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RISK MANAGEMENT IN BANKS AND OTHER FINANCIAL INSTITUTIONS: LESSONS FROM THE CRASH OF LONG-TERM CAPITAL MANAGEMENT (LTCM)

Mete Feridun

Abstract

Risk management is a rapidly developing discipline and there are many and varied views and descriptions of what risk management involves, how it should be conducted and what it is for. Market risk, in particular, is an area that has received increasing attention in the last decade as financial institutions' trading activities have significantly grown. This paper analyses the failure of LTCM hedge fund in 1998 from a risk management perspective aiming at deriving implications for the managers of financial institutions and for the regulating authorities. The study concludes that the LTCM's failure can be attributed primarily to its Value at Risk (VaR) system, which failed to estimate the fund's potential risk exposure correctly.

Key words: Risk Management, Value at Risk, Market Risk, Risk Control.
JEL Classifications: D81, D82, G24.

1. Introduction

Risk management is a constant challenge to all financial institutions. Banks need to consistently develop and improve their operational and technical practices. Credit Risk Management is assuming greater importance in the current environment. With the implementation of the Basel Accord, banks are increasingly moving towards quantitative risk evaluation of their loan portfolios. The areas of market risk have long been under the quantitative risk management scrutiny but credit risk has gradually emerged as an area for the quantitative risk management. This area has a unique set of challenges and opportunities for the quantitative risk managers. These include both quantitative modeling challenges as well as change management issues. The quantitative challenges include the calculation of default probabilities for the banks clients, estimation of the loss rates and inclusion of various structural elements of the credit deals. Further, these models have to be back-tested and validated. There are significant data issues including the variability of the accounting numbers, relatively low number of actual defaults and missing information on the key drivers of default.

The new Basel Capital Accord, also known as "Basel II", is an update of "The 1988 Accord", which was adopted by more than 100 countries worldwide. The new Basel II regulations put forward by the Basel Committee on Banking Supervision are aimed at improving the safety and soundness of the financial system by aligning capital adequacy assessment more closely with the underlying risks in the banking industry, providing a thorough supervisory review process, and enhancing market discipline. They further seek to maintain the current overall level of capital in the system and enhance competitive equality.

If Basel II is implemented correctly, intelligently and in a timely manner, it can potentially reduce capital reserves for some banks and, consequently, increase the amount of capital available for investments, thus enabling banks to achieve optimum risk – reward profiles and help to increase shareholder value. To comply with Basel II and accurately calculate risk measures, banks need to ensure the timeliness and integrity of their data, and aggregate different risk types. Automating and standardizing the aggregation of data residing in various systems and repositories across the bank will bring efficiency to the process while maintaining data integrity.

Banks affected by Basel II will have to implement more sophisticated approaches to measuring and managing credit, operational and market risk over geographic and departmental boundaries,

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and determine capital reserves to cover potential losses. The first challenge banks may face is to identify and aggregate their exposure data to meet the new data validation and corroboration requirements for credit risk management, and to implement a system that can report a complete view of risk across the bank.

Further, estimating default probabilities of corporate, private, SME and other counterparties will call for employing various estimation models to reflect different counter party profiles over different asset classes. Most banks decide to develop and implement their credit rating and credit scoring models internally rather than using third-party models, because it enables them to customize models to reflect their own proprietary knowledge, ensures fast implementation and enables them to adapt to changing market conditions quickly. All of these advantages lead to more accurate risk assessment. Furthermore, to meet Basel II's supervisory review requirements, each step in the model development and scoring process should be documented, thus providing the required transparency for compliance.

Generally speaking, Risk Management is the process of measuring, or assessing risk and then developing strategies to manage the risk. In general, the strategies employed include transferring the risk to another party, avoiding the risk, reducing the negative effect of the risk, and accepting some or all of the consequences of a particular risk. Traditional risk management focuses on risks stemming from physical or legal causes (e.g. natural disasters or fires, accidents, death, and lawsuits).

Financial risk management, on the other hand, focuses on risks that can be managed using traded financial instruments. Intangible risk management focuses on the risks associated with human capital, such as knowledge risk, relationship risk, and engagement-process risk. Regardless of the type of risk management, all large corporations have risk management teams and small groups and corporations practice informal, if not formal, risk management. In ideal risk management, a prioritization process is followed whereby the risks with the greatest loss and the greatest probability of occurring are handled first, and risks with lower probability of occurrence and lower loss are handled later. In practice the process can be very difficult, and balancing between risks with a high probability of occurrence but lower loss vs. a risk with high loss but lower probability of occurrence can often be mishandled.

The fundamental difficulty in risk assessment is determining the rate of occurrence since statistical information is not available on all kinds of past incidents. Furthermore, evaluating the severity of the consequences (impact) is often quite difficult for immaterial assets. Asset valuation is another question that needs to be addressed. Thus, best educated opinions and available statistics are the primary sources of information. Nevertheless, risk assessment should produce such information for the management of the organization that the primary risks are easy to understand and that the risk management decisions may be prioritized. Thus, there have been several theories and attempts to quantify risks.

Market risk, in particular, is an area that has received increasing attention in the last decade as financial institutions' trading activities have significantly grown. Huge losses suffered by organizations such as Long-Term Capital Management (LTCM), Barings Bank, and Metallgesellschaft within the last decade due to speculative trading, failed hedging programs, or derivatives, have increased the importance of risk management to a great extent.

In 1998, the failure of LTCM, the world's largest hedge fund, nearly devastated the world's financial system. LTCM was so big that the Federal Reserve Bank of New York had to facilitate a bailout to the fund, fearing that the liquidation might wreck the global financial markets. The primary factor contributing to LTCM's failure has been widely pointed out as its poor risk management. Another factor was the fund's investment strategy which relied heavily upon the convergence-arbitrage. Hence, the fund had to have a high level of leverage in order to meet a satisfactory rate of return. However, this kind of investment strategy brings high risks in derivatives trading and requires a thorough risk management schedule (Brian, 1995). The fund's risk management, however, failed to do so, eventually leading to the collapse of the fund.

This study aims at exploring the reasons behind the failure of LTCM from a risk management perspective, analyzing the impact of VaR implementation in the formation of the collapse. It also seeks to point out any lessons that can be derived from this experience for the similar hedge funds as well as for the regulators of the financial markets and institutions. This paper is structured as follows. Section 2 provides a brief account of VaR and three VaR methods used commonly by financial institutions. Section 3 presents an overview of the LTCM and its investment strategies as well as an overview of its VaR model used before the collapse. This section also provides a review of how VaR can be used to assess the capital base needed to support a leveraged portfolio. Section 4 points out the lessons for the managers of financial institutions and for financial regulators that emerge from the analysis. Section 5 presents the conclusions of the study.

2. Value-at-Risk Models

Value-at-Risk models are the primary means through which financial institutions measure the magnitude of their exposure to market risk. These models are designed to estimate, for a given portfolio, the maximum amount that a bank could lose over a specific time period with a given probability (Jorion, 1997). This way, they provide a summary measure of the risk exposure generated by the given portfolio. Management then decides whether it feels comfortable with this level of exposure or not and acts accordingly. Value-at-Risk models are extensively used for reporting and limiting risk, allocating capital, and measuring performance (Brian, 1995).

Calculation of VaR depends on the method used. It essentially involves using historical data on market prices and rates, the current portfolio positions, and models for pricing those positions. These inputs are then combined in various ways depending on the method used, to derive an estimation of a particular percentile of the loss distribution, typically the 99th percentile loss. According to the Basle Committee Proposal (1995, 1996), the computation of VaR should be based on a set of uniform quantitative inputs, namely a horizon of 10 trading days, or two calendar weeks, a 99% level of confidence, and an observation period based on at least a year of historical data. Three methods are commonly used for computing VaR. This section provides a brief account of these three methods.

2.1. Delta-Normal Approach

Delta-normal approach is the simplest method to implement. However, it has several drawbacks such as non-stability of parameters used, and the assumptions of normal distributions for all risk factors and linearity for all securities in the risk factors. This method consists of going back in time and computing variances and correlations for all risk factors. Portfolio risk is then computed by a combination of linear exposures to numerous factors and by the forecast of the covariance matrix (Dunbar, 1998).

For this method, positions on risk factors, forecasts of volatility, and correlations for each risk factor are required. Delta-normal approach is generally not appropriate to portfolios that hold options or instruments with imbedded options such as mortgage-backed securities, callable bonds, and many structured notes. This approach is relatively easier to compute and compare. It is also easy to compute marginal contribution to VaR.

RiskMetrics, a particular implementation of the delta-normal approach, assumes a particular structure for the evolution of market prices and rates through time. It, then, transforms all portfolio positions into their constituent cash flows and performs the VaR computation on those (Dowd, 1998). This model was launched by JP Morgan in 1994 aiming at promoting the use of value-at-risk among the firm's clients. The service comprised a technical document describing how to implement a VaR measure and a covariance matrix for several hundred key factors updated daily on the Internet. It is an entirely logical approach, particularly for portfolios without a lot of non-liearity, and is known to be responsible for popularizing VaR.

2.2. Historic or Back-Simulation Approach

Historic Approach is also a relatively simple method where distributions can be non-normal, and securities can be non-linear. Historic approach involves keeping a historical record of preceding price

changes. It is essentially a simulation technique that assumes that whatever the realizations of those changes in prices and rates were in the earlier period is what they can be over the forecast horizon. It takes those actual changes, applies them to the current set of rates, and then uses those to revalue the portfolio. The outcome is a set of portfolio revaluations corresponding to the set of possible realizations of rates. From that distribution, the 99th percentile loss is taken as the VaR (Dowd, 1998).

However, historic approach uses only one sample path, which may not efficiently represent future distributions. For this approach, specification of a stochastic process for each risk factor is required. Also required are the positions on various securities, and valuation models for all assets in the portfolio. This method involves going back in time, and applying current weights to a time-series of historical asset returns. This return restructures the history of a hypothetical portfolio using the current position. Obviously, if asset returns are all normally distributed, the VaR obtained under the historical-simulation method should be the same as that under the delta-normal method (Dowd, 1998). This approach is easy to compute and to understand. It allows for non-normality and non-linearity. It can also easily be adapted to scenario analysis. However it has several drawbacks such as unstable parameters and altering variances. In addition, the model may not work well if based on small sample (Stulz, 2000).

2.3. Monte-Carlo Approach

Monte Carlo approach is widely regarded as the most sophisticated VaR method. It looks easy to code Monte Carlo analyses. However, it takes hours or even days to run those analyses, and to speed up analyses complicated techniques such as variance reduction need to be implemented (Dowd, 1998). In theory, Monte Carlo method makes some assumptions about the distribution of changes in market prices and rates. Then, it collects data to estimate the parameters of the distribution, and uses those assumptions to give successive sets of possible future realizations of changes in those rates. For each set, the portfolio is revalued and, as in the historic method, outcomes are ranked and the appropriate VaR is selected. Monte-Carlo method makes it easier to cope with extreme non-linearities as it allows for non-linear securities. It can also easily be adjusted according to the distribution of risk factors. However it is computationally burdensome which constitutes a problem for routine use (Dunbar, 1998).

3. Risk Management at LTCM

Due to its sophisticated hedging strategies, LTCM became one of the most highly leveraged hedge funds in history. It had a capital base of $3 billion, controlled over $100 billion in assets worldwide, and possessed derivatives whose value exceeded $1.25 trillion. To predict and mitigate its risk exposures, LTCM used a combination of different VaR techniques. LTCM claimed that its VaR analysis showed that investors might experience a loss of 5% or more in about one month in five, and a loss of 10% or more in about one month in ten. Only one year in fifty should it lose at least 20% of its portfolio (Lowenstein, 2000).

LTCM also estimated that a 45% drop in its equity value over the course of a month was a 10 standard deviation event. In other words, this scenario would never be likely to occur in the history of the universe (Prabhu, 2001). Unfortunately for Long-Term Capital Management and its investors, this event did happen in August 1998. This reliance on Value-at-Risk may also indicate one of the problems that eventually led to Long-Term's demise. LTCM believed that historical trends in securities movements were an accurate predictor of future movements. Their faith in this belief led them to sell options in which the implied volatility was higher than the historical volatility (Prabhu, 2001).

Similarly, the Value-at-Risk models used by LTCM rely on historical data to project information about future price movements. These models project the probability of various losses based on the prior history of similar events. Unfortunately, the past is not a perfect indicator of the future. On October 18, 1987, for example, two-month S&P futures contracts fell by 29%. Under a lognormal hypothesis, with annualized volatility of 20% (approximately the historical volatility on this security), this would have been a –27 standard deviation event. In other words, the probability of such

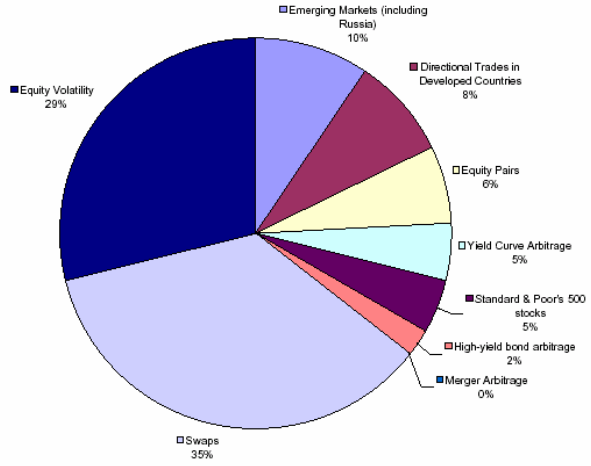
an event occurring would have been 10-160. This is such a remote probability that it would be virtually impossible for it to happen (Prabhu, 2001). On October 13, 1989 the S&P 500 fell about 6%, which under the above assumptions would be a five standard deviation event. A five standard deviation event would only be expected to occur once every 14,756 years (Jackwerth and Rubinstein, 1998). There are many other examples of abnormal market events happening with greater frequency than these models would lead one to expect. It would appear then, that lognormal models for expected returns do not fully account for these large losses, and that prior estimates of volatility may not be able to accurately predict future price movements. This reliance on a risk model that tends to underestimate the probability of large downward movements in securities prices may have led Long-Term Capital to be overconfident in its hedging strategies.

In August 1998, an unexpected non-linearity occurred that was beyond the detection scope of the VaR models used by LTCM (Davis 1999). Russia defaulted on its sovereign debt, and liquidity in the global financial markets began to dry up as derivative positions were quickly slackened. The LTCM VaR models had estimated that the fund's daily loss would be no more than $50 million of capital. However, the fund soon found itself losing around $100 million every day. In the forth day after the Russian default, they lost $500 million in a single trading day alone. As a result LTCM began preparations for declaring bankruptcy (Davis, 1999). However, US Federal Reserve, fearing that LTCM's collapse could paralyze the entire global financial system due to its enormous, highly leveraged derivatives positions, extended a $3.6 billion bailout to the fund, creating a major moral hazard for other adventurous hedge funds (Dong et al., 1999). Consequently, LTCM's failure can be attributed to VaR. As the regulation is applied less strictly to securities firms and other non-bank financial institutions, LTCM's preference of the horizon was in fact more delicate than the 10-day period required the Basle Committee (Hunter and Power, 2000). For a hedge fund, the horizon should match the period required to raise additional funds, which is rather difficult as additional capital will be needed precisely after the fund has suffered a large loss. Indeed, by the end of August 1998, LTCM had $2.3 billion of equity capital and $1 billion excess liquidity. The firm faced a dilemma between reducing risk and raising additional capital. Because of the magnitude of its positions, it was unable to reduce its risk exposure promptly. Neither was it able to attract new investors. It soon became clear that the firm had underestimated its capital needs. In addition, the positions of LTCM were allocated so as to maximize expected returns subject to the single constraint that the fund's perceived risk would not exceed that of the U.S. securities market. In a nutshell, the fund was maximizing return while not carefully monitoring its volatility. Besides, the fund determined a target daily volatility figure of $45 million based on the simplistic assumption that volatility would remain constant, while in reality it could easily double in turbulent times.

Along with its exposure to volatility, the fund also achieved extraordinary levels of leverage. Indeed, at the time of its near-failure, the LTCM Fund was the most highly leveraged hedge fund reporting to the Commodity Futures Trading Commission (CFTC). Combination of its large capital base and high degree of leverage enabled the fund to possess total assets exceeding $125 billion in value, a figure bigger than three times that of the next largest hedge fund. The fund was betting on the convergence of spreads, and during turbulent times, spread between relative bonds would widen causing the fund to lose its position. In order to regain the position, additional funds would be needed to meet margin calls (Davis 1999). However, the fund would not be able to liquidate quickly enough in case of adverse market conditions, leading to a risk of liquidity and insolvency. Indeed, LTCM faced harsh liquidity problems when its investments began losing value. As mentioned earlier, liquidity risk is not factored into VaR models as they assume that normal market conditions will prevail (Bangia et al., 1999). Therefore, LTCM's actual exposure to liquidity and solvency risks was not evaluated accurately by its VaR model.

The Fund's investors and counter parties were not adequately aware of the nature of the exposures and risks the hedge fund had accumulated either as they exercised minimal scrutiny of the fund's risk management practices and risk profile. This insufficient monitoring was alleviated by LTCM's practice of disclosing only minimal information to these parties. Financial statements disclosed by LTCM did not include details about the fund's risk profile and concentration of expo-

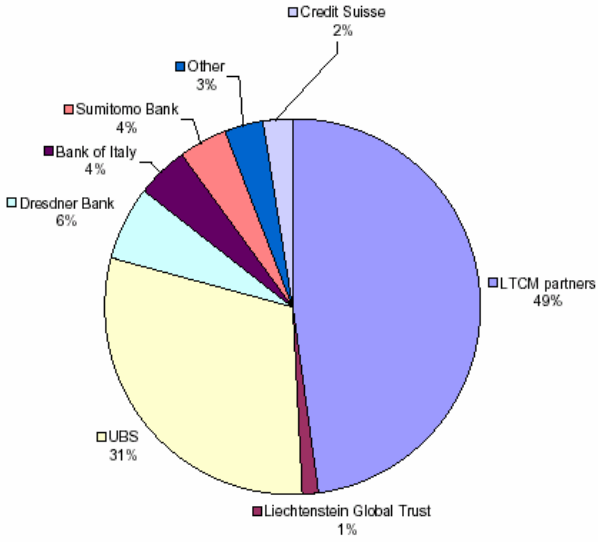
sures in certain markets (Stulz, 2000). Counter parties' current credit exposures were in most cases covered by collateral. However, their potential future exposures were not adequately assessed, priced, or collateralized relative to the potential price shocks the markets were facing at that time. Figure 1 indicates the losses incurred by LTCM in 1998 by trade types.



Source: Lowenstein (2000).

Fig. 1. Losses by trade type

At the same time, not only LTCM's liquidity, credit and volatility spreads widen, but also the liquidity of most global financial markets dried up. This expanded the problem faced by LTCM's creditors, because a liquidation of LTCM's positions would have been disorderly and could have had adverse market effects on their positions and that of many other market participants. The possibility of this situation occurring was not fully considered by either LTCM or its creditors. This raises the issue of how events that are assumed to be extreme and very improbable should be incorporated into risk-management and business practice, and how they should be dealt with by public policy. Figure 2 presents the losses incurred by financial institutions through collapse of LTCM.



Source: Prabhu (2001).

Fig. 2. Losses by Financial Institution

As the analysis indicates, LTCM relied too much on VaR models and not enough on stress testing, gap risk and liquidity risk. There was an assumption that the portfolio was sufficiently diversified across world markets to produce low correlation. But in most markets LTCM was replicating basically the same credit spread trade (Shirreff, 1999). Several risk management and policy implications emerge from this analysis, which will be pointed out in the next section.

4. Lessons for Financial Institutions and Financial Regulators

4.1. Lessons for Financial Institutions

As pointed out in the previous section, LTCM relied excessively on the VaR models for managing risk, which failed to predict the maximum potential loss due to its assumption that the market state would remain stable. This leads us to the conclusion that relying solely on VaR as a means of risk management would be erroneous. What can be implemented as a complementary measure to alleviate the limitations and disadvantages of VaR is another functional risk management method, namely stress testing. This procedure incorporates the impact of particular extreme case scenario in the analysis of risk and naturally complements VaR. While VaR gives fund managers an estimate of what they might lose with a certain maximum probability, stress tests enable them to have a clear idea of what they stand to lose in case the worst case scenario actually takes place.

A further implication for the managers of financial institutions is the importance of imposing stress-loss limits on their portfolio to protect against extreme shocks. Stress limits provide protection against extreme shocks in both individual and groups of risk factors. They might also prevent the management from concentrating in a single strategy or project, or from maintaining a single position. What is more, the information provided by stress tests can be very useful in determining capital allocation within an institution (Dowd, 1998).

Another implication lies in the philosophy of the trading strategies. As pointed out in the previous sections, LTCM's trading strategy exploited the intrinsic weaknesses in its risk management system as it aimed at maximizing expected returns subject to constrain on VaR. The fund's daily trading basically relied on the convergence arbitrage strategy. The fund took non-directional bets so that it is not dependent upon the direction of markets. This strategy induced the fund to make undiversified and highly leveraged bets on more subtle risks such as credit risks, political risks, or market disruptions. Hence, it can be concluded that the convergence arbitrage strategy does not necessary produce safety by betting neither direction and is a risky strategy.

To be brief, the reason of LTCM's failure is that it had severely underestimated its risk. The trading positions were singularly undiversified, as they were exposed to liquidity, credit, and volatility spreads, which are all similar risk factors. Although, the LTCM's VaR system seems to be the primary reason behind LTCM's collapse due to its failure in measuring the fund's potential risk exposures, it is still the best tool in risk measurement. Analysis of LTCM's collapse illustrates the perils of relying on VaR without the complementation a proper stress testing system. As explained earlier, LTCM's strategy was to maximize the return on a constrained VaR which worked well only under normal market conditions, and the market crash in 1998 was not expected by the nature of such a system.

To mitigate the limitation of VaR systems, financial entities have to develop and properly implement stress-testing systems, which area capable of helping to measure risk exposures in extreme cases. In addition, traditional risk management models ignore asset and funding liquidity (Bangia et al., 1999). When positions are relatively large and leveraged, it is important to account for the price impact of forced sales. The final implication derived from the story of LTCM for the managers of financial institutions would suggest that a fund diversifies its portfolio not only geographically but also wisely and strategically.

4.2. Lessons for Financial Regulators

The risk management limitations revealed by the LTCM incident were not unique to LTCM or to its creditors. As new technology has cultivated a major expansion in the volume and the leverage

of transactions, VaR models have underestimated the probability of severe losses. This shows the need for regulation in the appropriate models of VaR and the level of capital for risky positions taken by financial institutions.

As mentioned earlier, LTCM managed to establish leveraged trading positions of a size that posed potential systemic risk, primarily because the banks and derivatives firms that were its creditors and counter parties failed to enforce their own risk management standards. Other market participants and federal regulators relied upon these large banks and securities and futures firms to follow sound risk management practices in providing LTCM with credit. However, limitations in the risk management practices of these creditors and counter parties allowed LTCM to use leverage to grow beyond control. Federal financial regulators did not identify the extent of weaknesses in banks' and funds' risk management practices until after LTCM's collapse. Although regulators were aware of the potential systemic risk that hedge funds can pose to markets and the perils of declining credit standards, until LTCM's collapse, they seemed to believe that creditors and counter parties were appropriately constraining hedge funds' leverage and risk-taking (Hunter and Power, 2000). However, LTCM's collapse revealed weaknesses in credit risk management by banks and broker-dealers that allowed LTCM to become excessively leveraged. The existing regulatory approach, which focuses on the condition of individual institutions, did not sufficiently consider systemic threats that can arise from non-regulated financial institutions such as LTCM.

Similarly, periodic financial information provided in financial statements received from LTCM, its creditors, and its counter parties did not reveal the potential threat posed by LTCM. Regulators for each industry generally continued to focus on individual firms and markets, the risks they face, and the soundness of their practices, but they failed to address interrelationships across each industry. The risks posed by LTCM crossed traditional regulatory and industry boundaries, and the regulators had to coordinate their activities to have had a chance of identifying these risks. Although regulators recommended improvements to information reporting requirements, they did not recommend ways to better identify risks across markets and industries. Lack of authority over certain affiliates of investment firms limited the ability of the Securities and Exchange Commission (SEC) and CFTC to identify the kind of systemic risk that LTCM posed (Crouhy et al., 2001).

A number of policy implications for the regulating authorities of financial markets and institutions emerge from this study. To begin with, regulators should ensure that they address the risk management weaknesses that have been pointed out earlier. They should also outline sound practices for the institutions' interactions with highly leveraged institutions. In addition, regulators need to ensure that entities for which they have responsibility to regulate are apposite to the scale and complexity of the credit services they provide, investments they make, and liabilities they incur. In this respect, banks should ensure that their counter parties develop meaningful measures of potential future credit exposure and use these measures to set exposure limits. Regulators should encourage banks to develop policies setting out the situations in which potential future exposures should be collateralized. Another important issue that needs special attention by the regulating authorities is the guidance of enhancing the quality of reporting financial information by financial institutions, especially hedge funds.

5. Conclusions

This paper analyzed the collapse of the LTCM hedge fund aiming at deriving implications for the managers of financial institutions and for the policy makers. A number of significant conclusions emerge from the study as described in detail in the previous sections. For instance, LTCM's VaR model is major factor that accounts for its collapse in 1998 as it underestimated the fund's potential risk exposure. This was mainly due to its insufficiency in terms of identifying the risk factors such as liquidity and volatility. However, VaR is still an invaluable instrument for assessing the market risk. Nevertheless, it is not the solution for all risk management challenges, and is certainly not an appropriate measure upon which to build optimal decision rules. As a result, we must draw some valuable risk management lessons from the LTCM experience regarding VaR.

First of all, managers of financial institutions should not rely only on VaR for their market risk management practices. As mentioned earlier, LTCM's strategy was to maximize the return on a constrained VaR but this risk management system only works well under normal market conditions. The market crash in 1998, for instance was not expected due to the nature of VaR. This illustrates the danger of relying on VaR without the complementation of a proper stress testing system. In order to mitigate the limitations of VaR systems, managers of financial institutions have to develop and properly implement stress-testing systems, which may enable them to measure risk exposures in extreme cases.

Moreover, traditional risk management models do not take into account asset and funding liquidity. When positions are relatively large and leveraged, it is important to account for the price impact of forced sales. In this respect, the LTCM experience has important lessons for convergence-arbitrage strategies. It can be conveniently concluded that a fund should not only diversify its portfolio geographically around the global financial markets, but also wisely and strategically. Banks also face the challenge of calculating the statistical measures that express volatility in the market. The volatility associated with individual exposures must then be aggregated across the portfolio of all exposures to a Value-at-Risk (VaR) figure. VaR and risk adjusted performance figures must then be disseminated to decision makers, often with figures broken down by a variety of categories. These reports will help management adjust their business strategies with regard to market risk; further, regulators who have determined that VaR serves as the basis for regulatory capital requirements require the reports.

To meet the market discipline requirements of Basel II, a data access and storage mechanism must be created that is comprehensive; provides timely and appropriate information to analysis tools and robust reporting engines; provides a complete view of risk exposure across the enterprise in a variety of reporting formats; and provides consistent market risk measures in terms of both required data and applied analytics. Implementing a bank-wide risk management strategy is the only guaranteed way that banks can begin to comply with the minimum requirements of the new regulations, by ensuring that your risk calculations are accurate, complete and reliable. This study also suggests several implications for the regulating authorities. For instance sound practices need to be outlined for financial institutions' levels of exposure to leverage risk. Consequently, accurate measurement of potential credit exposure should be enforced. Last but not least, regulators should take steps in order to enforce improvement of the quality of information reporting by not only the hedge funds but also all types of financial institutions.

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