Enhancing Risk Management and Governance in the Region's Banking System to Implement Basel II and to Meet Contemporary Risks and Challenges Arising from the Global Banking System

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Session 3.1

Value at Risk

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Plan

- What is risk?
- How can we measure risk?
- Some experiments
- VaR as a useful risk measurement tool
- Three approaches to calculating VaR
- VaR applied to loan portfolios
- Conclusion

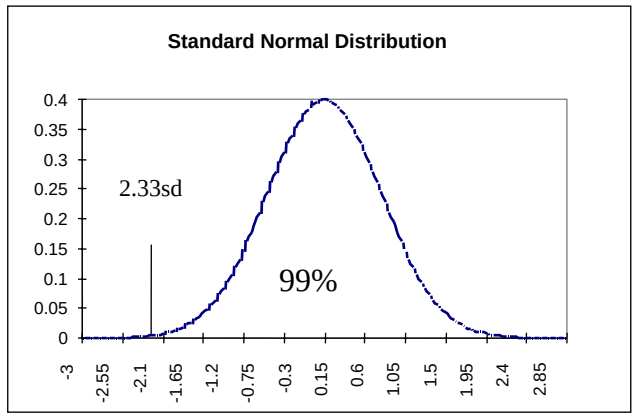
Risk

- Risk
  - variability of future values of key economic variables
  - possibility of both ups and downs
  - danger plus opportunity
  - technical measurement
    - standard deviation (volatility) of probability distribution of future outcomes
    - measures the dispersion around expected value weighted by the probability of occurence

Probability Distributions

- One way of quantifying risk is to describe outcomes and probability of occurrence in terms of a probability distribution
- Most people have heard of the normal or bell-shaped distribution
- The normal distribution can be described by its mean and standard deviation

Normal distribution



99% of the distribution lies to the right of a point 2.33 standard deviations to the left of the mean

Risk quantification

- Risk is measured as standard deviation of returns
- Then translated into dollar amounts for a particular situation
- What is a one standard deviation price movement in a particular market (eg the price of oil)?
- A tolerance for risk is defined either in terms of a probability or number of standard deviations
- For example, there is a 66% probability of a one standard deviation movement either way
- These concepts can be described in one term -

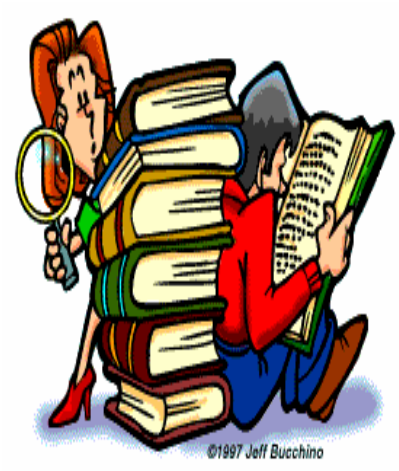
Value at Risk - VaR

- VaR is a measure of the minimum loss that would be expected over a period of time for a pre-specified small probability
- For example a VaR of $1 million over the next day at a probability of 0.05 implies that the firm would expect to lose at least $1 million over the next day 5 percent of the time - one day in twenty
- Or the firm can expect not to lose more than $1m over the next day 95 percent of the time

VaR

- VaR is a useful device for measuring the market risk of a portfolio
- It is useful in management reporting
- Three attributes are required when reporting a VaR:
- A dollar amount
- A level of confidence
- A time horizon or planning horizon

Quiz – Experiment 1



- Hersch Shefrin, “Beyond Greed and Fear”, Harvard Business School Press, 2000.

Overconfidence

- Count an answer as a hit if the correct answer lies between your low guess and your high guess
- Count an answer as a miss if the right answer falls outside the range between your high guess and your low guess
- What score did you get?
- Someone who is well calibrated should miss no more than one question.

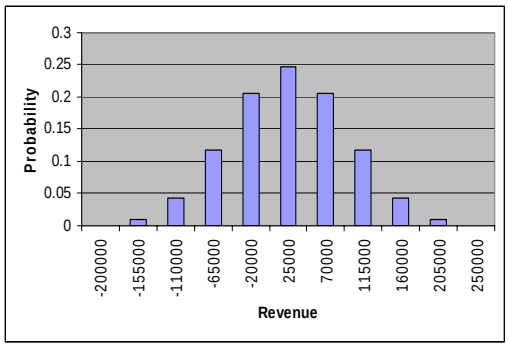
Lessons

- If you are overconfident then you will have more than one miss in the eight questions
- For risk management in order to have accurate confidence intervals we need to get reliable estimates of likely changes in interest rates, default frequencies etc
- We use history and statistics to develop a reliable VaR number

Experiment 2

- Imagine that you have a portfolio of 10 loans that will turn out to be “good” or “bad”.
- At the end of the year good loans earn a profit of $25,000 each and bad loans lose $20,000 each
- There is a 50% chance of making a good loan and a 50% chance of making a bad loan
- Write down the number that you think you will have a 5% chance of earning less (losing more) than.
- Best outcome is 10 ◈ $25,000 (all good loans)
- Worst outcome is 10 ◈ -$20,000 (all bad loans)

Outcomes



- Probability of loss = 38%
- For 10 tosses the VaR at a 5% confidence level is -$110,000
- How close was your VaR estimate?
- I am 95% confident that I will not lose more than $110,000 on my loan portfolio

Recall….

- There are three things necessary to document the VaR number:
  - A dollar amount
  - A level of confidence
  - A time horizon or planning horizon
- VaR is a tool to aggregate risks in to a single number
- It relies on models and/or market data….

Issues in Determining Value at Risk

- VaR is a single dollar amount that portfolio losses are not expected to exceed, with a specified degree of confidence, over a specified horizon, under normal market conditions.
  - What method will be used to calculate VaR?
  - What is the position ?
  - What is the time frame of interest ?
  - What are the critical financial prices causing exposure ?
  - How do we determine the probability of possible losses from position ?
  - What confidence level do we want to have ?
  - How do we determine whether calculated VAR is acceptable ?

VaR - methods of calculation

There are three main approaches to the calculation of a VaR number for a portfolio

1. The analytical method also called the variance-covariance method
2. The historical simulation method
3. The Monte Carlo simulation method

Each method has strengths and weaknesses

Three methods

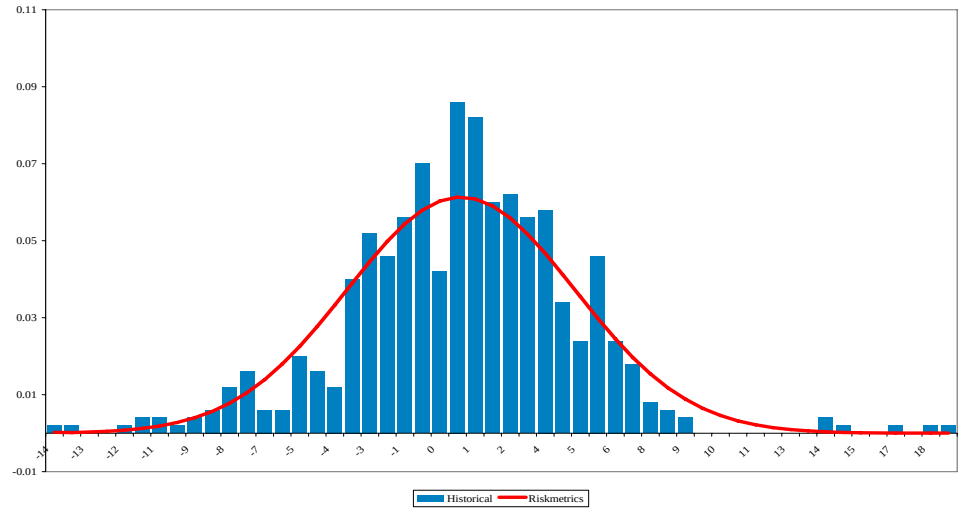
- All methods can take comovements into account.
- The analytical technique assumes a normal distribution
- Historical simulation takes a current portfolio and 'pushes' it through past market data, to calculate gains and losses on the portfolio if the market behaved as it did in the future
- It then arranges outcomes from lowest to highest
- Monte Carlo simulation uses a model to simulate outcomes

Example- Historical simulation

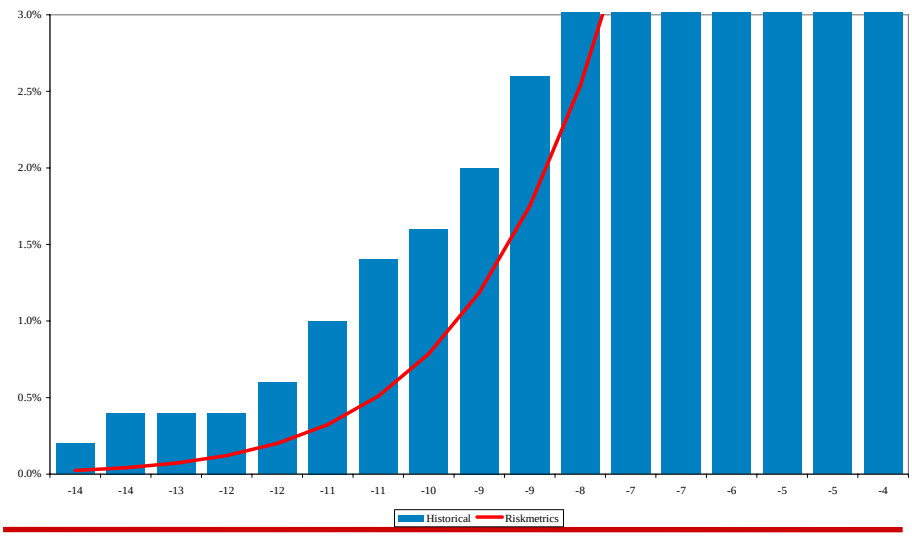
- The historical method estimates the portfolio's performance by collecting data on the past performance and using it to estimate the future probability distribution
- Assume 500 days of past data
- Arrange portfolio outcomes from largest loss to largest profit
- The VaR at 95% will be the 25th observation

Exposure
-14.3802
-13.885
-12.20931
-11.78222
-11.66984
-10.92417
-10.92288
-9.966426
-9.73539
-9.234375
-8.956875
-8.866874
-8.784115
-8.428429
-8.421086
-8.074462
-8.072581
-8.010511
-7.990498
-7.680214
-7.511758
-7.503667
-7.452797
-7.445649
-7.405385
-7.397101
-7.386265
-6.815453

Distribution of portfolio returns



Fat-tails



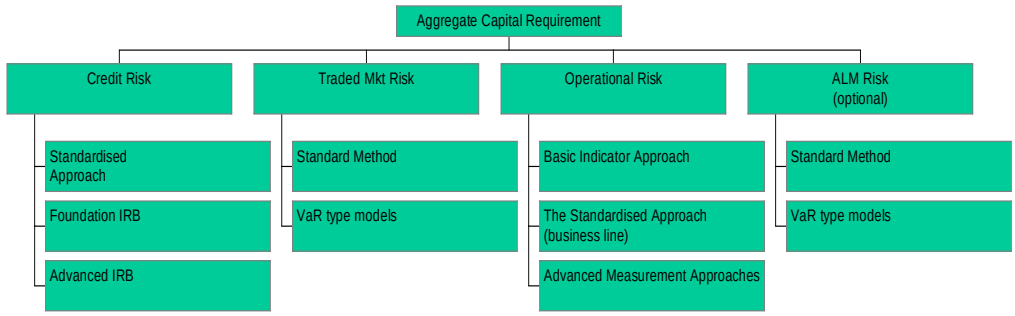
Examples

- LTCM had capital of $4.7b and a monthly (95%) VaR of $448m in April 1998 . On August 21 1998 it lost $551m (more than 10 times daily target vol)
  - Why?
- Signs of a bad model
  - In the case of UBS, 2007 saw its first exceptions since 1998...In the third quarter of 2007, UBS reported 9 exceedances at 99%. (Risk, February 2008).
  - The period without excessions was 100 times less likely than the 9 exceedances assuming a good model.

Use of VaR in banks

- At the beginning of 1998 in the US (1997 for the European community) regulators allowed certain large banks discretion to calculate the capital requirement for market risk using the VaR approach.
- Correlations are taken into account
- VaR is to be measured at the 99% confidence level over a ten day horizon
- Models are backtested

Basel 2: structure



Market vs credit risk

- VaR applied to market risk seeks to answer the question: “If tomorrow is a bad day, how much will I lose on tradable assets such as shares, bonds, currency?”
- VaR applied to credit risk seeks to answer: “If next year is a bad year how much will I lose on my loans and loan portfolio?”

The Market Risk Capital

- The VaR measure used by regulators for market risk is the loss on the trading book that can be expected over a 10-day period 1% of the time
- The capital requirement is

$$k \times \text{VaR} + \text{SRC}$$

where k is a multiplicative factor chosen by regulators (at least 3), VaR is the 99% 10-day value at risk, and SRC is the specific risk charge (primarily for debt securities held in trading book)

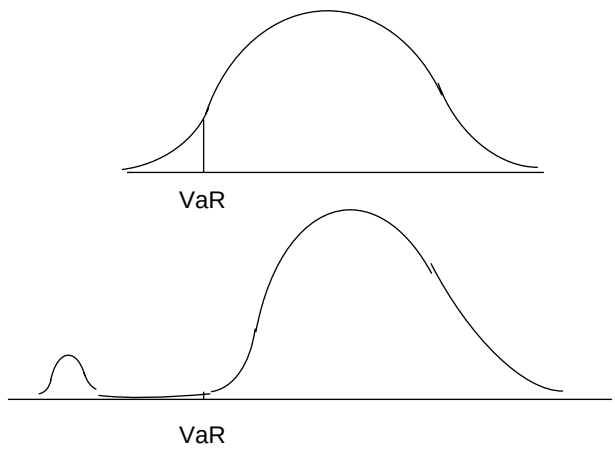
Credit VaR

- Loans are not publicly traded
- However using
  - available data on a borrower's credit rating
  - the probability that the rating will change over the next year
  - recovery rates on defaulted loans
  - credit spreads and yields in the bond (or loan) market
- It is possible to calculate the market value and the volatility of the loan portfolio
- These methods form the basis for the internal models approach under the new BIS standards

VaR vs. Expected Shortfall

- VaR is the loss level that will not be exceeded with a specified probability
- VaR does not specify the maximum possible loss
- Expected shortfall is the expected loss given that the loss is greater than the VaR level (also called C-VaR and Tail Loss)
- Two portfolios with the same VaR can have very different expected shortfalls

Distributions with the Same VaR but Different Expected Shortfalls



Conclusions

- VaR is a powerful tool for consolidating in a single number, risk across a portfolio of assets
- It provides a mechanism for containing risk within acceptable limits
- It is a powerful communication tool and for consolidating a measure of risk across portfolios
- It **does not** predict the size of the maximum loss
- VaR is used by regulators to set minimum capital requirements
- CreditVaR can be used to measure the risk of a loan portfolio
- It forms the basis of the new BIS standards

Web Resources for VaR

Don Chance's teaching notes on VaR:

http://www.bus.lsu.edu/academics/finance/faculty/dchance/Instructional/TN97-07.pdf

Also read his note on the normal distribution function:

http://www.bus.lsu.edu/academics/finance/faculty/dchance/Instructional/TN97-01.pdf

All About Value at Risk (a web-site with links to other VaR sites)

http://www.gloriamundi.org/