whose skills and training were at least equal to those of the LTCM partners. (For example, LTCM partners had many academic publications, but not a single one dealt with the takeover market.)

LTCM thus took new positions the outcomes of which were more dependent on chance than its earlier positions. Nevertheless, it is important to note that the more traditional, fixed-income positions of LTCM explain the bulk of the August and

September losses of 1998.

As far as it is possible to tell, however, the risk management systems of LTCM's counterparties failed to notice these changes until well into 1998. The cost of funds LTCM should have increased in early 1998, but there is no evidence that it did. This shows that financial institutions, thinking that the past successes of LTCM would keep repeating themselves, had too few safeguards in place when the markets changed against it.

Imitators had another impact on LTCM. They changed the nature of the markets in which it was trading. Rather than acting in splendid isolation, LTCM became the lead steer of a herd. As it moved, all imitators moved. Thus the fund faced poor market conditions when it had to move out of positions because it did not do so alone. LTCM partly recognised this in its risk measurement by using correlations that were greater than historical correlations. It also meant that the value of the fund's positions was at the mercy of its imitators pulling out of their positions. In the summer of 1998, Salomon did just that - it closed its bond arbitrage department, leading to losses for LTCM.

Modern finance traditionally assumes that there is enough competition in markets that investors or companies can take prices as given and simply react to them. The foundational work of Merton and Scholes is grounded in this assumption, as is virtually all subsequent research in derivatives pricing. Yet, in 1998, the prices at which LTCM could trade depended on what the market thought LTCM would or could do. Traditional risk measures, which assume that one can trade out of positions without affecting prices, thus become much less useful. LTCM's short-term risk measures took some of these effects into account, but the extent to which prices depended on its positions and actions took the fund's managers by surprise. The problem became critical after the impact of the market events of August 1998 on the fund became known.

Regulation and the crisis

LTCM's problems were compounded by regulations that required banks to use risk management models to set capital. This virtually guaranteed that a volatility spike would lead financial institutions to shrink their trading portfolios. The regulatory effect was worsened by the fact that many proprietary strategies were complex, leading top management to pull back in the face of greater macroeconomic uncertainty. As a result, financial institutions had turned from being stabilising to destabilising forces.

Financial intermediaries make money out of providing liquidity. As investors want to get out of positions, financial intermediaries receive a liquidity premium to take on those positions. One would therefore have expected that in August 1998, financial intermediaries would make profits by scooping up positions that investors had to abandon. However, because their capital requirements increased with volatility, financial institutions had to dump positions themselves. Instead of being providers of liquidity, financial intermediaries became consumers of liquidity, forced to do so because of the regulatory environment. As a result, losses in Russia forced them to sell securities in other markets, propagating financial contagion.

Providing liquidity in August 1998 had to be hugely profitable, but market participants who should have been the liquidity providers stayed on the sidelines. Failure to be able to take advantage of such profit opportunities is itself a failure of risk management.

Marking-to-market

At its founding, LTCM had an extremely conservative approach. To minimise the risk that its financing would be pulled, it funded itself with term contracts. Without term financing, the crisis would have been more dramatic and more compressed in time. To minimise counterparty risk, it chose derivatives contracts that were marked-to-market daily. In other words, no counterparty would be indebted to LTCM for large amounts because daily gains and losses on derivatives would be settled as they occurred.

In August 1998, as spreads widened, LTCM was making marked-to-market losses - the securities it was long in were losing value while those it was short in were gaining value. If LTCM was right about convergence, this was a temporary problem that did not in any way reduce the profitability of its strategies - the securities it had bought were mispriced and it was capturing a mispricing that would disappear at maturity of these securities or earlier.

Yet, LTCM's method of marking-to-market, combined with a decrease in the market value of its positions, caused it to run out of cash (though it never missed a margin call). Although LTCM correctly wanted its investors to commit money for the long term to enable it to take advantage of convergence strategies, it put itself in a position where it could fail before convergence was reached. It may well be that LTCM was right to choose marked-to-market contracts, but once more a strategy based on hedging failed because the hedger could no longer cope with its cash requirements.

How to do better

In many ways, the events of August and September 1998 showed that risks can be managed. Despite dramatic changes in markets, no investment bank or bank in developed countries collapsed. Derivatives played a significant role in helping many of these institutions hedge their risks. None of the reasons that justified the award of Nobel prizes to Merton and Scholes were affected by the events of August and September 1998.

Yet, at the same time, these events showed brutally that risk management is part of the social sciences. What makes social sciences different is that their object of study changes continuously, in this case partly as a result of financial innovation.

Understanding these changes and how they influence risk is critical in times of great uncertainty. Risk management is not rocket science - it cannot be, since the past does not repeat itself on a sufficiently reliable basis. Future risks cannot be understood without examining the economic forces that shape them - a skill that is not taught in physics departments or engineering schools. However, understanding risks makes sense only if that understanding is used to create value. This means that risk management cannot be done independently of an understanding of the profits that come from taking risks. Regulation that forces financial institutions to disregard profit opportunities in the name of risk control only ends up in making the financial system less stable.

The long and the short

A long position in a security is a position that benefits from price increases in that security (an investor who buys a stock has a long position, but an equivalent long position can also be established with derivatives).

A short position benefits from price decreases in the security. A short position is often established through a short-sale. To sell a security short, one borrows the security and sells it. When one unwinds the short-sale, one has to buy the security back in the markets to return it to the lender. One then benefits from the short-sale if the security's price is lower when one buys it back than it was when one sold it.

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