Enterprise Risk and Portfolio Management

SACE - Risk Management

Milan, February 28th, 2014

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The need for risk management

"The essence of risk management lies in maximizing the areas where we have some control over the outcome while minimizing the areas where we have absolutely no control over the outcome and the linkage between effect and cause "

1) *Peter L. Bernstein, "Against the Gods: The Remarkable Story of Risk", John Wiley & Sons, New York, 1996*

A brief history

A brief history

The world “risk” derives from the early Italian “risicare”, which means “to dare”. Risk and gambling have always had a strict relationship (hazard comes from the Arabic word for dice: al zahr.)
In 1494 a Franciscan monk named Luca del Borgo (aka Pacioli) published the “*Summa de Arithmetica, Geometria, Proportioni et Proportionalità*”, where he posed the following problem:

“*A and B are playing a fair game of balla. They agree to continue until one has won six round. The game actually stops when A has won five and B three. How should the stakes be divided*?”

The resolution of how to divide the stakes in an uncompleted game marked the beginning of a systematic analysis of probability

Let’s play a little Balla: the Pacioli solution

The division should depend somehow on the number of rounds won by each player, such that a player who is close to winning will get a larger part of the pot. But the problem is not merely one of calculation; it also includes deciding what a "fair" division should mean in the first place.

Pacioli, a little simplistically, suggested in his “Summa” to divide the stakes in proportion to the number of rounds won by each player:

A wins 5/8 of the pot
B wins 3/8 of the pot

The number of total expected rounds is not a variable!

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Getting closer: the Tartaglia solution

Noting that the number of rounds needed to win did not enter his calculations at all (therefore, **stopping after 1 round out of - say – 5, the first winner would have won the whole pot**), Tartaglia and others proposed various (mistaken or partial) solutions.

Tartaglia, for instance, constructed a method that avoids that particular problem by basing the division on the ratio between the size of the lead and the length of the game: suppose player A has achieved *a* points, player B *b* and that a total of *c* points are required to win. Let each ante S so that the entire stake is 2S. According to his solution:

Player A is due $S + \frac{a-b}{c} \cdot S$

Player B is due $S + \frac{b-a}{c} \cdot S$

The combinations (a=65,b=46) and (a=99,b=80) have the same solutions…

That is, each player is due to gain or to be reduced by an amount proportional to the difference in the number of points achieved by each: Tartaglia himself was not so sure about this solution.

A century later: Pascal and Fermat

The starting insight for Pascal and Fermat was that the division should not depend so much on the history of the part of the interrupted game that actually took place, as on the possible ways the game might have continued, were it not interrupted.
It is intuitively clear that a player with a 7–5 lead in a game to 10 has the same chance of eventually winning as a player with a 17–15 lead in a game to 20: what is important is not the number of rounds each player has won yet, but the number of rounds each player still needs to win in order to get the pot.
The solution, when one player needs *r* rounds to win and the other *s* rounds, is the following:

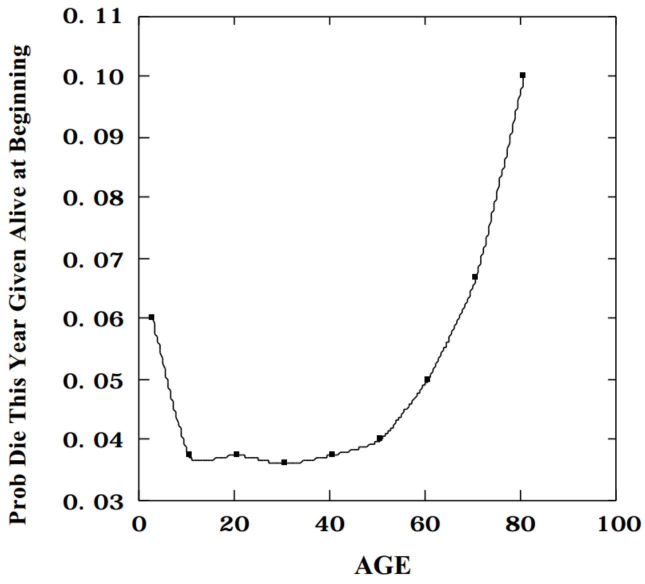
$$\frac{\sum_{k=0}^{s-1} \binom{r+s-1}{k}}{\sum_{k=s}^{r+s-1} \binom{r+s-1}{k}}$$

Of life and death: statistics

And we move to England (1662) where a haberdasher named John Graunt published a small book titled “Natural and Political Observations made upon the Bills of Mortality”.
Before Graunt, all analyses of the data had suffered the usual “can’t see the forest for the trees” difficulty: each parish priest (and there were hundreds) had his own way of recording births, deaths, marriages, etc. The data base was included in ledgers without any good sense of a common taxonomy.

Graunt solved this problem, and started modern demography (and statistics) by creating a the first ‘life table’ (of which a plotted version is shown), which provides probabilities of survival to each age.

(by the way, the life expectancy of a Londoner was 18 years…)



And the basis of life insurance…

Developing Graunt's work, Petty and – especially – Edmond Halley, produced the basis of modern actuarial science and that of life insurance: "*An Estimate of the Degrees of the Mortality of Mankind, Drawn from Curious Tables of the Births and Funerals at the City of Breslaw; With an Attempt to Ascertain the Price of Annuities upon Lives*"

Table of notorious Diseases.		*Table of Casualties.*	
Apoplex	1306	*Bleeding*	069
Cut of the Stone	0038	*Burnt, and Scalded*	125
Falling Sickness	0074	*Drowned*	829
Dead in the Streets	0243	*Excessive drinking*	002
Gowt	0134	*Frighted*	022
Head-Ach	0051	*Grief*	279
Jaundice	0998	*Hanged themselves*	222
Lethargy	0067	*Kil'd by several accidents*	1021
Leprosy	0006		
Lunatique	0158	*Murthered*	0086
Overlaid, and Starved	0529	*Poysoned*	014
Palsy	0423	*Smothered*	026
Rupture	0201	*Shot*	007
Stone and Strangury	0863	*Starved*	051
Sciatica	0005	*Vomiting*	136
Sodainly	0454		

The Bernoulli and their paradox

From the late 1600s to the late 1700s, the Bernoulli family provided eight members who have been recognized as celebrated mathematicians. Jacob, for instance, discovered the *Law of Large Numbers*, but it was Daniel who changed profoundly the way we looked at risk with his (even if credit should go to his cousin Nicolaus) *St.Petersburg paradox*:

"*A game of chance: you pay a fixed fee to enter and then a fair coin is tossed repeatedly until a tail appears, ending the game. The pot starts at 1 dollar and is doubled every time a head appears. You win whatever is in the pot after the game ends. Thus you win 1 dollar if a tail appears on the first toss, 2 dollars if a head appears on the first toss and a tail on the second, 4 dollars if a head appears on the first two tosses and a tail on the third, 8 dollars if a head appears on the first three tosses and a tail on the fourth, etc. In short, you win 2k−1 dollars if the coin is tossed k times until the first tail appears.*

What would be a fair price to pay for entering the game?"

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The St Petersburg paradox: the wrong answer

The answer is easily found through the *Expected Value:*

$$E=\frac{1}{2}\cdot 1+\frac{1}{4}\cdot 2+\frac{1}{8}\cdot 4+\cdots=\frac{1}{2}+\frac{1}{2}+\frac{1}{2}+\cdots=\sum_{k=1}^{\infty}\frac{1}{2}=\infty$$

Which is to say, given the expected win diverging to infinity, the gambler should pay *any* sum to enter the game.

Would you?

Expected utility and risk aversion

Bernoulli solved the problem with the introduction of a new concept: the **expected utility**

> "*The determination of the value of an item must not be based on the price, but rather on the utility it yields…. There is no doubt that a gain of one thousand ducats is more significant to the pauper than to a rich man though both gain the same amount.*"

To explain this new concept Bernoulli made this example: "*two men, each with 100 ducats, play a fair game of tossing coins, with 50-50 chance of winning or losing. Each man bets 50 ducats on the throw, which means that each has an equal chance of ending up with 150 ducats or only 50 ducats. Would that be a game worth playing?*"

The expected value for each man is 100 ducats, but the 50 ducats that the losing player would drop have a greater **utility** than the 50 ducats that the winner would pocket.

Expected utility and risk aversion

In a mathematical sense a zero-sum game is a loser's game when it's valued in terms of utility.

Now, the obvious characteristic of such behavior (for a risk adverse player) is that the utility is always increasing although at a decreasing rate. This feature of this particular utility function is called **diminishing marginal utility**.

Incidentally, the solution proposed by Bernoulli to the paradox is the following:

$$EU = \sum_{k=1}^{\infty} \frac{(\ln(w + 2^{k-1} - c) - \ln(w)) \cdot w}{2^k} < \infty$$

where the log function is used to model the utility, w is the gambler's total wealth and c is the cost to enter the game

Of people and rational behavior

Kahneman and Tversky's first paper on **Prospect Theory** (1979) describes an experiment showing that our choices between negative outcomes are mirror images of our choices between positive ones.

They first asked the subjects to choose between an 80% chance of winning $4,000 and a 20% chance of winning nothing versus a 100% chance of receiving $3,000.

The risky choice has a higher expected value: $3,200, but…

80% of the subject chose the $3,000

Was it only a matter of human greed? These people, as Bernoulli would have predicted, were **risk-averse**.

But if people are so dumb, how come more of us smart people don't get rich?

Then Kahneman and Tversky offered a choice between taking the risk of an 80% chance of loosing $4,000 and a 20% chance of breaking even versus a 100% chance of loosing $3,000.

This time, even if the gamble had a higher expected loss (again, $3,200),

92% **of the subject chose the gamble instead of the safer (but sure) $3,000 loss**. When the choice involves losses, we are **risk-seeker**, not risk-averse!

Tversky said: "*The major driving force is **loss** aversion: it is not much that people hate uncertainty – but rather, they hate losing*". One of the insight of the research is that Bernoulli had it wrong when he declared: "*the utility resulting from any small increase in wealth will be inversely proportionate to the quantity of goods previously possessed*".

The modern era

And we leap to 1952, when Harry Markowitz, then 25, published the seminal paper “*Portfolio Selection*” in the Journal of Finance (which earned him the Nobel Prize in Economic Science in 1990).

Before that, judgments about the performance of a security were expressed in terms of how much money the investor made or loss: risk had nothing to do with it. And it took another 20 years (and a few stock market crashes) to convince the investor to take a deeper look into risk.

Rather than looking at each security individually in search of the top performers, Markowitz’s objective was to use the notion of risk to construct portfolios who “*consider expected return a desirable thing and **variance** of return an undesirable thing*”.

Risk and variance

The behavior of a system that consist off only a few parts that interact strongly will be unpredictable. In a diversified portfolio, by contrast, some assets will be rising in price even when other assets are falling.

The mathematics of diversification (and there were lots of it: 10 out of the 14 pages of the original paper carry equations of graphs) helps to explain its attraction: *while the return of a diversified portfolio will be equal to the average of the rates of return on its individual holdings, its volatility will be* ***less than*** *the average volatility of the individual holdings*.

This mean that diversification is kind of a free lunch: you can combine a group of risky securities with high expected returns into a (relatively) low-risk portfolio (so long as you minimize the covariances among the returns of the individual securities).

Portfolio Selection

There are various limits and drawbacks about Markowitz theory: one being the use of variance as a proxy for risk, which is true only if assets returns are *jointly normally distributed* (which is not always the case) (Later on we'll see how to use *coherent risk measures)*

From a financial engineer point of view, it relies on estimators of its inputs (expected returns, variances, covariances) which can be hard to get, unreliable and computationally expensive.

But the main limit of the theory is that it assumes investors to be risk-averse and to behave **rationally**

One of the main issue of the model was the computational cost for calculating the covariances among all the individual holdings: together with Sharpe (who shared the Nobel Prize with Markowitz) they came up with a solution that led to the Capital Asset Pricing Model.

Some definitions and general concepts

What's in a name: Risk

There are many definitions of risk and risk management.

The definition set out in the **ISO standard** for risk management (**3100** and **Guide 73**) is that risk is the "***effect of uncertainty on objectives***". In order to assist with the application of this definition, Guide 73 also states that an effect may be positive, negative or a deviation from the expected, and that risk is often described by an event, a change in circumstances or a consequence.

This definition links risks to objectives. Therefore this definition of risk can most easily be applied when the objectives of the organization are comprehensive and fully stated.

Other notable definitions include:

Risk is the combination of the probability of an event and its consequence. Consequences can range from positive to negative. (Institute of Risk Management)

Uncertainty of outcome, within a range of exposure, arising from a combination of the impact and the probability of potential events. (Orange Book, UK HM treasury)

What's in a name: Risk

Some practitioners[1)] differentiate uncertainty into:

- *General uncertainty*: Complete ignorance about any potential outcome makes both rational decision making and any quantification impossible;
- *Specific uncertainty*: Objective, or at least subjective, probabilities can be assigned to the potential outcomes and hence allow for quantification.

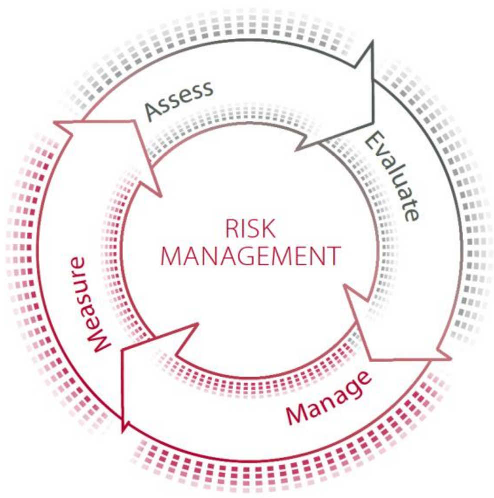
The term risk is usually used synonymously with specific uncertainty, because statistics allows us to quantify this specific uncertainty by using measures of dispersion (such as variance or standard deviation).
In a business context, risk usually expresses only the negative deviations from expected or "aimed at" values and is therefore associated with the potential for loss, whereas positive deviations are considered to represent opportunities.

1) *Gerhard Schroeck, "Risk Management And Value Creation In Financial Institutions", J.Wiley&Sons, Inc., 2002.*

What's in a name: Risk management

Risk management is often associated with an organizational unit, which is ideally an independent staff function reporting directly to the company's board of directors, hence making risk management a board responsibility.

Fact is, risk management is better defined as a ongoing process that supports the development and implementation of the strategy of an organization.

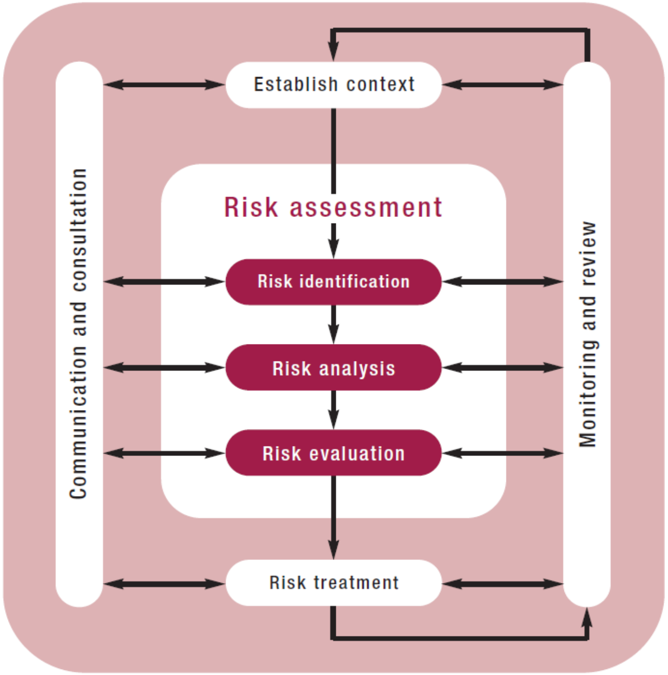


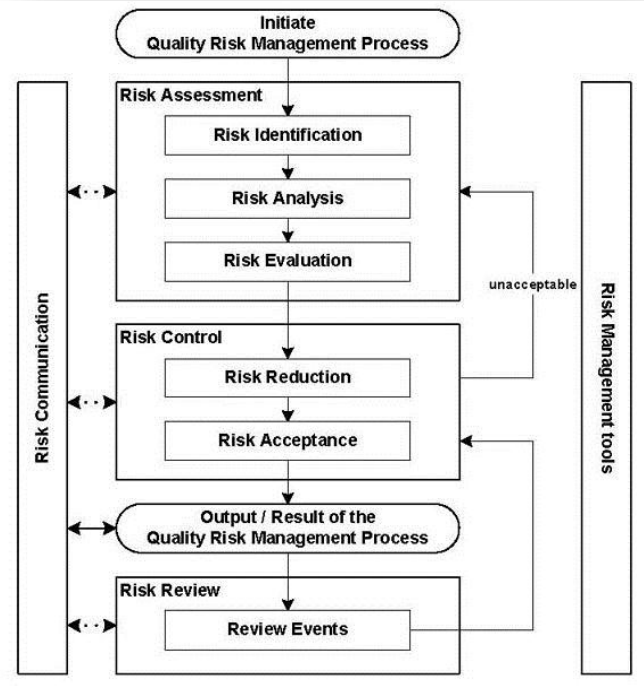
Companies need to implement best-practice risk analysis and risk measurement to capture accurately their risk exposures: the ultimate objective being the active managing of risk in a dynamic context.

Shareholders and top management must given full commitment to this goal, establishing an independent risk management function and providing full support.

What's in a name: Risk management

A number of alternative (if similar) paradigms have been proposed by regulatory boards, standardization bodies, expert groups etc.



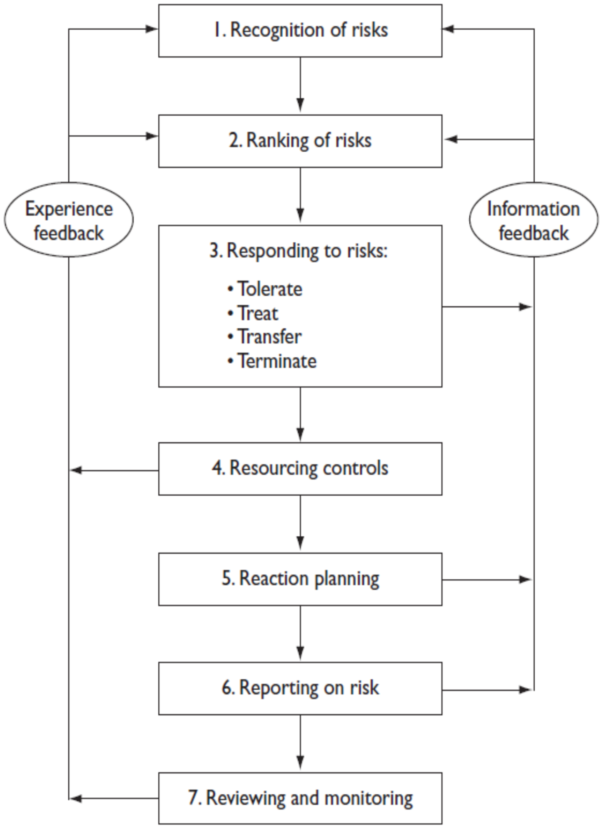


Risk management process according to ISO 3001… and according to US FDA

The 7Rs and 4Ts of risk management

The risk management process can be presented as a list of coordinated activities. There are alternative descriptions of this process, but the components listed below are usually present (and are known as the 7Rs and the 4Ts):

1. Recognition or identification of risks and identification of the nature of the risk and the circumstances in which it could materialize.
2. Ranking or evaluation of risks in terms of magnitude and likelihood to produce the 'risk profile' that is recorded in a risk register.
3. Responding to significant risks, including decisions on the appropriate action regarding the following options:
   - tolerate;
   - treat;
   - transfer;
   - terminate.
4. Resourcing controls to ensure that adequate arrangements are made to introduce and sustain necessary control activities.
5. Reaction planning and/or event management. For hazard risks, this will include disaster recovery or business continuity planning.
6. Reporting and monitoring of risk performance, actions and events and communicating on risk issues, via the risk architecture of the organization.
7. Reviewing the risk management system, including internal audit procedures and arrangements for the review and updating of the risk architecture, strategy and protocols.



Risk Assessment

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General principles: Assessment

Risk assessment involves the identification of risks followed by their evaluation or ranking. Although a simple description of a risk is sometimes sufficient, there are circumstances where a detailed risk description may be required in order to facilitate a comprehensive risk assessment process.

Organizations need to establish appropriate definitions for the different levels of likelihood and consequences associated with these different risks. Risk ranking can be quantitative, semi-quantitative or qualitative in terms of the likelihood of occurrence and the possible consequences or impact.

General principles: a taxonomy

Name or title of risk	Unique identifier or risk index
Scope of risk	Scope of risk and details of possible events, including description of the events, their size, type and number
Nature of risk	Classification of risk, timescale of potential impact and description as hazard, opportunity or uncertainty
Stakeholders	Stakeholders, both internal and external, and their expectations
Risk evaluation	Likelihood and magnitude of event and possible impact or consequences should the risk materialize at current level
Loss experience	Previous incidents and prior loss experience of events related to the risk
Risk tolerance, appetite or attitude	• Loss potential and anticipated financial impact of the risk • Target for control of risk and desired level of performance • Risk attitude, appetite, tolerance or limits for the risk
Risk response, treatment and controls	• Existing control mechanisms and activities • Level of confidence in existing controls • Procedures for monitoring and review of risk performance
Potential for risk improvement	• Potential for cost-effective risk improvement or modification • Recommendations and deadlines for implementation • Responsibility for implementing any improvements
Strategy and policy developments	• Responsibility for developing strategy related to the risk • Responsibility for auditing compliance with controls

How to perform a risk assessment

Technique	Pros	Cons
Questionnaires and checklists	• Consistent structure guarantees consistency • Greater involvement than in a workshop	• Rigid approach may result in some risks being missed • Questions will be based on historical knowledge
Workshops and brainstorming	• Consolidated opinions from all interested parties • Greater interaction produces more ideas	• Senior management tends to dominate • Issues will be missed if incorrect people involved
Inspections and audits	• Physical evidence forms the basis of opinion • Audit approach results in a good structure	• Inspections are most suitable for hazard risks • Audit approach tends to focus on historical experience
Flowcharts and dependency analysis	• Useful output that may be used elsewhere • Analysis produces better understanding of processes	• Difficult to use for strategic risks • May be very detailed and time consuming
HAZOP and FMEA approaches	• Structured approach so that no risks are omitted • Involvement of a wide range of personnel	• Most easily applied to manufacturing operations • Very analytical and time-consuming approach
SWOT and PESTLE analysis	• Well-established techniques with proven results • SWOT analysis can be linked to strategic decisions	• Focused approach that may miss some categories of risk • Rigid structure restricts imaginative thinking

How to perform a risk assessment

- A hazard and operability study (HAZOP) is a structured and systematic examination of a planned or existing process or operation in order to identify and evaluate problems that may represent risks to personnel or equipment, or prevent efficient operation. A HAZOP is a qualitative technique based on guide-words and is carried out by a multi-disciplinary team (HAZOP team) during a set of meetings.
- Failure mode and effect analysis (FMEA) was one of the first systematic techniques for failure analysis. It was developed by reliability engineers in the 1950s to study problems that might arise from malfunctions of military systems.
- PEST analysis (Political, Economic, Social and Technological analysis) describes a framework of macro-environmental factors used in the environmental scanning component of strategic management.

Hazard, Control and Opportunity

Guide 73 divides risks into three categories:

- Hazard (or pure) risks;

  Hazard risks are the risks that can only inhibit achievement of the corporate mission. Typically, these are insurable type risks or perils, and will include fire, storm, flood, injury and so on. The discipline of risk management has strong origins in the management and control of hazard risks.

- Control (or uncertainty) risks;

  Control risks are risks that cause doubt about the ability to achieve the mission of the organization. Internal financial control protocols are a good example of a response to a control risk; if the control protocols are removed, there is no way of being certain about what will happen.

- Opportunity (or speculative) risks;

  Opportunity risks are the risks that are (usually) deliberately sought by the organization. These risks arise because the organization is seeking to enhance the achievement of the mission, although they might inhibit the organization if the outcome is adverse. This is the most important type of risk for the future long-term success of any organization.

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Hazard, Control and Opportunity

Risk management tools and techniques should be brought to achieve the following:

- Hazard management makes outcomes less negative.
- Control management reduces the spread of possible outcomes.
- Opportunity management makes outcomes more positive.

It should be noted that identifying risks as: 1) hazard, control or opportunity; 2) high, medium or low; and 3) short term, medium term and long term should not be considered to be formal risk classification systems:

a more formal approach is required

Risk Classification

In order to identify all of the risks facing an organization, a structure for risk identification is required. Formalized risk classification systems enable the organization to identify where similar risks exist within the organization. Classification of risks also enables the organization to identify who should be responsible for setting strategy for management of related or similar risks.

Also, appropriate classification of risks will enable the organization to better identify the risk appetite, risk capacity and total risk exposure in relation to each risk, group of similar risks or generic type of risk.

Standard or framework	COSO	IRM	BS 31100	FIRM Risk Scorecard	PESTLE
Classification headings	• Strategic • Operations • Reporting • Compliance	• Financial • Strategic • Operational • Hazard	• Strategic • Programme • Project • Financial • Operational	• Financial • Infrastructure • Reputational • Marketplace	• Political • Economic • Sociological • Technological • Legal • Environmental

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An example: FIRM Risk Scorecard

The FIRM risk scorecard provides such a structure, but there are many risk classification systems available.

The FIRM risk scorecard builds on the different aspects of risk, including timescale of impact, nature of impact, whether the risk is hazard, control or opportunity, and the overall risk exposure and risk capacity of the organization.

Also, appropriate classification of risks will enable the organization to better identify the risk appetite, risk capacity and total risk exposure in relation to each risk, group of similar risks or generic type of risk.

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FIRM Risk Scorecard

	Financial	Infrastructure	Reputational	Marketplace
Description	Risks that can impact the way in which money is managed and profitability is achieved	Risks that will impact the level of efficiency and dysfunction within the core processes	Risks that will impact desire of customers to deal or trade and level of customer retention	Risks that will impact the level of customer trade or expenditure and customer retention
Internal or External risk	Internal	Internal	External	External
Quantifiable	Usually	Sometimes	Not always	Yes
Measurement	Gains and losses from internal financial control	Level of efficiency in processes and operations	Nature of publicity and effectiveness of marketing profi le	Income from commercial and market activities
Performance Gap	**Procedures** Failure of procedures to control internal financial risks	**Process** Failure of processes to operate without dysfunction	**Perception** Failure to achieve the desired perception of the organization	**Presence** Failure to achieve required presence in the marketplace
Control mechanism	• CapEx standards • Internal control • Delegation of authority	• Process control • Loss control • Insurance and risk financing	• Marketing • Advertising • Reputation and brand protection	• Strategic and business • plans • Opportunity assessment

FIRM Risk Scorecard: a personal case

An example[1)] of a completed grid is set out in this table: it illustrates the balance of operational, project and strategic issues for each of the four headings of the FIRM risk scorecard. It can be seen that hazard risks are closely related to infrastructure issues and strategic risks are more likely to arise in relation to issues concerned with the marketplace.

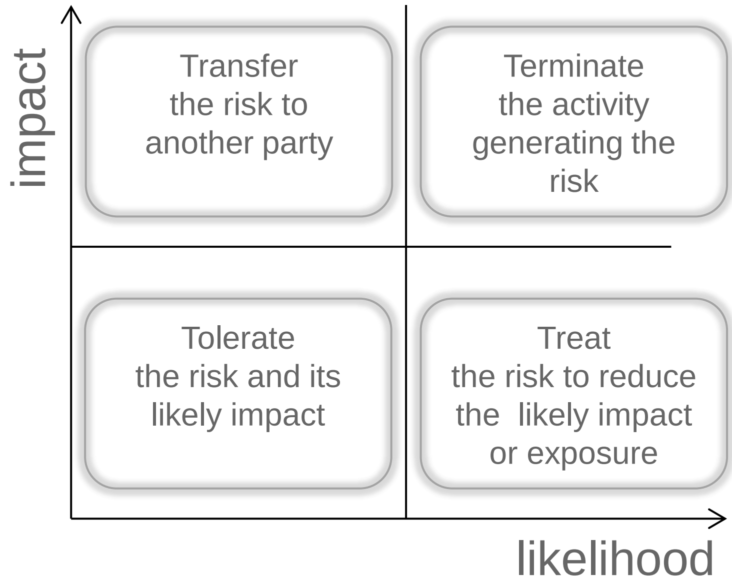
Dependency	Long term	Medium term	Short term
Financial risks	Procedures gap: How well do your procedures manage your finances?		
1. Investments	Pension arrangements Property purchase	Share purchase Business opportunities	Betting habits Insurance arrangements
2. Expenditure	Accommodation Holiday pattern	Car purchase Rail season ticket Credit card ownership	Shopping behaviour Travel arrangements
Infrastructure risks	Process gap: How well does your body facilitate your processes?		
3. Health	Family history Personal lifestyle Vegetarianism	Medical treatment Dieting Weight gain	Exercise Alcohol and drugs Illness or accident
4. Emotional	Marriage and children Ethnic origins Sexuality	Friendships Cosmetic surgery	Hobbies Sex
Reputational risks	Perception gap: How are you perceived by your peer group?		
5. Personal	Personality Neighbourhood Criminal behaviour	Mood and temperament Charity work	Clothes Personal hygiene Charity donations
6. Professional	Intelligence Behaviour patterns	Qualifications Redundancy Changing jobs	Attending training Continuous learning
Marketplace risks	Presence gap: What is your presence in the marketplace?		
7. Occupation	Career selection Education	Society memberships Presenting training	Society activities
8. Income	Ambition Seniority	Extra part-time work Sale of shares	Selling possessions Casual work

1) *Paul Hopkin, "Fundamentals of Risk Management", The Institute of Risk Management, 2010*

Risk Likelihood and impact

Large organizations frequently make use of a risk matrix as a means of summarizing their risk profile. The risk matrix is very useful and can be used for a range of applications. It can also be used to identify the type of risk response that is most likely to be employed.

Impact is not the same as magnitude, because a risk may have a high magnitude in terms of the size of the event, but the impact may be smaller.



To act or not to act

Tolerate	The exposure may be tolerable without any further action being taken. Even if it is not tolerable, the ability to do anything about some risks may be limited, or the cost of taking any action may be disproportionate to the potential benefit gained.
Treat	By far the greater number of risks will be addressed in this way. The purpose of treatment is that, whilst continuing within the organization with the activity giving rise to the risk, action (control) is taken to constrain the risk to an acceptable level.
Transfer	For some risks the best response may be to transfer them. This might be done by conventional insurance, or it might be done by paying a third party to take the risk in another way. This option is particularly good for mitigating financial risks or risks to assets.
Terminate	Some risks will only be treatable, or containable to acceptable levels, by terminating the activity. It should be noted that the option of termination of activities may be severely limited in government when compared to the private sector.

Risk Tolerance

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Risk Tolerance

Risk tolerance is defined as the '*organization's readiness to bear the risk after risk treatments in order to achieve its objectives*'.

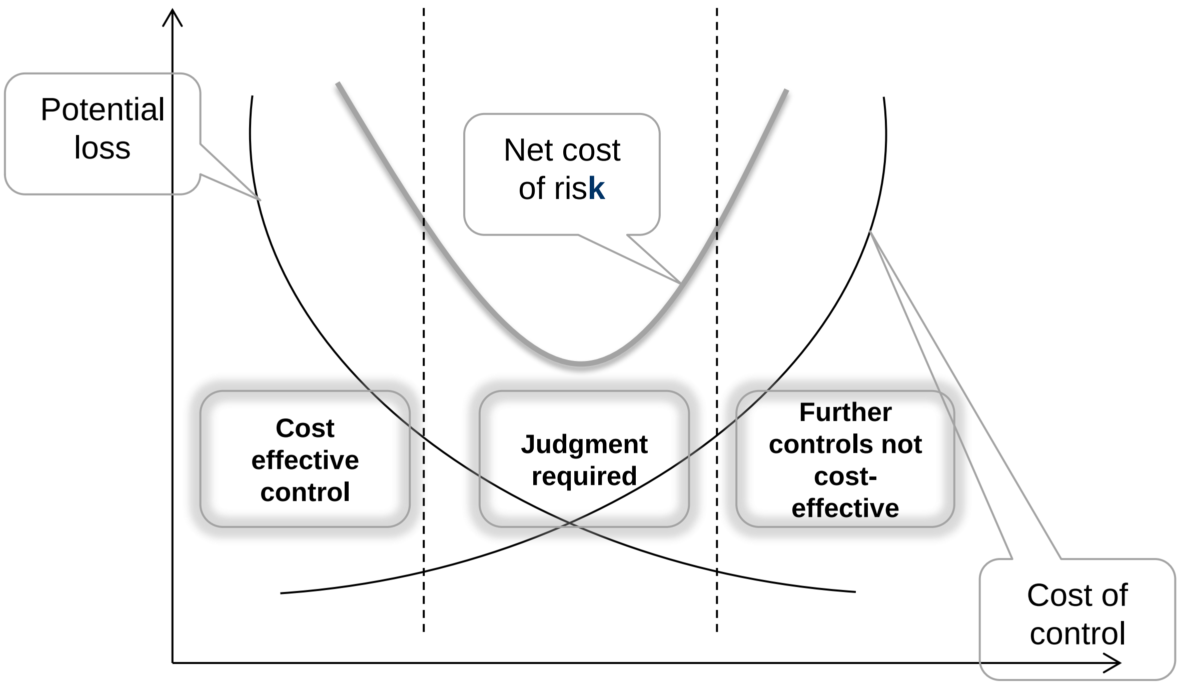
- An organization may have to tolerate risks that have a current level beyond its comfort zone and its risk appetite. On occasions, an organization may even have to tolerate risks that are beyond its actual risk capacity (making the organization vulnerable).
- Risk tolerance is shown as the approach that will be adopted in relation to low-likelihood risks with low impact. However, an organization may decide to tolerate risk levels that are high because they are associated with a potentially profitable activity or relate to a process that is fundamental to the nature of the organization.

It is unusual for a hazard risk to be accepted or tolerated before any risk control measures have been applied. Generally speaking, a risk only becomes tolerable when all cost-effective control measures have been put in place, in order to move the risk to the low-likelihood/low-impact quadrant of the risk matrix, so that the organization is accepting or tolerating the risk at its current level.

Risk Treatment

Risk control

When reasonably practicable, it is obvious that preventive controls should be introduced as the first option. If prevention is not possible, then corrective controls should be introduced to minimize the likelihood and impact of an adverse event.



Risk Transfer

Risk transfer

Risk transfer is one of the main risk responses available in relation to hazard risks. This transfer normally takes place by way of insurance and it is often described as risk financing.

- The fundamental principle of insurance is that the insurance company is contracted to pay a certain sum of money in the event of defined circumstances arising or defined events occurring.
- Insurance contracts can require the insurance company to pay for losses suffered directly by the insured; in other types of insurance contract the insurance company is to pay compensation to other parties if they have been injured or suffer loss because of the activities of the insured.
- Insurance contracts are contracts of utmost good faith. This means that the insured party is required to disclose all information relevant to the insurance contract. If this information has not been disclosed, the insurance company or underwriter has the right to refuse to continue to provide insurance cover and may refuse to pay any claims that have arisen.

Risk transfer: Insurance

There are advantages and disadvantages associated with the use of insurance as a risk transfer mechanism:

- The advantages of insurance are that it provides indemnity against an expected loss. Insurance can reduce uncertainty regarding hazard events that may occur. It can provide economic benefits to the insured, because the loss may be greater than the insurance premium. Finally, insurance can provide access to specialist services as part of the insurance premium.

- The disadvantages of insurance include the delays often experienced in obtaining settlement of an insurance claim and the difficulties that can arise in quantifying the financial costs associated with the loss. There may be disputes regarding the extent of the cover that has been purchased and the exact terms and conditions of the insurance contract. Finally, the insured may have difficulty in deciding the limit of indemnity that is appropriate for liability exposures. This may result in under-insurance and the subsequent failure to have claims paid in full.

Risk transfer: other instruments

There are alternatives to insurance when an organization wishes to transfer the financial consequences of a hazard event:

- contractual transfer of risk;
- captive insurance companies;
- pooling of risks in mutual insurance companies;
- derivatives and other financial instruments.

In order to reduce the cost of the risk transfer, organizations may decide to retain a certain amount of the financial consequences associated with the losses. Risk retention may be achieved by accepting a large excess or deductible on an

insurance policy, or deciding not to insure a certain risk exposure (self-insurance).

Risk transfer characteristics

When looking at the purchase of an instrument of risk transfer, the organization will need to consider the following six aspects:

- cost;
- coverage;
- capacity;
- capability;
- claims;
- compliance/regulatory issues.

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Risk transfer: cost

The cost of a cover is defined by the (insurance) premium/fee/equity that is required from the organization in order to obtain the desired risk transfer.

A second (implicit) component of the cost is the level of self-insurance (including excess or deductible) or *loss retention* that is imposed by the policy. This means that if a loss occurs, the organization will have to pay the first part of the claim before receiving any money from the insurance company, or take the first loss in case of a hedging instrument.

Risk transfer: coverage

Risk transfer usually have limitations, warranties and exclusions. These will state that claims will be refused in certain circumstances, or the exact events which will trigger the payment to the protection buyers.

These coverage issues need to be explored in detail by the organization purchasing the instruments to ensure that adequate coverage is available.

The only reason for buying insurance or other instruments is that claims will be paid when one of the identified events occurs. The history of the particular insurance company in relation to the payment of claims and the reputation of that insurance company will be important factors when deciding which insurance company to appoint.

Well (heavily?) regulated sectors such as Insurance or Banking, or the use of standardized framework (such as the ISDA agreement), offer a strong mitigant to coverage risk.

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Risk transfer: capacity

For very large organizations with considerable assets, one single counterparty on its own may not be willing (or capable) to offer coverage up to the full value of those assets.

When buying risk transfer instruments, the organization will need to think about the capacity that the counterparty (insurance company, bank, surety) is willing/able to offer in relation to the value of the assets/exposure that need to be covered.

In order to obtain the required capacity, organizations may rely on the service of specialized entities (insurance brokers, syndication…).

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Risk transfer: capability

An increasingly important issue for buyers of risk transfer instruments is the financial security, status and capabilities of the counterparty (AIG? Lehman?).

The nature of the business model operated by *risk buyer* means that they (usually) receive payments at the beginning of the contract, but do not have to pay indemnifications until some time later (if ever). This results in a positive cash-flow position and the associated opportunity to earn investment income.

However, such an activity bears its own financial risks, which could pose a threat to the reliability of the cover paid by the organization.

Accordingly, buyers of instruments need to pay greater attention to the financial status or credit rating awarded to individual counterparties when making decisions about which company to use.

Risk transfer: claims and compliance

The handling of insurance claims (or the quantification of the derivative payoff) can be a detailed and complex exercise. Sometimes claims handling involves complex legal processes involving specialist engineers and accountants.

Property damage claims or financial derivatives may be easier to quantify, but claims associated with the business interruption element of the loss can be very difficult to measure and agree.

Compliance issues may arise with regards to the validity of the cover: certain countries may not an insurance policy written by a non-admitted insurer (including a captive insurance company).

Other issues may involve the tax treatment of the instrument.

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Risk Termination

Risk Termination

When a risk is both of high likelihood and high potential impact, the organization will wish to terminate or eliminate the risk.

It may be that the risks of setting a plant in certain parts of the world or the environmental risks associated with continuing to use certain chemicals are unacceptable to the organization and/or its stakeholders.

In these circumstances, appropriate responses would be elimination of the risk by stopping the process or activity, substituting an alternative process or outsourcing the activity that is associated with the risk.

Even if an organization may wish to terminate a risk, it could be the case that the activity that gives rise to it is fundamental to the ongoing operation of the organization. In such circumstances, the organization may not be able to terminate or eliminate the risk entirely and thus will need to implement alternative control measures.

Risk Termination

It is likely that such control measures will be a combination of risk treatment and risk transfer.

As these control measures are applied, the level of risk will move to a level where the organization will be able to tolerate the risk.

Because of the variable nature of risks, it may not be possible to get all risks to a level that is within the risk appetite of the organization: the organization may find that it has to tolerate certain risks beyond its empirical risk appetite in order to continue to undertake a certain activity.

Evolution of Risk Management

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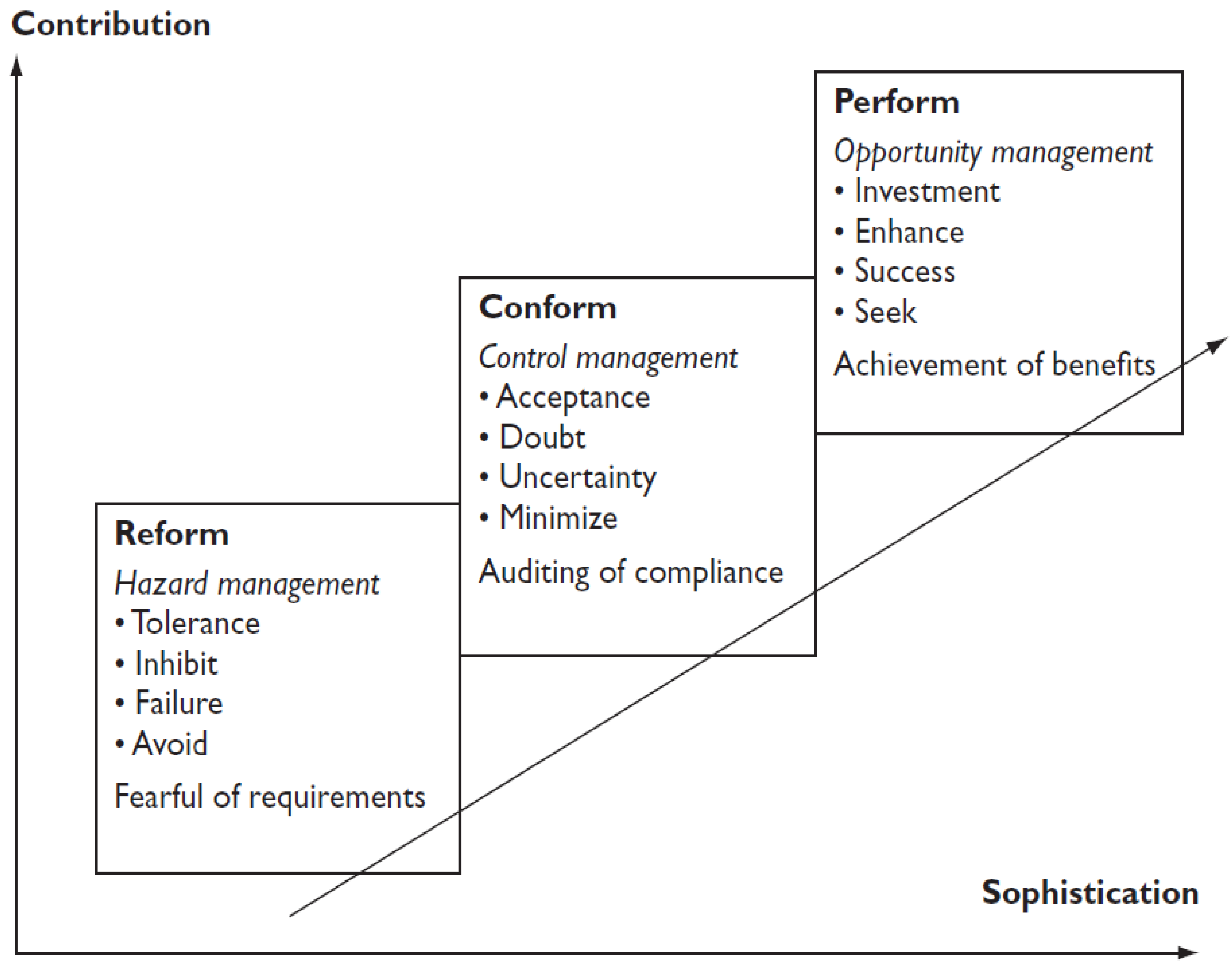
Evolution of Risk Management

At first, an organization may be aware of a new risk and the need to take appropriate action:

- In that case, there will be a need for the organization to reform in response to the hazard risk.
- As the organization responds to the risk, it will seek to conform with the appropriate risk control standards.
- After this stage, the organization may realize that there are benefits to be obtained from the risk. The organization will then have the ability to perform and view the risk as an opportunity risk.

Evolution of Risk Management



Evolution of RM: the bank sector case

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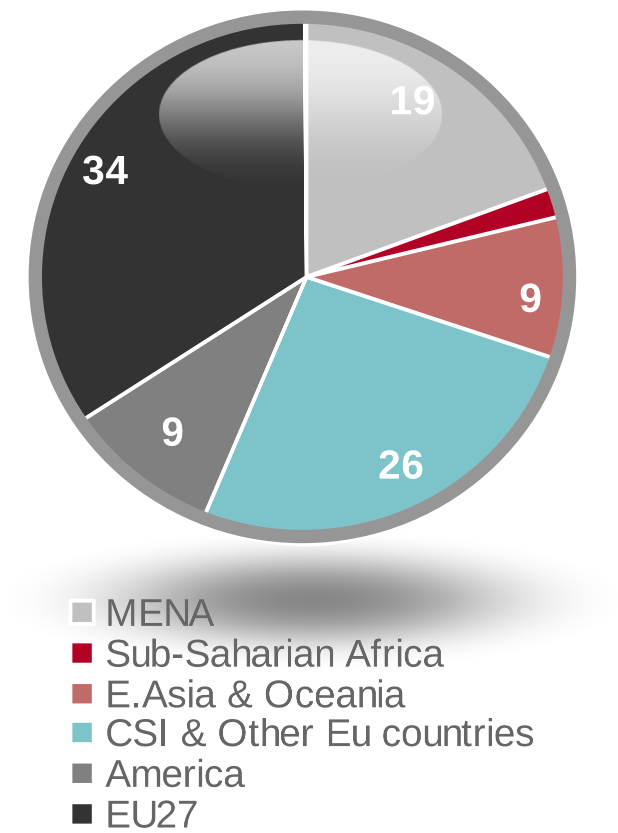
Portofolio Structure (as of 30.09.2010)

Cap (mln Eur)

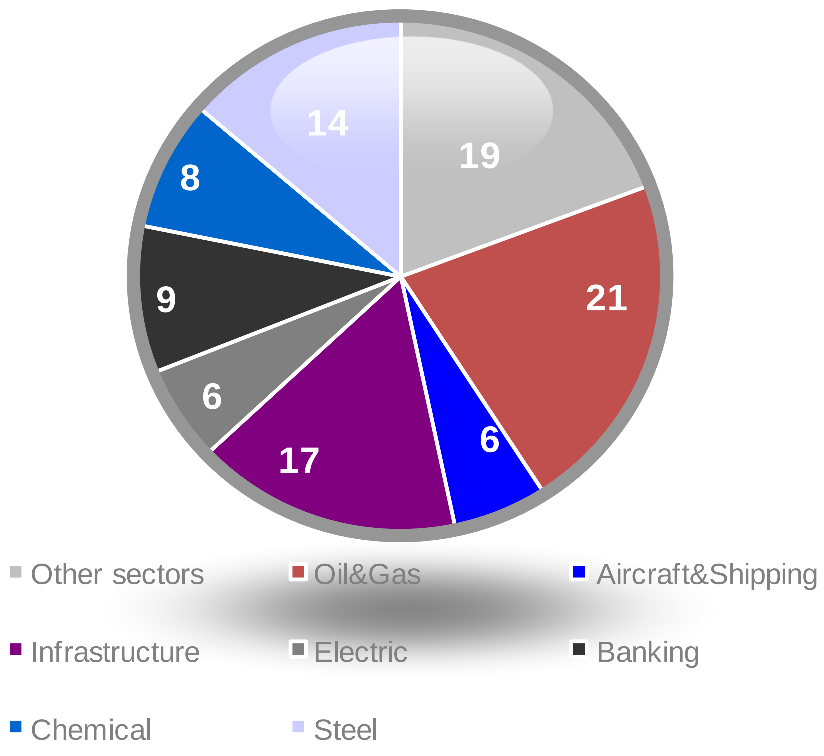
Type of Risk	2010	2009	2008	Var.
Political	2,335.1	1,450.0	1,406.8	65,9%
Sovereign	2.348,3	2,842.9	3,243.7	-27,6%
Private	22.013,5	18,027.8	16,588.5	32,7%
Others	552,5	671.7	698.6	-20,9%
Total	27.249,5	22,992.4	21,937.6	24,2%

Portofolio Structure (as of 31.12.2010)

Geographic Area Breakdown



Industrial Sector Breakdown



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Credit Risk: the basic elements

Credit risk refers to the risk of a loss arising from the obligor or issuer not being in a position to service the debt obligations. Also, it refers to the mark-to-market loss of a bond resulting from a change in the market perception of the issuer ability to serve the debt.

In computing credit risk (at single security level), the following factors play important roles:

- *Probability of Default (PD):* this is the probability that the issuer will default on its contractual obligation to repay its debt;
- *Recovery Rate (RR):* This is the fraction of the face value of an obligation can be recovered once the counterparty has defaulted. Among other variables, seniority of the bond and the prevailing economic environment are important determinants of recovery rates. Sometimes *Loss Given Default* (*LGD*) = 1 – RR is used instead;
- *Rating Migration*: This is the extent to which the credit quality of the issuer improves or deteriorates as expressed by a change in the probability of default (used in credit models *a la Merton* such as CreditMetrics);
- *Exposure at Default* (*EAD*): an estimation of the extent to which the lender may be exposed to a counterparty in the event of, and at the time of, that counterparty's default.

Credit Risk: Probability of Default - 1

Structural models: firstly developed by Merton (1974), and extended by Black&Cox (1976).

- They require the modeling of the firm value of the counterparty through a stochastic process;
- Default occurs as soon as the firm value crosses a given barrier;
- The level of this barrier can be found through calibration to the credit default swaps (CDS) of the counterparty or balance sheet data (if available).

They relate default to capital structure of the firm: firm's liabilities are viewed as contingent claims on the assets of the firm and default occurs at debt maturity when the firm's asset value falls below the debt value;

Credit Risk: Probability of Default - 2

Reduced (Intensity-based) models: originated with Jarrow and Turnbull (1992), and subsequently studied by Jarrow and Turnbull (1995), Duffie and Singleton (1999) among others.

- The default time is modeled as the first jump time of a given jump process (usually a Poisson's);
- The intensity of the jump process is deterministic and calibrated to the term structure of CDS rates of the counterparty;
- This intensity $\lambda(t)$, also called *hazard rate*, is the probability of a default occurring at an infinitesimal time *dt* after *t* given that it did not occur before;
- Hazard rates can also be modeled as stochastic processes to account for credit spread volatilities.

Other types of credit events, such as rating transitions, can be modeled in terms of intensities as well.

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Credit Risk: Recovery Rate

***Recovery Rate* for a bond/loan is defined as the percentage of the face value that can be recovered in the event of default.**

- The amount recovered can take up to several months to materialize;
- Moody's, for instance, proxies the recovery rate with the secondary market price of the defaulted instrument approximately 1 month after the time of default;
- Empirical research on recovery rates suggests that industrial sector, seniority of the debt, state of the economy, and credit rating of the issuer 1 year prior to default are variables that have significant influence on potential recovery rates;
- During periods of economic downturns, the recovery rate is usually lower relative to historical averages. There is also a time dimension to the potential recovery rates;

Typically, beta distribution is assumed for LGD with exogenous mean ELGD and standard deviation σ specified as $\sigma^2 = (ELGD(1 - ELGD))/k$, where k is a constant

Credit Risk: Rating Migration - 1

In practice, default is just one of many states to which the issuer's rating can make a transition. The action of rating agencies can result in the issuers rating being downgraded or upgraded.

- One can associate the concept of a state with each rating grade, so that rating actions result in the transition to one of several states. Each rating action can be viewed as a credit event that changes the perceived probability of default of the issuer;
- Associated with rating migrations are transition probabilities, which model the relative frequency with which such credit events occur;
- Incorporating rating migrations into the credit risk-modelling framework provides a much richer picture of changes in the aggregate credit quality of the issuer.

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Credit Risk: Rating Migration - 2

Modeling the rating migrations process requires estimating a matrix of transition probabilities, which is referred to as the rating transition matrix (which is a Markov matrix)

2009 One-Year Alphanumeric Rating Migration Rates

	Aaa	Aa1	Aa2	Aa3	A1	A2	A3	Baa1	Baa2	Baa3	Ba1	Ba2	Ba3	B1	B2	B3	Caa1	Caa2	Caa3	CaC	Default	WR
Aaa	62.42%	14.65%	16.56%	2.55%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.82%
Aa1	0.00%	57.99%	15.07%	12.79%	5.02%	0.46%	0.00%	0.46%	0.46%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	7.76%
Aa2	0.00%	0.00%	48.90%	31.28%	9.69%	5.73%	0.88%	0.44%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.08%
Aa3	0.00%	0.44%	0.88%	46.02%	30.09%	9.73%	5.75%	1.33%	0.00%	0.44%	0.00%	0.44%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	4.87%
A1	0.00%	0.00%	0.00%	0.00%	59.38%	20.31%	5.94%	5.00%	1.25%	0.31%	0.31%	0.00%	0.00%	1.25%	0.31%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.94%
A2	0.00%	0.00%	0.00%	0.00%	0.24%	63.77%	22.95%	5.31%	0.48%	1.21%	0.24%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.80%
A3	0.00%	0.00%	0.51%	0.00%	0.26%	0.51%	67.86%	13.01%	8.42%	2.04%	0.51%	0.00%	0.26%	0.00%	0.26%	0.00%	0.00%	0.00%	0.00%	0.00%	0.51%	5.87%
Baa1	0.00%	0.00%	0.00%	0.28%	0.00%	0.00%	2.23%	69.83%	12.29%	5.31%	0.56%	0.56%	0.00%	0.28%	0.28%	0.56%	0.00%	0.00%	0.00%	0.00%	0.84%	6.98%
Baa2	0.00%	0.00%	0.00%	0.00%	0.00%	0.47%	0.00%	4.98%	70.38%	13.74%	3.08%	0.24%	0.47%	0.00%	0.00%	0.00%	0.24%	0.00%	0.00%	0.00%	0.71%	5.69%
Baa3	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.02%	6.80%	69.73%	6.12%	4.76%	1.02%	1.36%	0.00%	0.34%	0.00%	0.00%	0.00%	0.00%	0.68%	8.16%
Ba1	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.50%	9.02%	57.14%	12.03%	4.51%	3.01%	0.75%	0.75%	0.00%	0.00%	0.00%	0.75%	2.26%	8.27%
Ba2	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.33%	6.11%	61.67%	12.78%	3.89%	2.78%	0.00%	0.00%	0.56%	0.00%	0.56%	0.56%	7.78%
Ba3	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.48%	4.83%	57.00%	15.94%	7.25%	1.45%	0.97%	0.48%	0.00%	0.48%	3.86%	7.25%
B1	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.18%	8.27%	56.30%	10.63%	7.87%	3.54%	0.39%	0.00%	0.00%	3.54%	8.27%
B2	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.31%	0.00%	0.93%	6.52%	52.48%	10.56%	9.63%	1.55%	0.00%	0.31%	8.07%	9.63%
B3	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.25%	4.79%	58.19%	13.85%	6.55%	1.01%	0.76%	8.31%	6.30%
Caa1	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.80%	10.40%	37.60%	13.60%	8.00%	2.80%	16.40%	8.40%
Caa2	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.67%	0.67%	4.70%	22.15%	16.11%	8.72%	36.91%	10.07%
Caa3	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.23%	17.74%	16.13%	54.84%	8.06%
Ca-C	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.17%	1.59%	0.00%	20.63%	65.08%	9.52%

(Moody's Corporate Default and Recovery Rates,1920-2009)

Credit Risk: Exposure at Default

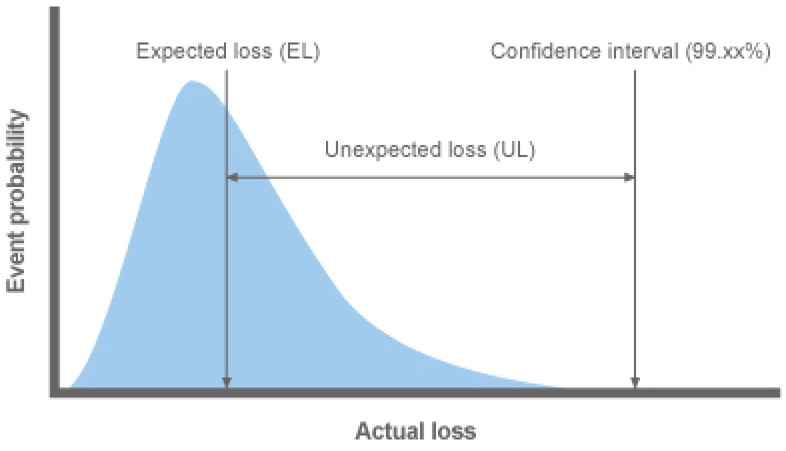
In general EAD can be seen as an estimation of the extent to which a lender may be exposed to a counterparty in the event of, and at the time of, that counterparty's default.

- Under Basel 2, it is a measure of potential exposure (in currency) as calculated by a Basel Credit Risk Model for the period of 1 year or until maturity whichever is sooner. For loan commitments, Exposure at Default measures the amount of the facility that is likely to be drawn if a default occurs.
- EAD value is calculated taking account of the underlying asset, forward valuation, facility type and commitment details. But, it does not take account of guarantees, collateral or security (i.e. ignores Credit Risk Mitigation Techniques with the exception of on-balance sheet netting where the effect of netting is included in Exposure At Default).

Credit Risk: to sum it up

EL = PD * LGD * EAD

On a more accurate basis, the expected loss is to expressed as the *mean* of the *loss distribution* (whereas its *standard deviation* accounts for the *unexpected loss*).



Credit Risk: Portfolio Credit Risk

Quantifying credit risk on a portfolio follows the same approach, but needs to deal with a loss distribution affected by default correlations.

- In broad terms, default correlation measures the strength of the default relationship between two (or more) obligors;
- An increase in default correlation between two obligors increases the unexpected loss of a two-position portfolio (assuming all other parameters remain the same);
- Formally, default correlation between two obligors is defined as the correlation between the default indicators for these two obligors over some specified interval of time, this being typically 1 year; correlation between obligors is usually done through indirect methods (see Sharpe and Markowitz) .

From the practitioners point of view, it can be seen that the mechanics involved in the process of quantifying portfolio credit risk is susceptible to considerable model risk.

Value at Risk

The need for VaR

During late 90s the authorities recognized the complexity of correctly assessing (market) risk exposure, especially for derivative products. Under BIS 98, financial institutions were allowed, alongside the “standard model” proposed by BIS, to use “internal model” based on the Value at Risk methodology.

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A new view on risks

Internal models deal with the fact that risk is made up of both “systematic risk” and “specific risk”, and distinguish between these risk components. In particular, specific risk refers mainly to idiosyncratic factor related to the individual counterparty.

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Value at Risk: a definition

The funny thing about VaR is that it hasn't got a definition. Rather, we define VaR with a property it must have, but not how to compute it.

"With probability q the potential loss of the portfolio will not exceed the Value at Risk figure."

Speaking in mathematical terms, this is simply the (1−q)–quantile of the distribution of the d–day change of value for a given portfolio P. More specifically:

$$VaR_{q,d}(P) = -F_{P^d}^{-1}(1-q) \cdot PV(P)$$

where P^d is the change of value for a given portfolio over d days (the d–day return), F_{P^d} is the distribution function of P^d, and PV(P) is the present value of the portfolio P.

The quantile F^{-1} function is a generalize inverse function:

$$F_{P^d}^{-1}(q) = \begin{array}{l} \inf\{x : F_{P^d}(x) \geq q\} \quad \text{for } 0<q<1 \\ \inf\{x : \mathbb{P}(P^d \leq x) \geq q\} \end{array}$$

Value at Risk: Pros and Cons

Pro:

- Easy to calculate and to understand (easily 'sold' to boards and top management);
- It is a common language of communication within the organizations as well as outside (e.g. regulators, auditors, shareholders);
- It is not really complicated, yet it is "messy" and "time–consuming" (especially for Monte Carlo method);

Cons:

- It is not a coherent measure, more specifically it is not sub-additive;
- It fails to recognize the concentration of risks;
- Most parametric approaches neglect the heavy tails and the skewness of the distribution;

There are various approaches for calculating the VaR.
The most widely adopted are:

- variance-covariance approach (parametric);
- historical simulation (non parametric);
- Monte Carlo simulation (non parametric)

Value at Risk: variance-covariance

Assuming that the distribution of the observed returns are normally distributed, the VaR computation can be simplified considerably. This approach is a parametric one since it involves estimation of a parameter – the standard deviation.

With this assumption the d-day VaR to the q–quantile calculates to:

$$VaR_{q,d}(X) = -\sqrt{d} \cdot N_{0,1}^{-1}(1-q) \cdot \sigma \cdot PV(X)$$

for a single asset, where
$N_{0,1}^{-1}$ is the inverse of the standard normal distribution function,
σ is the – estimated – daily standard deviation of the asset, and
PV(X) is the present value invested in asset X.
For a portfolio of multiple (n) assets:

$$VaR_{q,d}(X) = -\sqrt{d} \cdot N_{0,1}^{-1}(1-q) \cdot \sqrt{Y \Sigma Y^t}$$

Where Σ is the n x n covariance matrix and Y=PV(X) is an n-length vector with Y_i the amount invested in asset i.

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Value at Risk: var-covar limits and variations

The problem with that approach is the *non-linearity* of some positions (e.g. options)- a possible solution is to assume it to be linear in a small enough range. In that case, we can use the (single factor) *Delta Approximation*, i.e. the value of the option can be modelled with its first-order Taylor approx:

$\Delta c \approx \delta \Delta x$ hence (where C is a Call option, δ its delta and X its underlying)

$$VaR_{q,d}(C) = \delta \cdot VaR_{q,d}(X) = -\sqrt{d} \cdot N_{0,1}^{-1}(1-q) \cdot \sigma \cdot PV(X) \cdot \delta$$

This mechanism can be expanded to obtain a higher degree of accuracy in stronger non-linearity with the Delta-Gamma Approx.

$\Delta c \approx \delta \Delta x + \frac{\gamma}{2}(\Delta X)^2$ (the second-order Taylor series approx)

Assuming $(\Delta X)^2$ to be normal distributed:

$$VaR_{q,d}(C) = -\sqrt{d} \cdot N_{0,1}^{-1}(1-q) \cdot \sigma \cdot PV(X) \cdot \sqrt{\delta^2 + \frac{\gamma^2}{4}\sigma^2}$$

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Value at Risk: Historical Simulation

Historical simulation is based on order statistics. Given 100 observations the 99 percent quantile of the d–day returns is simply the lowest observation.
Let *l* be the number, which represents the q–th quantile of the order statistics with *n* observations. With this, x_l is the q–th quantile of an ordered time series X, which consists of n observations with

$$q = \frac{l}{n}$$

Estimating the q–quantile via order statistics is a generalisation of the median (which is the 50 percent quantile). While the median is in general a robust estimator, the robustness of the q–quantile depends on the quantile and the number of observations.

Historical Simulation does not assume any distribution on the asset returns. Also, it is relatively easy to implement. However, there is a couple of shortcomings of historical simulation:

- asset returns are assumed independent and identically-distributed (iid) which is not the case.
- it applies equal weight to all returns of the whole period and this is inconsistent with the nature where there is diminishing predictability of data that are further away from the present (weighted historical simulation is used to cope with this issue)

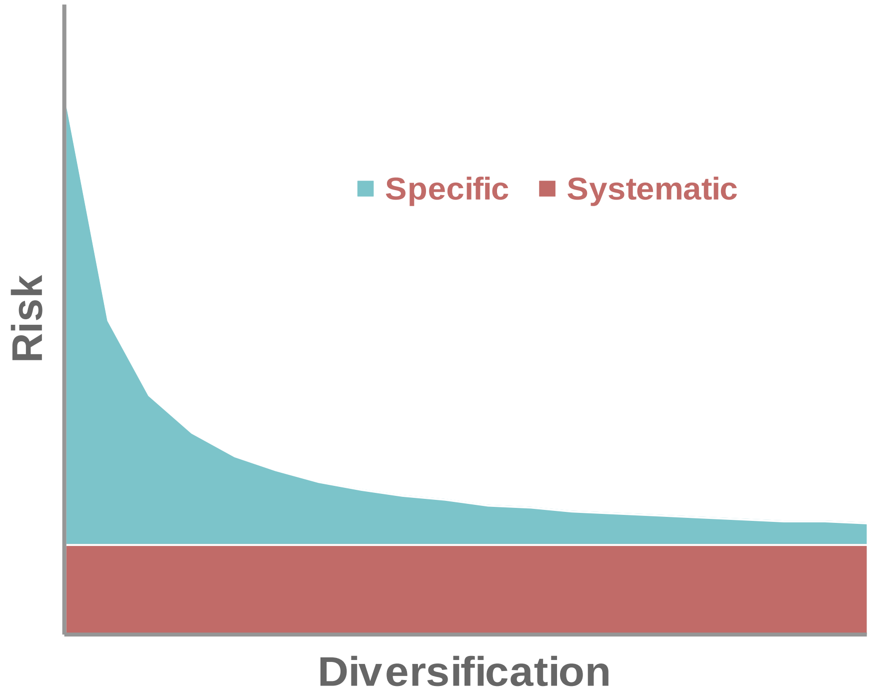
Value at Risk: Monte Carlo Simulation

Monte Carlo simulation is most helpful when some or all assets in a portfolio are not amenable to analytical treatment (e.g. complex derivatives, non-linear pricing, trigger events etc.).

- is the generation of time series (such as distribution of returns or paths of asset prices) by the use of random numbers;
- draws numbers from a chosen distribution (e.g. normal, Student-t, or a diffusion) which is supposed to be the future distribution of the underlying to produce a time series – a future scenario;
- uses some price methodology to calculate the value of the portfolio and its VaR.

Credit for inventing the Monte Carlo method often goes to Stanislaw Ulam, a Polish born mathematician who worked for John von Neumann on the United States' Manhattan Project during World War II. Ulam is primarily known for designing the hydrogen bomb with Edward Teller in 1951. He invented the Monte Carlo method in 1946 while pondering the probabilities of winning a card game of solitaire.

Risk and effect of diversification



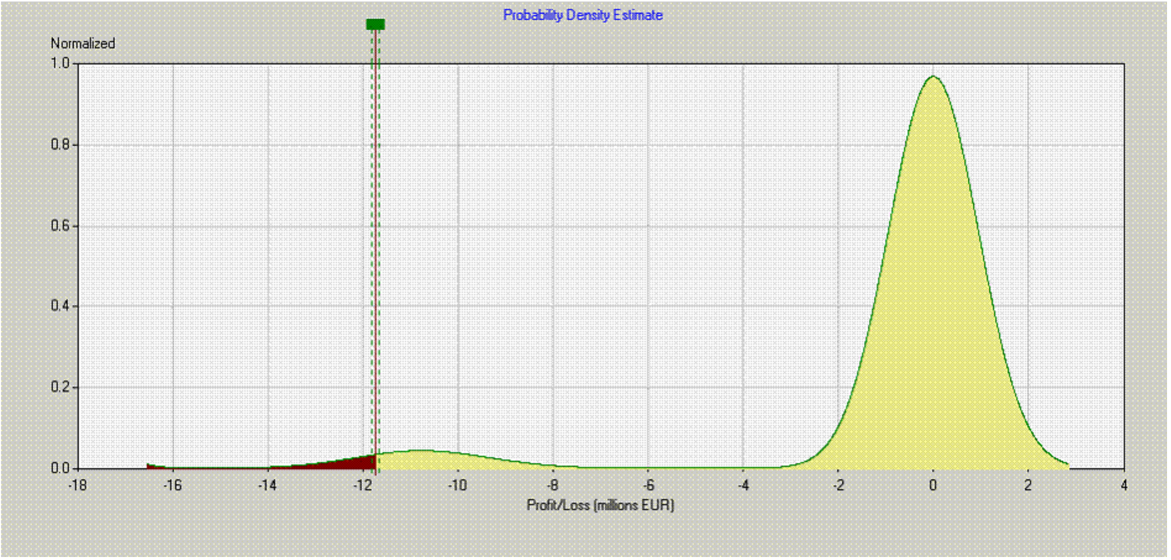
The ECAs case

Highly concentrated portfolios, such as the typical ECA ones, have a great deal of specific risk (as shown on the figure on the left).
Hence, the need for advanced risk evaluation methodologies in order to capture the peculiarities of our risks.

A more accurate measure of risk

Limitation of VaR as a risk measure

The biggest limit of VaR is that it lacks any indication of the risk (i.e., losses) exceeding the VaR figure. Moreover, VaR is not **sub-additive**, i.e., it could be that *VaR(X+Y) > VaR(X) + VaR(Y).* And this is a situation often found in credit risk, and whenever the distribution is bimodal, such as the following…



…which is the actual SACE's loss distribution

A more accurate measure of risk

Expected shortfall

To overcome the VaR limits, more accurate measure of risk can be used: *Expected Shortfall* (AKA TailVaR or Extreme VaR), which is computed as the expected value of the quantile exceeding the VaR.

It can be shown that ES *is* sub-additive, i.e., given two portfolios A and B:

$$ES(A+B) < ES(A)+ES(B)$$

in a way which is consistent with the portfolio theory (the more diversified the portfolio, the less risky it is).

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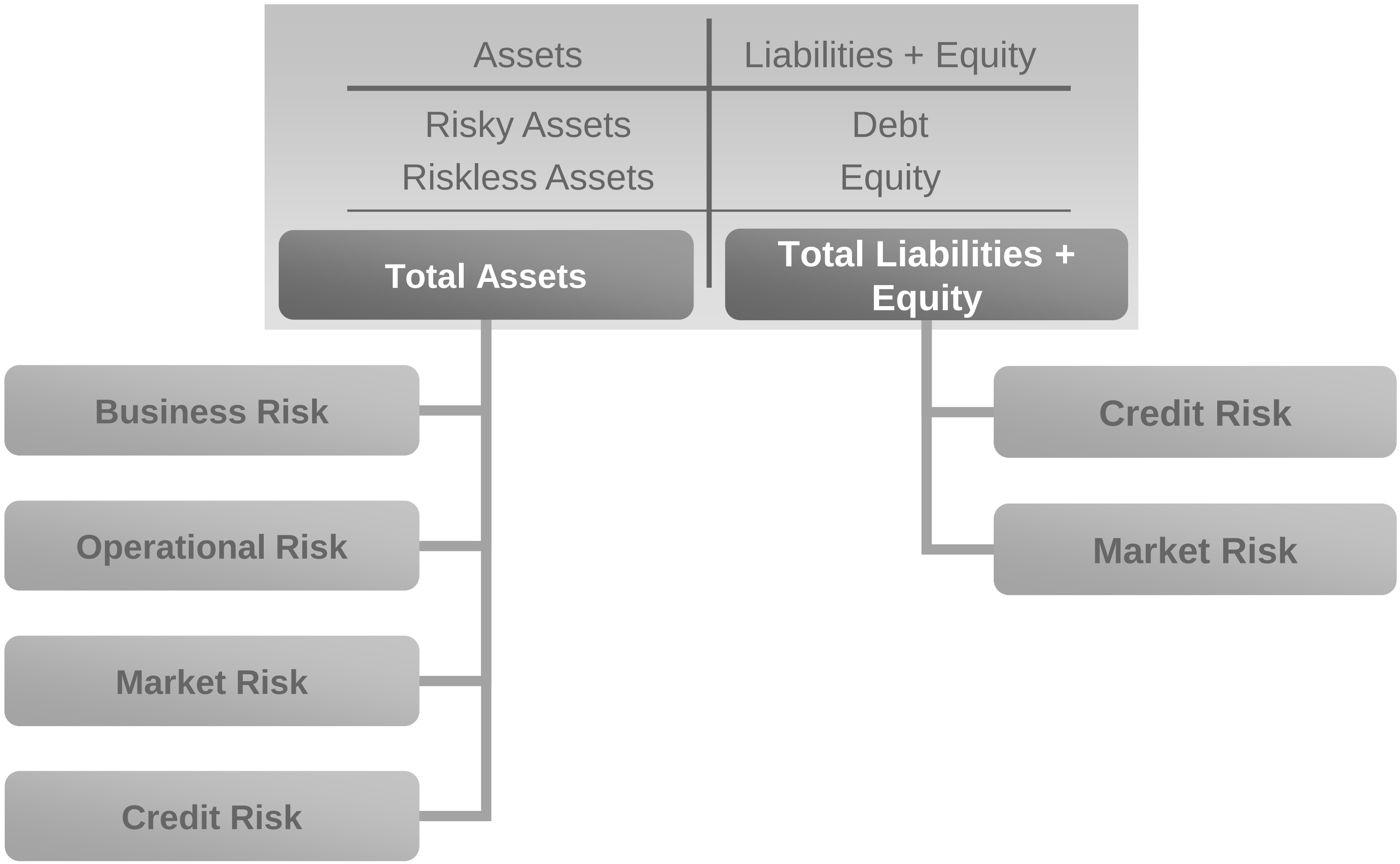
Firm-Wide approach to Risk Management



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Asset & Liability Management

The key objectives

Asset&Liability Management (*ALM*) can be defined as a structured decision-making process for matching and mismatching the mix of assets and liabilities in a company. The aim of the process is to maximize the net worth of the portfolio, while assuming reasonable amount of gap and liquidity risk.
Simply stated, the key objective are:

- *To stabilize net interest income (accounting earnings)*
- *To maximize shareholder wealth (economic earnings)*
- *To manage liquidity*

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Asset & Liability Management

Market Risk

It is the risk on the net worth of the company that arises from all its interest *and* foreign currencies sensitive positions.
It can be measured either by a simple approach (e.g. duration analysis) or through more sophisticated tools (e.g. VaR).

Liquidity Risk

Simply put, It is the risk that an asset hold by the company cannot be traded because nobody is willing to buy it. Liquidity risk tends to compound other risks. If a trading organization has a position in an illiquid asset, its limited ability to liquidate that position at short notice will compound its market risk

Accordingly, liquidity risk has to be managed in addition to market, credit and other risks

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Capital Adequacy Levels

The key objectives

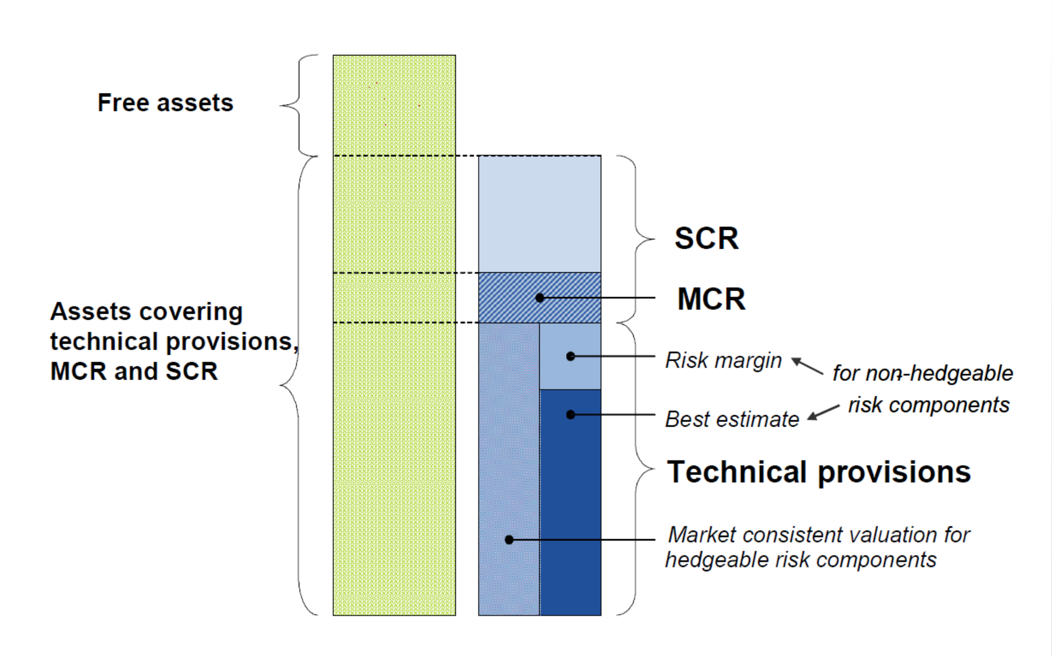
The amount of the minimum capital should take into account the types of risk that are intended to be covered. The required minimum capital should by no means be used to compensate for normal foreseeable fluctuations in the development of certain risks. The capital adequacy and solvency regime has to define the form of capital that is deemed suitable to provide support when a company encounters an unexpected or extreme event. In determining the form of suitable capital, regulators consider the extent to which the capital element:

- *represents a permanent and unrestricted investment of funds;*
- *is freely available to absorb losses;*
- *does not impose any unavoidable charge on the earnings of the insurer;*
- *ranks below the claims of policyholders and other creditors in the event of the insurer being wound up.*

The Solvency2 ALM approach

Technical provisions: best estimate + risk margin

Assets:



"The SCR (*Solvency Capital Requirement*) should deliver a level of capital that enables an insurance undertaking to absorb significant unforeseen losses over a specified time horizon and gives reasonable assurance to policyholders that payments will be made as they fall due"

SACE

Solvency Capital Requirement – 30.06.2011

Shareholders' Funds
€ 5.637,4 mln

Solvency Ratio
332%

- **Risk Capital** € 1.698,1 mln
  - **Adjustment for taxes** € 826 ,1 mln
  - **Risk Capital before taxes** € 2.524,2 mln
    - **Operational Risk** € 72,3 mln
    - **Base Risk Capital** € 2.451,9 mln
      - **Counterparty Risk** € 11,6 mln
      - **Market Risk** € 153 mln
      - **Underwriting Risk** € 2.473,6 mln
      - **Intangible** € 0,259 mln

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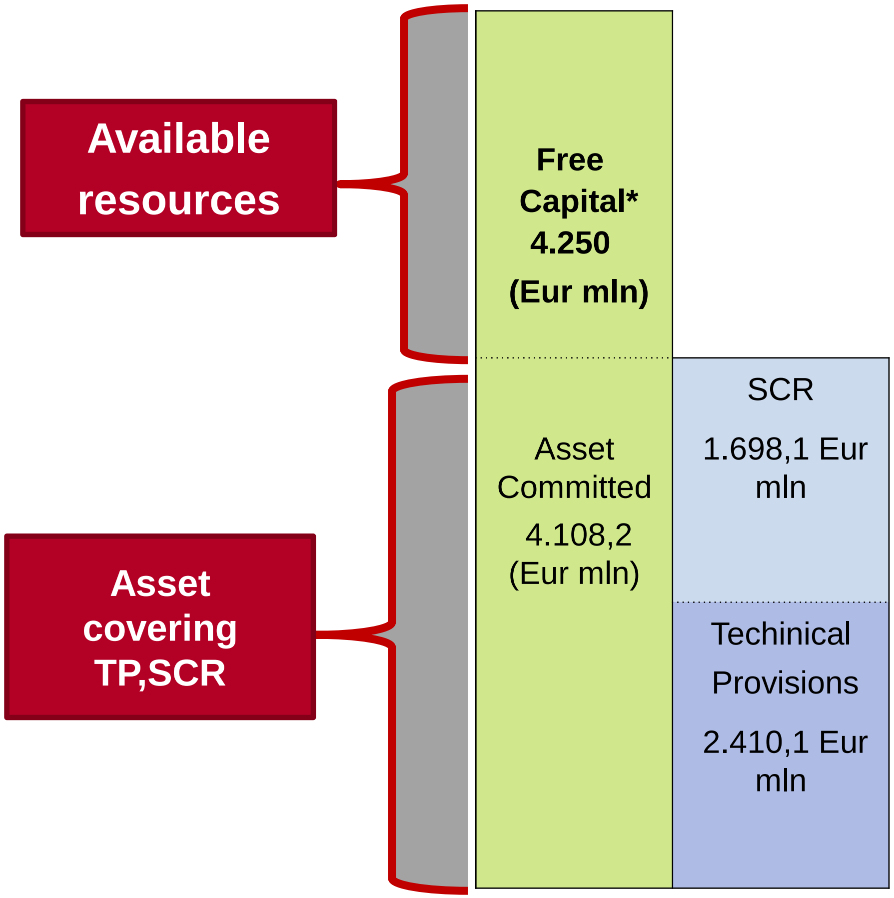
The Solvency 2 ALM approach - SACE



* Using the standard formula 99,5% confidence level. SACE's own AA- requires a higher percentile, resulting in a lower free capital level.

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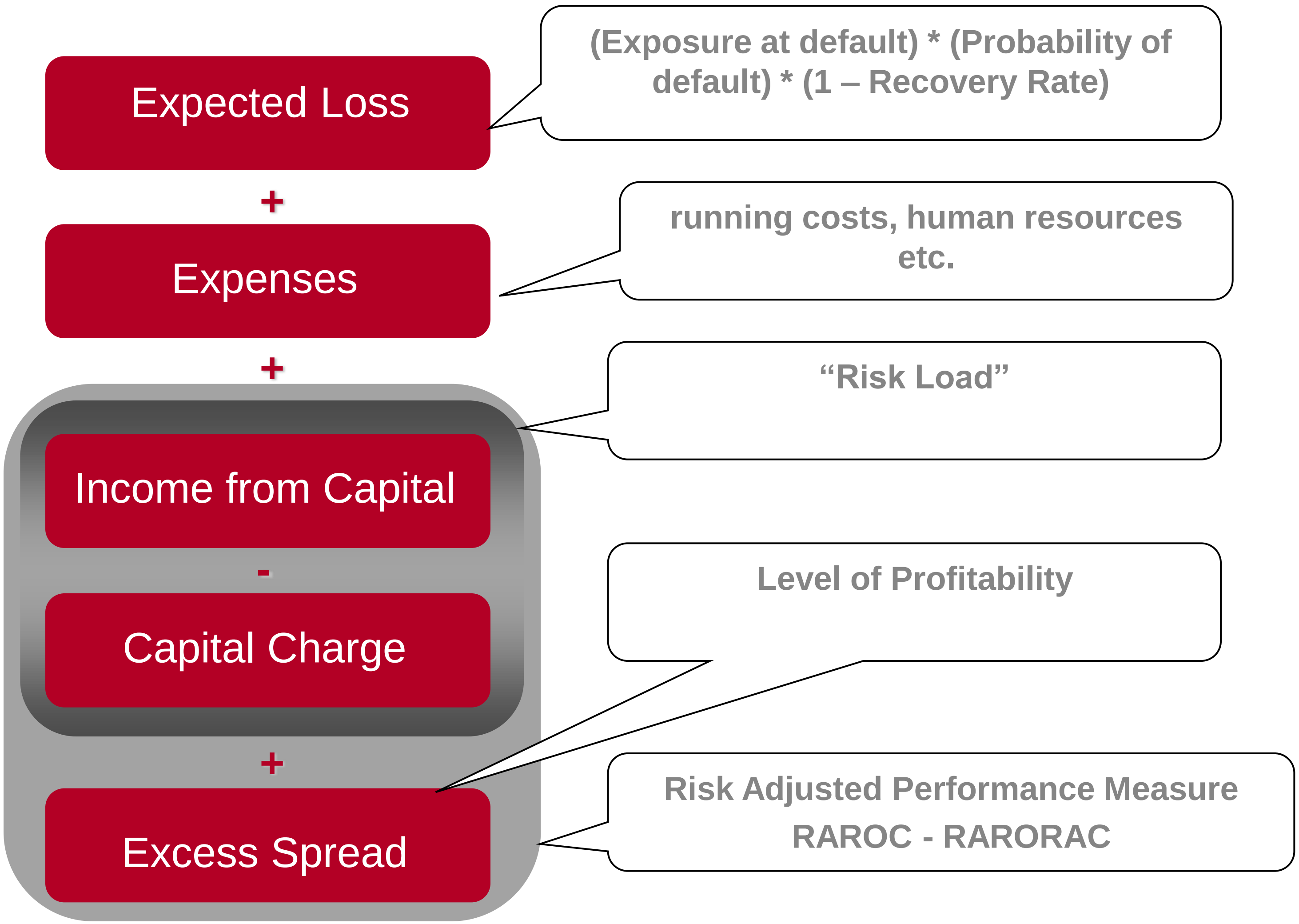
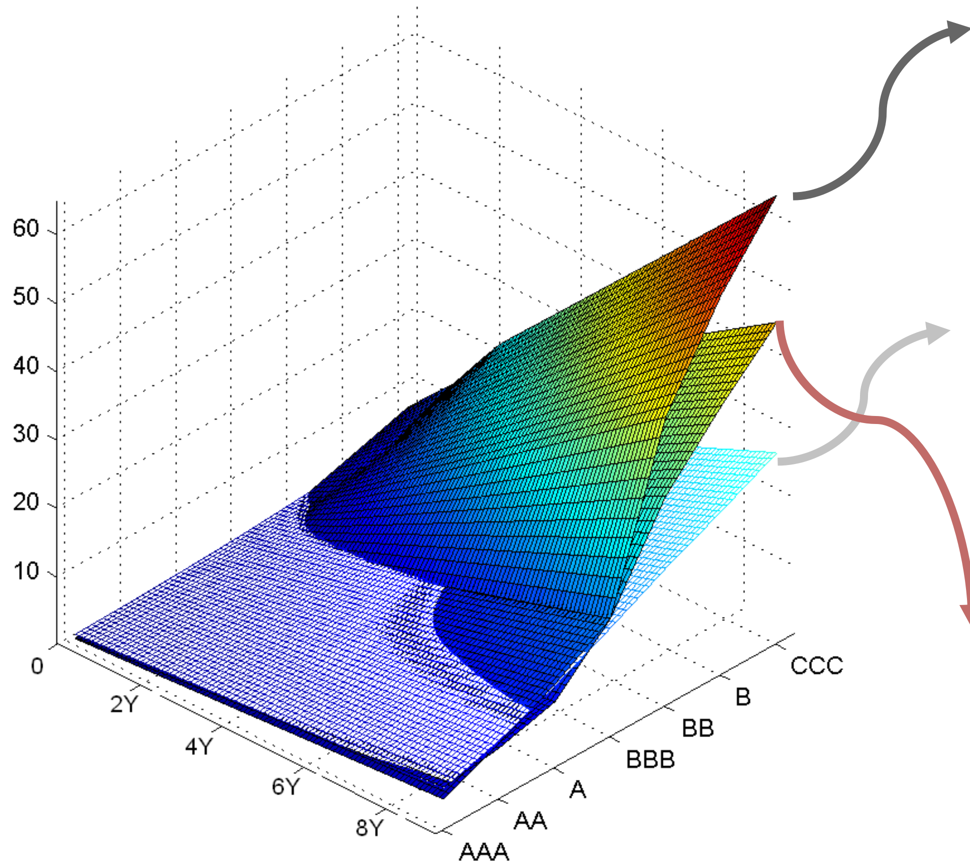
Fair Premium Level



Expected Loss and ECA adjustment



Mark to Market

A fair, expected-loss based premium is obtained from the credit spread curves available on the market

OECD Premium Benchmark

An Minimum Premium Rate is computed accordingly to OECD rules

Adjusted Pricing to Risk

An intermediate value is taken accordingly to the ECA's risk appetite and commitment to the specific deal.

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Pricing Model – Pricing to Risk

The transaction is assigned a rating

- Counterparty rating for unsecured risk
- Transaction rating for secured risk

+

Credit Spread is defined

- For each rating and each tenor: it is computed by the simple moving average

+

The implicit PD is estimated

*

Loss Given Default

- The EL (Expected Loss) is computed adjusting the PD for the recovery rate

=

Pricing to Risk

- The resulting premium is checked against the MPR(where applicable)

Thank you for your attention

Any questions?

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