



Techniques for Risk Analysis

Shelton Nicholls

Central Bank of Trinidad and Tobago



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Structure of Presentation

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1. Definition of Risk

- **Risk can be defined very generally as “the uncertainty that an investment will earn its rate of return”.**
- **This uncertainty ultimately translates into a probabilistic concept that measures the potential loss that arises from an investment.**



2. Taxonomy of Risks

- In trying to arrive at a useful taxonomy of risks, it is important to note that the importance of a particular class of risks will depend on the nature of the investment instrument being considered. There are basically two broad classes of risks:
 - **Systematic Risk**
 - **Un-Systematic Risk**



2.1 Systematic Risk

- **Systematic Risks**: Risks that are associated with market factors that are beyond the control of the investor. There is a systematic relationship between the market and the investment and therefore this risk is non-diversifiable.
 - Interest Rate Risk
 - Re-investment Risk
 - Exchange Rate Risk
 - Market Risk
 - Purchasing Power Risk
 - Political Risk



2.2 Un-Systematic Risk

- **Unsystematic Risk**: Risk Associated with the operations of a company and its way of doing business or risks associated with a specific investment instrument.
 - Business Risk
 - Default Risk
 - Liquidity Risk
 - Financial Risk
 - Credit Risk
 - Event Risk



3. Properties of a Good Risk Measure

- **Property 1- Sub-additivity** : Risk measure of an aggregate portfolio must be less than or equal to the sum of the risk measures of the smaller components that constitute the portfolio (one cannot reduce the risk of a portfolio by splitting it into smaller components)
- **Property 2 -Positive Homogeneity**: Risk measure should be proportional to the scale of the portfolio (i.e. halving the portfolio halves the risk measure)



3. Properties of a Good Risk Measure (cont'd)

- **Property 3 - Monotonicity**: If a portfolio with payoffs, y , dominates one with payoffs, x , then the portfolio of payoffs y , must have less or equal risk.
- **Property 4 – Risk –Free Condition or Translation invariance**: Adding a risk-free instrument to a portfolio decreases the size of the risk by the size of the investment in the risk-free instrument.
 - (see Artzner, Delbaen, Eber and Heath (2000, 2001))



4. Techniques/Measures of Risk

● 4.1 Traditional Measures of Risk

● 1. Standard Deviation of Return

- *Standard deviation of the difference in return on the individual investment and the expected return on the portfolio.*

● 2. Tracking Error

- *Standard deviation of the the difference in return between the investment and a specified benchmark.*



4. Techniques/Measures of Risk

4.1 Traditional Measures of Risk (cont'd)

- **3. Relative Risk Measure or Covariance (Beta)**
 - *Equals the covariance of the security with a market index divided by the variance of the market index.*
- **4. Probability of Shortfall**
 - *The probability that the returns from the investment falls below a benchmark or reference point.*



4.1.1 Limitations of Standard Deviation Measure

- Deviations above and below the mean are given the same weighting. Investors though are generally more risk averse to returns below the mean (negative returns).
- Measures depends on multivariate normal distributions (association between random variables is described by marginal distributions and the linear correlation coefficient)



4. Techniques/Measures of Risk

4.2 Modern Measures of Risk

- **1. Value at Risk (VaR)*****
 - For a given time horizon k , ($0 < k < 1$), VaR_k measures the maximum loss in a specified period with probability level, k .
- **2. Conditional VaR (Uryasev)**
 - This is the expected value of the losses exceeding VaR



Techniques or Measures of Risk

4.2 Modern Measures of Risk

- 3. **Expected Shortfall**
 - *The difference between the actual returns and the benchmark over the range of returns when there is a shortfall.*
- 4. **Expected Regret**
 - *The expected value of the loss distribution of returns beyond a threshold or benchmark.*



Basel Committee and VaR Risk Measure

- Consultative Document issued by the Basel Committee on banking Supervision in January 2001 advances three important principles:
 - **VaR is assumed as the risk measure.**
 - The risk of each loan is portfolio invariant.
 - **Regulatory capital for a loan must be correlated to its marginal contribution to VaR.**



Limitations with VaR

- VaR model does not satisfy the sub-additivity principle and portfolio diversification sometimes results in an increase in risk (only satisfies principle when joint distribution of returns is elliptical).
- VaR has many local extremes which may lead to unstable rankings.
- Non-convexity makes it difficult to use VaR in optimisation problems.
- VaR may produce conflicting results at different confidence levels.
- VaR cannot describe appropriately dependent extremal events.



Software for Risk Analysis

Two of the more popular and respected software used for quantitative risk measurement are:

- **RiskMetrics** (initially developed by JP Morgan)
www.riskmetrics.com
- **Infinity** (developed by SunGuard)
www.risk.sunguard.com
- NB. Software represents only one aspect of Risk Management/Budgeting and should not take the place of proper risk evaluation.



Integrating Risk Budgeting into the Organisation

- Some Core Steps in the Process of Risk Budgeting in an Organisation
 - Identify relevant risks that need to be considered in the risk budget
 - Allocate allowable measure of risk to investment process (Decide on how much risk managers should take for each class of investment)
 - Determine the aspects of Risk to be monitored



Integrating Risk Budgeting into the Organisation

- Establish risk tolerance levels
- Establish a system for measuring risks
 - Use of VaR, Tracking Error, Risk Decomposition, Stress Testing etc.
- Institute mechanisms for frequent monitoring and reporting of risk relative to tolerance levels
- Establish systems for compliance and reporting

