Society of Actuaries in Ireland

Risk Measurement – Is VaR the right measure?

24th January 2011

Agenda

- Risk Measurement – VaR & TailVaR
- Link to Risk Management System
- Time Horizon
- Regulatory practice
- Recent history

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- **Risk Measurement – VaR & TailVaR**
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Risk Measurement

- Judging a '*good*' Risk Measure
- Different measures - VAR, Tail VaR/Conditional Tail Expectation (CTE)
- Definitions and explanations
- Origin of measures
- Limitations

Risk Measurement

- Risk measure should be selected that:
  - corresponds with the purpose for which it will be used
  - the perspective of the stakeholder

- A wide range of uses e.g.
  - Pricing
  - Capital allocation decisions
  - Risk management/hedging
  - Solvency requirements and capital adequacy
  - Examining the risk appetite of the firm.

Coherence of risk measures

- Risk measures can be judged against a set of requirements they need to meet in order to be ***coherent***.

- These are:
  - **Sub-additivity** – Adding two portfolios doesn't generate any additional risk
  - **Monotonicity** – positions that lead to higher losses in any situation produce higher risk and require more capital
  - **Positive homogeneity** – increasing a portfolio by a factor of x implies corresponding increase for that risk
  - **Translation invariance** – adding a deterministic amount to the loss distribution changes the risk by that same amount

Value at Risk

VaR measures the worst loss that might be expected over a given time interval, given normal market conditions and with a specific confidence level.

- One of the most widely used risk measures by insurers and banks in quantitative risk management.

- Three key elements –
  1. A specified level of loss in value , V
  2. A fixed time period over which risk is assessed, N
  3. A confidence interval X%

- We are X% certain that we will not lose more than V dollars in the next N days.

Example - Value at Risk

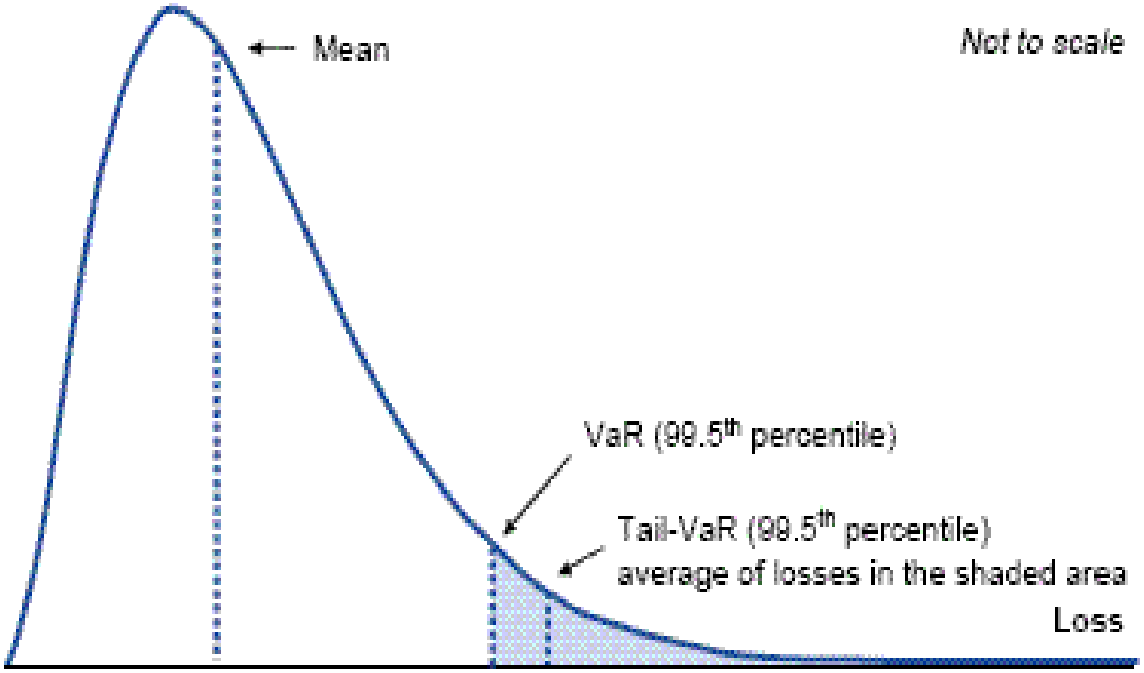


Diagram shows VAR at the 99.5% level

- If the VaR on an asset is €100m at a one year, 99.5% confidence interval ... there is only a 0.50% chance that the value of the asset will drop more than €100m over any given year.

VaR Approaches

- Variance Covariance Approach
- Historical Simulation
- Monte Carlo Approach

Variance Covariance Approach

- Variance-Covariance or Parametric Approach
  - Variances and covariances estimated
  - Usually using historic data
  - Assumes normal distribution
  - Possible to specify other distributions but usually will still transform back to a multivariate normal distribution
  - Quick and easy but lots of assumptions

Historical Simulation Approach

- Historical simulation
  - VaR estimated by running portfolio through actual historical data
  - Useful when limited data regarding distribution
  - No assumptions except...past representative of future
  - Difficulty dealing with new assets or new risks

Monte Carlo Approach

- Monte Carlo approach
  - Uses a simulation model to generate a large number of possible outcomes
  - Need to specify probability distribution for risk factors and how the risk factors move together
  - Slow – significant computational requirements
  - Most flexible – bring in subjective judgement & other information

History of VaR

- Not widely used prior to mid-nineties although was around in some form or another
- Developed earlier in time, in context of portfolio theory
- JP Morgan
  - Published RiskMetrics in 1995
  - How much can we lose on portfolio in one day?
  - 4.15 report - all firm risk on 1 page within 15 minutes of market close
  - Industry benchmark
- 1997 SEC required quantitative disclosure of risks
- Basel 2 allowed internal VAR models

Limitations of VaR

1. VaR does not measure "event" (e.g., market crash) risk.
   - portfolio stress tests are recommended to supplement VaR.
2. VaR does not capture liquidity difference among instruments
3. VaR requires assumption about probability distribution
   - usually normal
4. VaR relies on historical data to some extent and makes explicit estimates about correlation across asset classes
5. VaR does not capture model risk, which is why model reserves are also necessary.
6. VaR is not the optimal tool for decision making – doesn't consider wider risk factors e.g. political & regulatory risk
7. VaR is not coherent as it is not sub-additive
   - sub-additivity property plays a fundamental role in credit risk.
   - VaR meets other 3 reqs. of coherence

Example of non-coherence of VaR

Consider two assets – both are:

- Zero coupon bonds with a 4% probability of default and which mature in 1 years time.
- Current yield on both bonds is 0%.
- The event of default in either bond is independent of the other.

Holding either of the bonds:

- 95% VaR over 1 year is 0% since the probability of default is less than 5%.

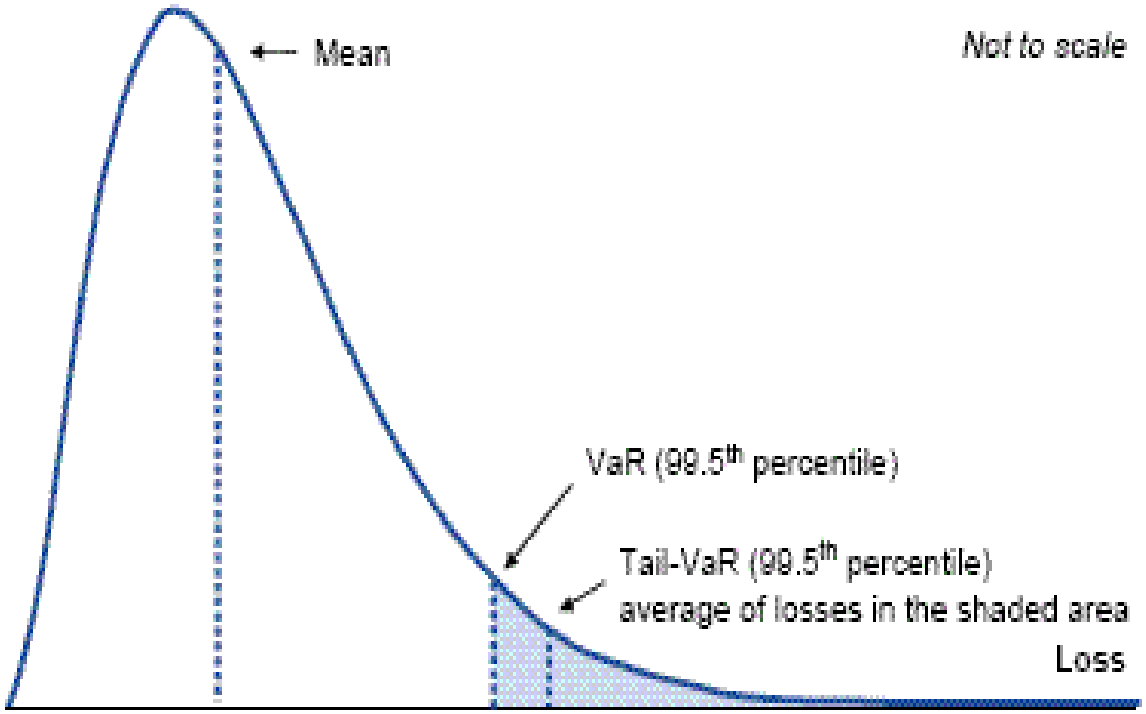
Portfolio consisting of 50% of each bond by value:

- 95% VaR over 1 year is >0% since the probability of at least 1 of the 2 bonds defaulting exceeds 5%.

VaR violates the sub-additivity property of a coherent risk measure.
***Tail VaR addresses some of the issues with VaR*.**

Tail Value at Risk (Tail VaR) or Conditional tail Expectation (CTE)

VaR assesses the loss at a specific confidence level whereas Tail VaR measures the average of losses in the event that the specified confidence level is breached.



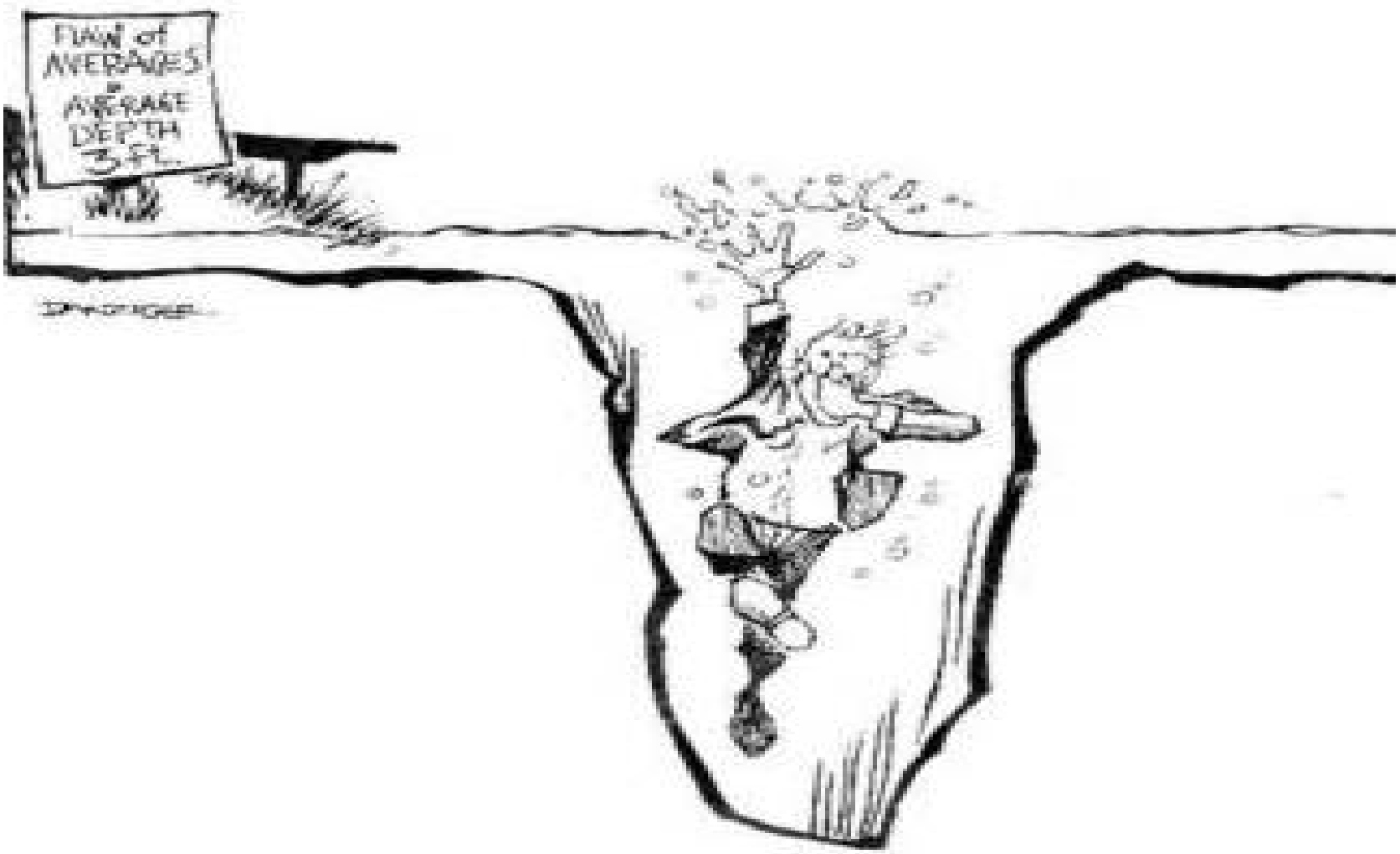
Tail Value at Risk (Tail VaR) or Conditional tail Expectation (CTE)

- Many insurance risks will feature a ‘fatter tail’ than the normal distribution – Tail VaR reflects these losses
- Closer approximation of an insurer’s risk profile
- More accurate reflection of extreme events which may jeopardise firm’s financial position.
- TailVaR would capture the risk on the zero coupon bonds in the previous example and meets all of the requirements of coherence.

Difficulties and limitations of Tail VaR

- Requires a suitable amount of data in the tail in order to understand the distribution of the tail.
- Tail VaR is perceived to be more difficult to estimate from the same amount of (scarce) data than VaR
  - This leads to increased modelling error
  - And makes it more difficult to calculate TailVaR than VaR
- Does not properly adjust for extreme low-frequency and high-severity losses as it only accounts for the average loss
- Both VaR and TailVaR ignore useful information in a large part of the loss distribution and therefore lacks incentive for mitigating losses below the confidence level.

Flaw of Averages – Average Depth 3ft



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Use in Risk Management

- Aims of the risk management framework:
  - Minimising the downside losses
  - Managing uncertainty
  - Performance optimisation
- Requires production of timely and relevant risk reporting
- Business decisions based on risk budget & risk/return optimisation
- In an ideal world economic capital information would be available *live* particularly for significant market risk exposures
- Traditionally insurance uses much longer frequencies
- But for variable annuity type products or traditional with-profits products - real need to obtain this info on a real-time basis

You can't manage what you can't measure…

Risk Appetites

- Risk appetite can be defined as the amount of risk a business is prepared to tolerate at any point in time
  - Reflection of capacity to absorb risk
  - Depend on objectives, culture & evolving business environment
  - Aligned to strategy
  - Can benchmark against industry but for each business will be unique
- Boards will aim to make informed decisions within their risk tolerance
- Use of qualitative and quantitative risk appetites
  - Quantitative in particular will utilise risk measurement techniques

Own Risk and Solvency Assessment (ORSA)

- Solvency 2 Requirement
- Includes assessment of overall solvency needs
  - Provides the link between firm's own view of risk profile and risk tolerance limits and the firm's solvency needs
  - Solvency 2 uses 1 year VaR at a 99.5% confidence interval but within ORSA can use different calibration and justify/explain differences
  - Demonstrate continuous compliance with S2 regulatory capital & technical provisions
  - Stress & Scenario testing
  - Extreme/worst case scenarios
- Developing appropriate risk measurement techniques will be essential.

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Time Horizon

- Solvency II uses 1 year time period
  - Supplemented by forward looking ORSA
  - Cover 1 year extreme event and transfer to willing buyer
  - Systemic risks?
  - Relying upon regulators?

- Key issue is liquidity of the positions
  - Banks examine market risk over 10 day period

- Capitalisation horizon versus valuation horizon

Time Horizon

- 1 year period
  - Practical advantages
  - Greater comparability and consistency
- Longer time horizon
  - Requires more judgement
  - Less consistency
  - Greater variation of capital and approaches
- Value in considering both horizons?

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Value at Risk

- Solvency II
  - 99.5% 1 year
  - Equivalent to BBB rating
- 99.5% 1 year
  - FSA Twin Peaks
  - Netherlands – Financial Assessment Framework
  - Australia
- Basel II
  - 99.9% 1 year for credit risk and operational risk
  - 3 times 99% 10 day for market risk in trading book + 3 times stressed VAR + incremental risk charge

Tail Value at Risk

- Swiss Solvency Test
  - CTE99 1 year
- US Variable Annuity
  - CTE70 full life for reserves
  - CTE90 full life for capital
- Canada guaranteed segregated fund
  - CTE95 full life

Tail Value at Risk

- Variable Annuities Ireland
  - CTE90 business before 31 December 2010
  - CTE95 after that date
  - Plus zero lapse for direct writers
  - Also CTE65 plus resilience plus solvency margin
  - Or Equivalent VAR measures

VaR Versus TailVaR

- IAA “Global Framework for Insurer Solvency Assessment”
  - CTE99 1 year
  - CTE90/95 over full life
  - Many insurance risks have skewed distributions

- CEA favoured VaR over TailVaR
  - VAR generally accepted risk measure
  - Institutions already use to measure/manage risk
  - Practical advantages
  - Conceptually simpler
  - Easier to communicate
  - More likely to be embedded in business

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Failures of Value at Risk

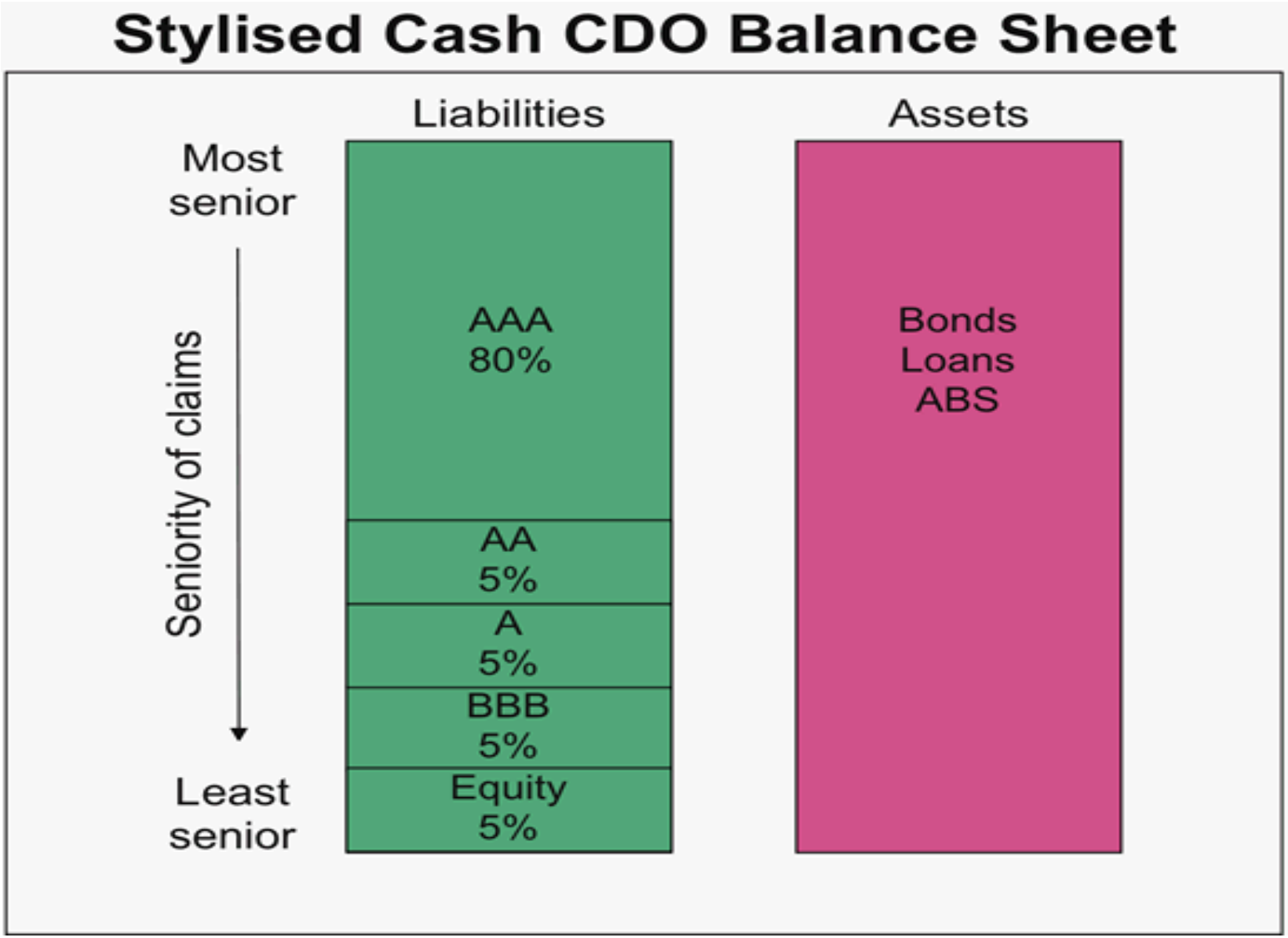
- LTCM
  - 2 Nobel Prize winners (Merton and Scholes)
  - Massive scale and leverage
    - $125 billion assets to $5 billion equity
  - “Picking up nickels in front of a steamroller”
  - Twin crises in Asia and Russia
  - $3.6 billion bailout
  - Relied on VAR
  - Correlation in extreme markets

Failures of Value at Risk

Failures of Value at Risk

- Subprime and CDOs
  - Banking system lost > $1 trillion
  - 30 years of history

Collateralised Debt Obligation



Failures of Value at Risk

- Subprime and CDOs
  - Securitisation of subprime – any diversification?
  - Originate to distribute model resulted in market changing
  - Not captured in model

Failures of Value at Risk

- AIG and credit default swaps
  - Wrote massive amounts of CDS
  - $80 billion exposure to CDOs
  - Collateral calls triggered when housing market fell
  - Calls increased when downgraded from AA
  - $182 billion bailouts

Value at Risk Critics

Value at Risk Critics

- Nassim Taleb
  - "War against value at risk"
  - "A fraud"
  - Risk models do more harm than good
  - Don't observe distributions in real life
  - Avoid prediction of remote payoffs
    - no model better than any model?

Value at Risk Critics

- David Einhorn
  - Hedge fund manager Greenlight Capital
  - Shorted Lehman Brothers
    - May 2008 presentation questioning LB's writedowns
    - Next day shares fell 5%
  - "like an air bag that works all the time, except when you have a car accident"
  - "false sense of security among senior managers and watchdogs"

Value at Risk Critics

- “Very useful when they don’t matter and totally useless when they do”

- Overall cap on leverage

Criticisms of Value at Risk

- Overexposure to risk
  - Measure risk focusing on intermediate risks
  - Optimise returns ignoring worst case scenarios
  - Leads to strategies which take risk in worst case

- Agency risk
  - Traders/Management aware of weaknesses
  - Maximise risk within limits
  - Most instances will maximise return

Value of VaR

- Communication value
  - Management can understand
  - Expresses risk as a number
- Process as important as result
  - Important that not just the result is communicated
- Practical Advantages
  - Only need to specify one scenario for VAR
  - Easier to apply across industry

VaR

- Solvency II Standard formula sets minimum capital level
  - Consistent across risks/sectors/companies
  - Facilitates comparison and understanding

- Not a perfect measure
  - Doesn’t capture most extreme scenarios
  - Confidence in models beyond 1 in 200?
  - Killer scenarios require thought

VaR

- Not sufficient to rely upon VAR figures
  - Additional thought and justification required
  - Scenario testing and stress tests
  - ORSA

- Value in supplementary coarse risk measures?

VaR

- Goldman Sachs December 2006
  - Mortgage business lost money 10 days in a row
  - Examined positions in depth
  - Sold MBS and hedged
  - VAR models gave signal
  - Prompted further analysis and action