INSTITUTE OF ACTUARIAL & QUANTITATIVE STUDIES

**Class:** TY BSc

**Subject :** Risk Management & Investment Management -1

**Chapter:** Unit 4 Chapter 1

**Chapter Name:** Decoding risk management failures

# Topics to be covered

1. Limitations

2. Unknown Risks

1. Unknowable Risks

1. VaR and it's Limits
    1. Variance/Covariance Approach
    2. Historical Simulation Approach
    3. Monte Carlo Approach

2. Expected Shortfall

1. Risk Management Issues

1. ERM and communication

# Continued…

8. Operational Risk
8. Model Risk
8. Business Risk
8. Liquidity Risk
8. Summary

# 1 Limitations

- After the global financial crisis, consultants and policy makers reached the conclusion that, as articulated by Ernst & Young Partner Randall Miller, “companies with more mature risk management practices outperform their peers financially.”
- Consultants offered to show less risk-savvy companies how to reap the “likely profit margin increase” that has accrued to “risk management leaders… over the last three years” and to achieve the spectacular EBITDA-differentials between the “top” and “bottom” of the risk management maturity scale.
- Despite such claims, academic studies have yet to confirm whether and how risk management practices add value.
- We can also be skeptical of the universal and standardized procedures that consultants advocate as best risk management practices. Their surveys of contemporary practice document the widespread creation of risk management departments, risk committees and the hiring of specialized staff for these (not surprising given recent regulations and guidelines that mandate, or strongly recommend them).
- The surveys also provide evidence of widespread adoption of risk management tools such as risk ratings, KRIs, horizon scanning, scenario planning and stress testing.
- But what these large sample surveys fail to provide is convincing evidence of the quality, depth, breadth, and impact of risk management in the adopting organizations.

# 1 Limitations

- For example, a company may have a risk management department run by a professional CRO who has the expressed backing of the CEO and board. But unless that CRO also has the resources, leadership, and support to reveal the company's strategy risks proactively and authoritatively, his or her department may be largely ineffective.
- Simple surveys of practice do not reveal how often risk professionals prevented high risk projects from going forward. Nor do the surveys offer much of a sense of the kind and value of the help CROs provide business managers when setting and trying to adhere to the firm's declared "risk appetite."23 Not surprisingly, the surveys also document that mandated and codified risk management practices have not been embraced by corporate managers.
- A survey of C-suite executives reported that fewer than half believed that their organization had an effective risk-management program.

# 2 Unknown Risks

- Most of the risks we have considered before are what are termed known risks. They are risks such as market risks and credit risks that can be quantified using historical data.
- Two other types of risk are important to financial institutions: unknown risks and unknowable risks.

- **Unknown risks are risks where the event that could cause a loss is known, but its probability of occurrence cannot easily be determined**.
- Operational risks and business risks include many different types of unknown risks. What is the probability of a rogue trader loss? What is the probability of a loss from a major lawsuit? What is the probability that operations in a particular country will be expropriated by the government? These probabilities cannot usually be estimated using historical data.

# 3 Unknowable Risks

- **Unknowable risks are risks where even the event that could cause a loss is not known.**

- Unknowable risks are in many ways the most insidious because they come as a complete surprise and often lead to dramatic losses. An unknowable risk is sometimes referred to as a black swan. (Black swans were not considered possible until they were discovered in Australia.)
- As pointed out by Taleb (2007), once it has occurred, a black swan event is often considered to be obvious.
- Did the producers of multivolume encyclopedias in 1970 consider the possibility that technological developments would render their product worthless? Probably not, but ex post it seems a fairly obvious risk.

# 4 VaR and it's Limits

- Since the late 1990s, VaR has become the standard way to measure and report market risk, and the methodology has also been extended to credit risk.
- VaR is a very useful risk measure during normal market conditions—i.e., much of the time—and offers a powerful way of assessing the overall market risk of trading positions over a short horizon, such as a two-week (i.e., 10 trading days) period.
- In effect, the methodology allows us to capture in a single number the multiple components of market risk, such as curve risk, basis risk, and volatility risk.
- However, each time there is turmoil in the world's markets, the limitations of VaR and other sophisticated measures of market risk are revealed. The reason is simple: VaR models are based on the assumption that key parameters such as volatilities and correlations are stationary—i.e., that they do not change in value during the period in which the risk is measured.
- This assumption is often proven to be wrong during extreme market conditions, making VaR an unreliable measure of risk at exactly the moment that robust risk analytics are most required.

# 4 VaR and it's Limits

## Variance/Covariance Approach

- To simplify the derivation of VaR, we can choose to make certain assumptions.
- Under the analytic variance/covariance or "delta normal" approach, we assume that all the risk factors and the portfolio values are log normally distributed or, equivalently, that the natural log of the returns are normally distributed.
- This makes the calculation much simpler because the normal distribution is completely characterized by its first two moments, the mean and the variance, and the analyst can analytically derive the mean and the variance of the portfolio return distribution from:
    - The multivariate distribution of the risk factors
    - The composition of the portfolio

# 4 VaR and it's Limits

## Historical Simulation Approach

- The historical simulation approach to VaR calculation is conceptually simple and does not oblige the user to make any assumptions about the distributions.
- However, at least one to three years of historical data are necessary to produce meaningful results.
- First, the changes in relevant market prices and rates (the risk factors) are analyzed over a specified historical period—say, two years. The portfolio under examination is then revalued, using changes in the risk factors derived from the historical data, to create the distribution of the portfolio returns from which the VaR of the portfolio can be derived. Each daily simulated change in the value of the portfolio is considered as an observation in the distribution.
- Three steps are involved:
  i. Select a sample of actual daily risk factor changes over a given period of time—say, 500 days (i.e., two years' worth of trading days)—using the same period of time for all the factors.
  ii. Apply those daily changes to the current value of the risk factors, revaluing the current portfolio as many times as the number of days in the historical sample. Sum these changes across all positions, keeping the days synchronized—i.e., each day of historical changes in the factors is applied to today's factors to yield a simulated observation for the distribution for the specific portfolio.
  iii. Construct the histogram of portfolio values and identify the VaR that isolates the first percentile of the distribution in the left-hand tail (assuming VaR is derived at the 99 percent confidence level).

# 4 VaR and it's Limits

## Monte Carlo Approach

- Monte Carlo simulation consists of repeatedly simulating the random processes that govern market prices and rates. Each simulation (scenario) generates a possible value for the portfolio at the target horizon (e.g., 10 days). If we generate enough of these scenarios, the simulated distribution of the portfolio's values will converge toward the true, although unknown, distribution. The VaR can be easily inferred from the distribution.

# 4 VaR and it's Limits

## Monte Carlo Approach

- Monte Carlo simulation involves three steps:
  i. Specify all the relevant risk factors. As in the other approaches, we need to select all the relevant risk factors. In addition, we have to specify the dynamics of these factors—i.e., their stochastic processes—and we need to estimate their parameters (volatilities, correlations, mean reversion factors for interest rate processes, and so on).
  ii. Construct price paths. Price paths are constructed using random numbers produced by a random number generator. For a simple portfolio without complex exotic options, the forward distribution of portfolio returns at a 10-day horizon can be generated in one step. Alternatively, if the simulation is performed on a daily basis, a random distribution is drawn for each day to calculate the 10-day cumulative impact. When several correlated risk factors are involved, we need to simulate multivariate distributions. Only in the case where the distributions are independent can the randomization be performed independently for each variable.
  iii. Value the portfolio for each path (scenario). Each path generates a set of values for the risk factors for each security in the portfolio that are used as inputs into the pricing models. The process is repeated a large number of times, say 10,000 times, to generate the distribution, at the risk horizon, of the portfolio return. This step is equivalent to the corresponding procedure for historical simulation, except that Monte Carlo simulation can generate many more scenarios than historical simulation.

# 4 VaR and it's Limits

## Pros and Cons – Variance/Covariance Approach

| Pros | Cons |
|---|---|
| Computationally efficient; it takes only a few minutes to run the position of the entire bank. | Assumes normality of the return portfolio. |
| Because of central limit theorem, the methodology can be applied even if the risk factors are not normal, provided the factors are numerous and relatively independent. | Assumes that the risk factors follow a multivariate log normal distribution, and thus does not cope very well with "fat-tailed" distributions. |
| No pricing model is required; only the Greeks are necessary, and these can be provided directly by most of the systems that already exist within banks (i.e., the legacy systems). | Requires estimation of the volatilities of the risk factors as well as the correlations of their returns. |
| It is easy to handle incremental VaR. | Security returns can be approximated by means of a Taylor expansion. In some instances, however, a second-order expansion may not be sufficient to capture option risk (especially in the case of exotic options). |
| | Cannot be used to derive the confidence interval for VaR. |

# 4 VaR and it's Limits

## Pros and Cons – Historical Simulation Approach

| Pros | Cons |
|---|---|
| No need to make any assumption about the distribution of the risk factors. | Complete dependence on a particular historical data set and its idiosyncrasies (past in prologue). For example, extreme events such as market crashes either lie outside the data set and are ignored or lie within the data set and (for some purposes) act to distort it. |
| No need to estimate volatilities and correlations; they are implicitly captured by the actual (synchronous) daily realizations of the market factors. | Cannot accommodate changes in the market structure, such as the introduction of the euro in January 1999. |
| Fat tails of distributions and other extreme events are captured so long as they are contained in the data set. | Short data set may lead to biased and imprecise estimation of VaR. |
| Aggregation across markets is straightforward. | Cannot be used to conduct sensitivity analyses. |
| Allows the calculation of confidence intervals for VaR. | Not always computationally efficient when the portfolio contains complex securities. |

# 4 VaR and it's Limits

## Pros and Cons – Monte Carlo Approach

| Pros | Cons |
|---|---|
| Can accommodate any distribution of risk factors. | Outliers are not incorporated into the distribution. |
| Can be used to model any complex portfolio. | Computer intensive. |
| Allows the calculation of confidence intervals for VaR. | |
| Allows the user to perform sensitivity analyses and stress testing. | |

# 4 VaR and it's Limits

- VaR is far from being a perfect or complete measure of risk—no such thing exists. The use and reliability of VaR is often dictated by the availability of data— for instance, on volatilities and correlations.10 And to facilitate the implementation of a VaR model, especially in the case of the analytic variance/covariance and Monte Carlo approaches, it is common to assume that market conditions will remain stationary. Prices and values are assumed to have a "smooth" behavior that excludes the possibility of jumps and other extreme events.
- This makes VaR an unreliable risk metric at times of crisis and disruption.
- For example, in the third quarter of 2007 after the subprime crisis erupted, major banks reported a number of VaR exceptions way beyond what might be expected under normal conditions (i.e., two or three each year on average at the 99 percent confidence level). Credit Suisse declared 11 exceptions, Bear Stearns 10, and UBS 16; Lehman Brothers declared 3, Goldman Sachs 5, and Morgan Stanley 6, with the VaR of the three last banks being calculated at the 95 confidence level.

# 5 Expected Shortfall

- One of the biggest criticisms of VaR is inherent in the methodology. VaR does not attempt to offer any indication of how large or frequent a loss might be once the loss exceeds the VaR number—i.e., VaR fails to capture what is known as "tail risk."
- For example, we might hope that a portfolio with a VaR of $100 million at the 99 percent confidence level is unlikely to experience losses above $100 million more often than once every 100 days (i.e., 1 percent of the time), or two to three times in one year. Even supposing the VaR is accurately estimated, we can therefore expect losses of over $100 million on around three trading days for any particular year.
- **"Expected shortfall" (ES), also called "conditional VaR" (CVaR), is an alternative risk measure that gives an indication of the magnitude of the potential losses in the tail**:
- ES = Expected loss beyond VaR (i.e., the expected loss given that the loss exceeds the VaR)
- ES then measures the downside risk beyond VaR at a given confidence level.
- Taking account of tail risk using ES is likely to become a critical capability in many institutions. In its "Fundamental Review of the Trading Book," published in 2012, the Basel Committee even went so far as to propose adopting this risk metric in lieu of VaR.

# 5 Expected Shortfall

- Different approaches can be applied to estimate VaR and ES simultaneously.
  i. For a normal distribution, VaR and ES can be derived directly from the volatility of the portfolio return distribution. For example, assuming zero expected profit/loss and confidence levels of 95 and 99 percent, then VaR can be found directly from the statistical table for the normal distribution, which shows quantile values of 1.65 and 2.33, respectively. The corresponding ES are 2.06 and 2.67, respectively. These values will be higher than the corresponding VaR at the same confidence levels.
  ii. When VaR is derived from a Monte Carlo simulation with 100,000 runs (scenarios), then ES at the 99 percent confidence level is simply the average value of the 1,000 worst-case scenarios.
  iii. A more sophisticated approach, known as "Extreme Value Theory," consists of fitting the tail of the historical distribution of the portfolio returns to a fat-tail distribution called a Generalized Pareto Distribution (GPD). Once the GPD has been calibrated, VaR and ES can be derived analytically.

# 6 Risk Management Issues

- Concentration of risk, use of complex derivatives, understating risk, herd behaviour and transfer of risk to unworthy participants are some of the issues with risk management.
- Poor risk management and risk governance culture sometimes allow powerful business leaders to significantly understate risks and can cause troubles in risk management. There are conflicts of interest which arise due to compensation structure and lack of proper checks and balances.
- Risk management has not consistently been able to prevent market disruptions or to prevent business accounting scandals resulting from breakdowns in corporate governance.
- Management itself might be tempted to leave gaps in risk measurement that, if mended, would disturb the reported profitability of a business franchise.
- In many firms across a broad swathe of industries, bonuses are paid today on profits that may later turn out to be illusory, while the cost of any associated risks is pushed, largely unacknowledged, into the future.
- The implied cost of any risk can be artificially reduced by applying poor or deliberately distorted risk measurement techniques.
- There is enormous scope for individual professionals to take advantage of loopholes or where certain discretion is allowed. Therefore it is imperative to have a strong regulatory system with well-structured risk management systems to avoid conflict of interest situations.
- Risk can be classified into various types. Namely; Market Risk; Credit Risk; Liquidity Risk; Operational Risk; Legal and Regulatory Risk; Business Risk; Strategic Risk and Reputation Risk.

# 6 Risk Management Issues

- Risk management in practice though smoothens cash flow and reduces cost of capital and compliance for the firm. It also helps set up a risk appetite and enhances the ability of firms to finance growth while communicating well with the shareholders about objectives.
- After getting an idea of the strategies that can be used, the firms should put risk management into practice. The first step involves determining the objective of the risk management policy of the firm.
- A independent Board of Directors is necessary for formulating a good risk management policy and how the board is constituted is crucial. The BoD formulates the strategy and conveys risk appetite of the firm and how to manage it.
- A well calibrated and executed risk management strategy can lower the risks for the firm while also allowing it to use it as a growth opportunity. The limits and complexity of using these instruments should be understood well before using them.

# 7 ERM & communication

- The whole Enterprise Risk Management (ERM) framework though should focus around integration of risk management and hence a central risk management unit.
- The major benefits of having an ERM program are : Increased organizational effectiveness , Better risk reporting and Improved business performance.
- Organizations that make rational investments in risk management and are proactive, optimize their risk profiles. These investments are more than offset by improved efficiency and reduced losses.
- The Chief Risk Officer (CRO) is the head of an independent risk function in an organization.
- The CRO is tasked with providing the overall leadership, vision, and direction for ERM, establishing an integrated risk management framework for all aspects of risks across the organization while also communicating with senior management and other stakeholders of the organization.

# 7 ERM & communication

- The risk management committee (a subset of the full board of directors) is responsible for setting the firm's risk appetite and independently monitoring ongoing risk management.
- The compensation committee is independent of management. Its role is to discuss and approve the remuneration of key management personnel.
- Audit committee is responsible for monitoring risk management procedures, tracking the progress of existing systems, and affirming the efficacy of the existing policies/systems.
- The core components of an ERM program include Corporate Governance, Line Management, Portfolio Management, Risk Transfer, Risk Analytics, Data and Technology Resources and Stakeholder Management.
- The risk culture of a firm is the goals, customs, values, and beliefs (both implicit and explicit) that influence the behaviors of employees.

# 8 Operational Risk

**Operational risk** refers to potential losses flowing from inadequate (or failed) internal processes, human error, or an external event.

- Operational risk could relate to factors such as inadequate computer systems (technology risk), insufficient internal controls, incompetent management, fraud (e.g., losses due to intentional falsification of information), employee mistakes (e.g., losses due to incorrect data entry or accidental deletion of a file), natural disasters, cyber security risks, or rogue traders.
- Chase Manhattan and Kidder Peabody were classical examples of operational risks being exploited by knowing insiders or clients.
- Similarly, Jack Leeson at Barings Bank exploited his internal knowhow and was unsupervised. It was a conflict of a supervisory and executive role in action.
- In the Indian context, Harshad Mehta and Ketan Parekh both exploited weaknesses in the system and defrauded it.
- The PNB and PMC bank cases were examples of collusion between lenders and the borrowers to fraud the system.
- NSEL was a multi-party failure with the government in the form of a regulator also failing to do it's duty.

# 9 Model Risk

**Model risk** is a type of risk that occurs when a financial model is used to measure quantitative information such as a firm's market risks or value transactions, and the model fails or performs inadequately and leads to adverse outcomes for the firm.

- The use of models introduces model risk, which potentially involves the following:
  i. Using the wrong model for estimation
  ii. Incorrectly specifying a model
  iii. Using incomplete data
  iv. Deploying the wrong estimators
  v. Making the wrong assumptions

- LTCM was a classic case of model risk being manifested on the marketplace. Despite the presence of a lot of academic stalwarts, they failed to account for tail-event risks and correlations becoming stronger during times of crisis.
- London Whale was a mix of both supervisory failure which compounded underlying issues caused due to the model failure.

# 10 Business Risk

**Business risk** is the exposure a company or organization has to factor(s) that will lower its profits or lead it to fail. Anything that threatens a company's ability to achieve its financial goals is considered a business risk.

- Business risk is influenced by a number of different factors including:
  i. Consumer preferences, demand, and sales volumes
  ii. Per-unit price and input costs
  iii. Competition
  iv. The overall economic climate
  v. Government regulations

- MGRM and Banker's Trust incidents involved a consumer side business risk which these entities failed to fully account for in their business models.
- JP Morgan, Enron and Citigroup deliberately underplayed their risks to portray better results and in the process ended up losing vast sums of money.

# 11 Liquidity Risk

**Liquidity risk** occurs when an individual investor, business, or financial institution cannot meet its short-term debt obligations. The investor or entity might be unable to convert an asset into cash without giving up capital and income due to a lack of buyers or an inefficient market.

- Investors, managers, and creditors use liquidity measurement ratios when deciding the level of risk within an organization. They often compare short-term liabilities and the liquid assets listed on a company's financial statements.
- As we've seen through a lot of the case studies, non-availability of capital at required times caused a lot of these firms to fail. Even if fundamentals for such firms were strong, they didn't take into consideration the liquidity risk associated when large contracts are signed in real-life scenarios and how difficult it is to execute them successfully.
- Liquidity risk is compounded whenever other financial issues rear their heads and acts as a force-multiplier to the issues a firm faces.

# 12 Summary

- We've learned about the various types of risk organizations face.
- Some of these challenges are internal while others maybe external.
- A lot of the financial issues can be red-flagged due to the emergence of technology and metrics which help to monitor such issues constantly.
- With each crisis faced, internal controls have been raised and so have the regulatory standards.
- Though business activity does involve considerable risk taking, we can minimize those by following the best of risk management procedures at our disposal and learning from our past mistakes.
- That helps us avoid losses and the opportunity cost associated with them.
- As risks are handled better, firms and eventually economies become more resilient, sustainable and equitable. That's the end goal of enterprise as we know it.