The Collapse of Long-Term Capital Management: A Business Analyst's Perspective

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In 1998, a year after the Asian financial crisis, Long-Term Capital Management (LTCM), the world's largest hedge fund at that time, collapsed. Its downfall is considered one of the crucial incidents in financial history, not only in the U.S. but for the entire world. To prevent potential systemic risks, the Federal Reserve Bank (FED or FRB) played a major role in its rescue. Fourteen major world financial institutions injected approximately 3.6 billion USD in equity capital into LTCM, preventing bankruptcy and mitigating financial stress globally.

Although financial wizards, mathematician experts, and two financial Nobel laureates teamed up as LTCM's partners, utilizing sophisticated models that integrated advanced mathematics and statistics, a disaster still occurred. Interestingly, The VIX Guy (2020) said that LTCM's model predicted that the probability of losing everything in one year was only one in a septillion (1,000,000,000,000,000,000,000,000). This raises important questions about how things went wrong and what we can learn from it. From a business analyst's perspective, this research will investigate key factors that led to the downfall, the business model and its failure, and the role of quantitative models and data selection.

Background

Long-Term Capital Management is a hedge fund founded by John Meriwether, the bond trader wizard, in 1994. He was a former head of the fixed-income arbitrage desk unit at Solomon Brothers, the biggest investment bank at the time. Known as an arbitrage expert who relied purely on mathematical and statistical models, he sought the difference in market prices between two highly correlated investment-grade bonds, then bought the undervalued and sold the overvalued. He lost his job in 1992 due to the responsibilities arising from a subordinate's involvement in treasuries trading scandal.

At LTCM, Meriwether's lineup is very interesting, including David W. Mullins Jr., vice chairman of the Federal Reserve, and Robert C. Merton and Myron Scholes, Nobel laureates in Economic Science, along with his former coworkers at Solomon Brothers. LTCM initially raised $1.2 billion as capital, setting a record high for fundraising. In 1994, LTCM successfully generated a 21% annual return (after fees). Their performance skyrocketed to 43% and 41% in the second and third years, respectively. Although, in 1997, the Asian financial crisis hit and affected their performance, they still delivered an impressive 17% annual return after fees. However, in August 1998, the party came to an end. LTCM faced a liquidity crisis, losing almost 50% of their capital in just 4 months, from $4.67 billion at the beginning of April to $2.28 billion at the end of August 1998. In the worst day, they loss $553 million (Lowenstein, 2000). In September 1998, the FED stepped in alongside 14 major financial institutions, deciding to provide emergency $3.6 billion as equity capital to LTCM.

LTCM's investment strategies are based on mathematics and statistics, primarily relying on Option Pricing Theory (Black and Scholes, 1973). The goal is to calculate asset prices and identify arbitrage opportunities if the asset price differs from its theoretical price. Although the difference is relatively small, they use financial leverage to scale their profits. Before the crisis, the asset size under LTCM's management was enormous, approximately $128 billion. Compared to their capital, its peak leverage level was extremely high at 55 times, as reported by Lowenstein (2000), whereas the industry standard typically ranges from 15 to 20 times.

Business models and its failure

What is "hedge fund"? and what are they doing? The term of "hedge fund" was apparently first used in a 1966 Fortune magazine article which described the activities of a fund now commonly considered to be the first hedge fund (Loomis, 1996). However, it is hard to imagine a greater misnomer than "hedge fund," since hedge funds typically do just the opposite of what their name implies: they speculate (Edwards, 1999). In general, hedge fund takes long positions in what they viewed as undervalued securities, partially funded by taking short positions in overvalued securities, creating a leveraged exposure that was "market neutral" or "hedged" (Caldwell, 1995). It was clearly that hedge fund leveraged speculation on the performance of one type of security relative to another type of security, while "hedging" is to be attempting to immunize the portfolio from general market movements or from systematic risk (Edwards, 1999).

The speculative strategy of arbitraging contributes countless advantages and opportunities to the industry, such as lower costs, financial leverage, increased trading volume, market liquidity generation, and the ability to profit from mispricing. However, everything comes at a price. If this strategy is overused without proper understanding, it can lead to unfavorable consequences. Overleveraging, artificial trading demand, and market liquidity manipulation pose risks to the stability and sustainability of the financial market. Once the market cannot withstand these pressures, there may be no happy ending.

As mentioned before, LTCM is a passionate arbitrage strategy hedge fund that applies advanced mathematics and statistics from an academic perspective, creating a futuristic investment landscape. In its first year, LTCM focused its investments on the bond market, especially G7-issued bonds. With an initial capital of $1.2 billion in 1994, LTCM proved to the world by delivering a 21% annual return after fees. This achievement was remarkable, considering fixed income as their primary investment asset class. Not only did they maintain the momentum, but they also accelerated it by delivering fabulous 43% and 41% annual returns after fees in 1995 and 1996, respectively. They took more risks and went beyond their expertise by extending their investment universe to mortgage-backed securities, derivatives, equity pairs, and merger arbitrage. LTCM's capital grew rapidly from $1.2 billion to nearly $5 billion at the beginning of 1997, putting them under immediate pressure to allocate their capital and generate a breathtaking return.

Fast forward to the end of 1997, they managed to earn 17% after fees. It was certainly their worst year yet, but still an impressive achievement considering that the world was under a financial crisis in Asia known as the 'Tom Yam Kung' crisis. In addition to that, their secret of bond arbitrage is out, and almost every investment bank on Wall Street gets into the game. 'An arbitrage opportunity disappears faster than a flash of lightning,' complained one of LTCM's

traders (Lowenstein, 2000). They had no choice but to expand their investment universe by entering emerging markets, investing in illiquid assets, and non-investment-grade bonds. At the same time, it meant an unavoidable higher exposure to risks. And they did not prepare themselves well enough.

All good things must come to an end; in 1998, LTCM encountered liquidity stress and experienced a loss in investment capital. They lost more than 55% of their capital in only 4 months. Fortunately, in September 1998, the Federal Reserve (FED) stepped in quickly to ensure that the failure of LTCM would not affect the financial system. This support aimed to stabilize LTCM, meet its outstanding obligations, and prevent a disorderly unwinding of its positions, which could have had far-reaching consequences for the financial markets.

To accomplish performance targets, LTCM chose to diversify its investment strategy beyond their expertise, exposing itself to an unimaginable leverage level, trading concentrated in illiquid assets, and underestimating the ongoing crisis. Sadly, it cost LTCM everything.

The role of quantitative model and data selecting

LTCM applied sophisticated statistical and mathematical models at the center of its philosophy, especially the Option Pricing model created by Black and Scholes (1973). Their trading strategy was truly revolutionary, as before then, valuation had been based merely on conjectures and rules of thumb. Given the assumption of ergodicity in the determination of stock prices, option prices could be derived from the current price and the average volatility. This is in spite of the fact that the options price is contingent upon the future price (Allington et al., 2012).

The basic logic underneath the investment strategy of LTCM is conceptually simple, though not in its implementation, and strictly speaking, it was at variance with the Efficient Market Hypothesis theorem. However, the method and assumptions were within the Black-Scholes framework (Allington et al., 2012). There are three ideas behind this complex principle. First, asset prices always move towards their fair value. This is the key to the arbitrage theorem: overvalued assets must converge down to the fair value, while undervalued assets will increase their value over time. Second, all market participants are assumed to be rational and have homogeneous expectations. Regardless of how market conditions change, they act logically, all doing the same thing. Lastly, asset prices follow the random walk assumption, where the distribution of asset price returns is a bell curve, and the assumption is that market volatility is constant.

To be honest, in the first three years, they exceeded all expectations. Their performance surpassed everyone in the industry, and their returns were also higher than every other asset class. They also created a risk model to measure their risk level, which turned out that the probability of maximum loss in a day is equal to $35 million (Lowenstein, 2000). According to the model, it is impossible for them to lose every single dollar in a year; the chance is one in septillion (The VIX Guy, 2020). To this point, it seems that LTCM has done everything nicely and cleanly, so why did they still fall? The Asian financial crisis in 1997 plays a big part in the downfall.

The crisis ruined every assumption of the model. Investors lost their rationality due to the fear of loss and/or shifted their exposure to a risk-off position, significantly lowering market liquidity. Moreover, the conversion of asset prices no longer held. Safer but overpriced assets continued to overprice, while underpriced assets continued to devalue. The spread widened,

causing LTCM to lose their wealth. Last but not least, asset price movements were no longer random. The historical data of asset price volatility, the main variable in the pricing model, became unusable since market volatility far exceeded historical levels. The assumption of an implied normal bell curve was also unleashed, revealing fat-tailed distributions. The only hope to avoid the downfall was for those working with the model to take opposite actions, as the model continued to suggest taking more risk by engaging in more arbitrage and increasing leverage. Unfortunately, they stubbornly proceeded along with the model's recommendations, and the end was at their doorstep.

What can we learn as a business analyst's perspective

The collapse of Long-Term Capital Management serves as a compelling case study for business analysts, providing insights into the challenges associated with quantitative modeling, data selection and preparation, and business standpoint.

Initially, LTCM seemed like a miracle due to its belief in the sophisticated mathematical model it pioneered. Their business model solved multiple financial market issues such as creating a new investment alternative vehicle, supplying liquidity to the market, and maintaining assets' prices at their fair value. However, continuing the miracle proved to be cruel. They expanded their investment universe with less market understanding, overleveraging by entering larger positions, and locking themselves up by holding a significant portion of illiquid assets. They took more risks without hesitation about the future.

They believed wholeheartedly that their magical models could save them from any threat, but tragically, it didn't. The Option-pricing model has been criticized and taken the blame as the cause of the downfall. In truth, mathematical models and option-pricing models played only a minor role, if any, in LTCM's failure. At LTCM, models were used to hedge local risks (Scholes, 2000). The models worked as they should, but the problem lay in the data input. Historical data is insufficient when the market moves beyond the assumption outliers. The users lacked an understanding of the model's limitations; the model works only when all assumptions are held, in other words, in normal market conditions. As a result, unsurprisingly, the model gave the wrong suggestions.

So, the last line of defense depends on the person in charge of trading execution. What are they going to do? We all know an unhappy ending result; LTCM kept arbitraging and entering more illiquid assets, waiting for the end to come. On August 17, 1998, Russia announced the default on its debts and devalue its currency. One month later, on September 23, 1998, emergency capital was injected into LTCM as a stabilizer. In early 2000, the fund liquidated all positions, dissolved its crisis, and ended its legacy.

What could we had done better next time?

The core philosophy of LTCM revolves around the Option-pricing model and Efficient Market Hypothesis (EMH), which relies on the Rational Expectation Hypothesis (REH). Most of the time, it is correct. However, to completely understand the market, it would be better if you knew the other side of the coin — behavioral finance (see, e.g., Barberis and Thaler, 2003; Shiller, 2000). The perfectly opposite side of the rational investor theorem examines how emotions,

cognition, and a combination of social and psychological factors can impact financial decision-making (Allington et al., 2012).

Models and data play a major role in this story. It is undeniable that the model becomes unusable when the market is in chaos. Because there is no such thing as a perfect model, understanding the properties, limitations, and weaknesses of the model is critical. Other models are needed to encounter with such market conditions. In fact, there is nothing wrong with the data they used except for the way they were using it. The bell curve assumption holds given normal market conditions; however, during a crisis, the data tends to follow a fat-tailed distribution.

Human error seems to be the villain of this story. Even if they are all experts and geniuses, they still fail. Overconfidence, unawareness, and a lack of hesitation in what they are doing play a role. They also lose the ability to make decisions since they heavily rely on the model's outcome, following with no questions asked. Therefore, the processes of doubt, questioning, and finding answers are crucial for improving and sharpening knowledge and skills.

Conclusion as a business analyst

- Understand business standpoint is necessary since it frames your working philosophy.
- Always looks for the other side of the coin. Nothings perfect; understand the flaws definitely helps us to achieve objectives.
- A keen understanding of the model is a must. Model assumptions and limitations could lead to a dead end if used improperly.
- The idea that one model fits all is a fallacy. Create a new one if needed.
- Too complex models create more problems when interpretation is needed. The trade-off between the two can change the story's outcome.
- Data is king, but the way data is treated is the king's father. Each dataset has its own uniqueness; understanding the property of the data and how to use it is a must as well.
- Even if you undoubtedly understand the model and the data, you STILL should question the model outcome. Does it look correct, or is there anything unusual?

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