Modelling of Operational Risk
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Operational Risk?

- Definition:
  - Operational Risk Management (ORM) is defined as a continual cyclic process which includes:
    - Communication and consultation
    - Establishing of context
    - Identify risk
    - Risk assessment
    - Risk treatment
    - Monitoring and review
  - ORM is the oversight of operational risk, including the risk of loss resulting from inadequate or failed internal processes and systems; human factors; or external events

Basel definition

- OR is defined as the risk of losses resulting from inadequate of failed internal processes, people and systems, or external events
  - In this definition, legal risk is included, whereas strategic and reputational risk are excluded

Operational Risk – The three levels

- In Depth
  - Is used before a project is implemented, when there is time to plan and prepare
    - Examples include training and drafting instructions and requirements
- Deliberate
  - Is used at routine periods through the implementation of a project or process
    - Examples include quality assurance and on-the-job training
- Time-Critical
  - Is used during operational exercises or execution of tasks. It is defined as the effective use of all available resources by individuals, crews, and teams to safely and effectively accomplish the mission or task using risk management concepts when time and resources are limited
    - Examples of includes execution check-lists and change management

The role of Risk Management

- Is the role of Risk Management to implement procedures and controls that satisfy the regulatory requirements while minimizing the capital requirements?

- Is the role of Risk Management to be forward-looking and to focus on lower-tail outcomes, using key-words like: conservative valutation approaches, out-of-box thinking, helicopter perspectives?

The failure of Risk Management - I

- It is clearly the case that over the period 2007-2009 we witnessed a catastrophic failure of risk management as a dicipline and profession:

- David Rowe "Lessons for Financial Risk Management from the Great Recession" (PRMIA, Copenhagen meeting 10. November 2009)
  - introduced the concept of "Dark Risk"
- Claus Madsen "The Financial Crisis and ERM" (PRIMIA, Copenhagen meeting, 23. March 2009) ended the presentation with the following statement:
  - "We have met the enemy and he is us", Walt Kelly (1970), http://en.wikipedia.org/wiki/Pogo_(comics)

The failure of Risk Management - II

- ## Thou shalt never assume
  - The 8th commandment from "The Rogue Warrior's Ten Commandments of SpecWar"

- Belief 1: Innovation and complexity are infinitely sustainable
- Belief 2: All risk can be hedged away
- Belief 3: Risk can be controlled and modelled using historical data
- Belief 4: Risk Management is for the specialists
- Belief 5: Risk Management is about optimizing performance

The failure of Risk Management - III

- The ability to exercise control is limited by an information gap that grows larger the more the firm is engaged in competitive product innovation
  - At the same time the opportunities for mistakes, unauthorised behaviour and fraud grows

- Like matter and energy risk cannot be destroyed – only transformed
  - Transformation leads to degradation until it can no longer to hedged – as at some point no one is able to value it anymore!

The failure of Risk Management - IV

- The financial disaster of 2007-2009 is at least in part linked to the growing complexity of both financial instruments and related operations
  - Model Risk "...the risk of losing perspective of the limitations of models in general and to the pitfalls associated with their applications" (Goldman Sachs and SBC Warburg Dillon Road 1998)

- Majority of risk models are build on key assumptions which are well understood to be false...
  - Normality, independence of returns, absence of fat tails, constant volatility etc

- George Box (1987) "all models are wrong, but some are useful"...see next slide

The failure of Risk Management - V

- Model risk is, therefore, only marginally a problem of inappropriate choice and incorrect implementation

- Model risk is fundamentally a manifestation of the so-called problem of induction – as formulated by Nassim Taleb (2004)
  - "No amount of observations of white swans can allow the inference that all swans are white, but the observation of a single black swan is sufficient to refute that conclusion"

- The known, the unknown and the unknownable

The failure of Risk Management - VI

- Aside from the issue of forward-looking measurement and senior management participation in the risk assessment process, what makes a difference for effective firm-wide identification, assessment and reporting is the unequivocal establishment of risk management as a responsibility of Board members and top managers

The failure of Risk Management - VII

- Portnoy (2003)
  - "Reported earnings follow the rules and principles of accounting. The results do not always create measures consistent with underlying economics. However corporate management's performance is generally measured by accounting income, not underlying economics. Risk management strategies are therefore directed at accounting rather that economic performance."

- Generally agreement that: "....the single most important contribution to the value of the firm is the prevention of financial distress..."
- Question: Does this corresponds to risk-management practice as it has evolved since the mid 90s?

The failure of Risk Management - VIII

- Risk managers' focus must shift from performance smoothing to distress prevention – that is focus on the identification and study of disaster scenarios

- Risk management routinely fails as a consequence of the very nature of our risk management tools and of the way financial institutions are managed in a competitive environment
  - It is a myth that effective risk management is destinguished merely by better models and better controls
- Risk management makes a difference to the survival of the firm if it focuses on its survival, rather than just crunching numbers and providing reports and if its try to identify the potential for catastrophic losses that are embedded in the way the firm does business!

A last remark...

- The art of war teaches us to rely not on the likelihood of the enemy's not coming, but on our readiness to receive him; not on the chance of his not attacking, but rather on the fact that we have made our position unassailable
  - Sun Tzu "The art of War", chapter VIII "Variation on Tactics", rule 11

Risk Assessment and Capital Allocation - I

- Few things have failed so spetacularly during the 2007-2009 period, than the assessment of risk and the related capital allocation

- Risk Assessment has shown both theoretical and practical limitations
  - Such as the likelihood for very severe events
- Capital allocation has failed to prevent some of the largest financial institutions to survive

Risk Assessment and Capital Allocation - II

- The future is not written.....

- Basel II.5 and Basel III

- Scenario Analysis

- Stress Testing

- AMA version 2.0

Risk Approaches to OR - I

- Basic Indicator Approach
  - Based on annual revenue of the Financial Institution
- Standardized Approach
  - Based on annual revenue of each of the broad business lines of the Financial Institution
- Advanced Measurement Approaches
  - Based on the internally developed risk measurement framework of the bank adhering to the standards prescribed (methods include IMA, LDA, Scenario-based, Scorecard etc.)

- The Operational Risk Management framework should include identification, measurement, monitoring, reporting, control and mitigation frameworks for Operational Risk.

Risk Approaches to OR - II

- In the AMA banks may use their own method for assessing their exposure to operational risk, as long as it is sufficiently comprehensive and systematic

- Under Basel II requirements, the financial institution intending to use the AMA for quantification of OR should demonstrate accuracy of the internal model within 56 risk cells (eight business lines times seven event types)
  - To meet regulatory requirements, the model should make use of internal data, relevant external data, scenario analysis and factors reflecting the business environment and internal control systems

Risk Approaches to OR - III

- The commonly used model for an annual loss in a risk cell (business line/event type)

$$Z_t^j = \sum_{s=1}^{N_t^j} X_s^{\,j}(t)$$

- The upper script j is used to identify the risk cell. The annual number of events N_t^j is a random variable distributed according to a frequency counting distribution, normally poisson

- The severities, in year t, are represented by random variables distributed according to a severity distribution, normal lognormal or generalized pareto (alternatively Weibull)

Risk Approaches to OR - IV

- The current risk measure specified by regulatory authorities is Value-at-Risk (VaR) at the 0.999 level for a one year holding period

- In this case simple summation over VaRs corresponds to an assumption of perfect dependence between risks. This can be very conservative as it ignores any diversification effects

- Some observations about VaR...

  - Strong dependency on distribution assumptions

  - Frachot, Moudoulaud and Roncalli (2003) – there is needed well above 10.000 data points in order to estimate a 99.9% VaR with an accuracy no better than 10%

  - VaR is not a coherent risk measure

Risk Approaches to OR - V

- One or the main differences between OR and market and credit risk is that for OR we only have losses

- Modelling dependence between different risk cells and factors is an important challenge in OR management. The difficulties of correlation modelling are well known and, hence, regulators typically take a conservative approach when considering correlation in risk models

Risk Approaches to OR - VI

- Conceptually the dependence between the annual losses can be introduced in several ways:
  - Modelling dependence between frequencies N(j) and N(i) directly through e.g. copula methods
- Considering dependence between severities (e.g. the first loss amount of the jth risk is correlated to the first loss of the ith risk, second loss in the jth risk is correlated to second loss in the ith risk, etc
- Modelling dependence between annual losses directly via copula methods

Playing the Ball....

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- "…The standard setup for OR modelling deviates somehow from the above by organizing risk rvs in a random r×c matrix L = (Li,j), i = 1, . . . , r, j = 1, . . . , c. This structure comes from the fact that, in case of OR, the Basel II framework supports the structuring of a financial institution into r = 8 business lines (BL) and c = 7 risk types (RT). For instance L2,3 could stand for next year's total loss for BL 2 (corporate finance) and RT 3 (internal fraud). Depending on the complexity of the bank, one may deviate from this standard 56 = 8 × 7 structure; some banks using the LDA have less, some have more cells. The risk measure used is Value-at-Risk, % = VaR, at the 99.9%confidence level and for a 1 year holding period hence corresponding to the calculation/estimation of a 1 in 1000 year loss across the OR loss matrix L…

- The Basel II framework allows for several levels of risk aggregation. In principle, Basel II allows VaR estimation at any level of granularity within L, then asks to add up the resulting VaR measures (corresponding to co-monotonicity of the underlying rvs) and finally allows for a reduction of this value based on diversification arguments. As it stands, with r × c = 56 and rather general assumptions on the stochastic properties of the underlying random variables, the problem is analytically extremely difficult (!)

to Martin....

- Three (at least) aspects play a pivotal role: the asymmetry of the loss matrix (r 6= c), the shape of the marginal loss distributions and the dependence between the underlying loss rvs (!)...

- At present it is too early to have concrete probabilistic assumptions for the dfs of OR loss severities and/or frequencies, as indeed for the various interdependence structures. One conclusion however is clear: aggregation at will may lead to regulatory arbitrage. Some clear guidelines on how to aggregate risk measures (VaRs) within the LDA (Loss Distribution Approach) are no doubt called for..."

- Remark: Embrechts, P. & G. Puccetti, 2008: "Aggregation Operational Risk across Matrix Structured Loss Data – The Case of Operational Risk", Journal of Operational Risk, vol. 3, no. 2