ESSEC

Advanced Master's in Financial Engineering

FINM32227

Financial Risk Management

CLASS HANDOUTS

SESSION 9

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Economic Capital and RAROC

Risk Management Mistakes to Avoid

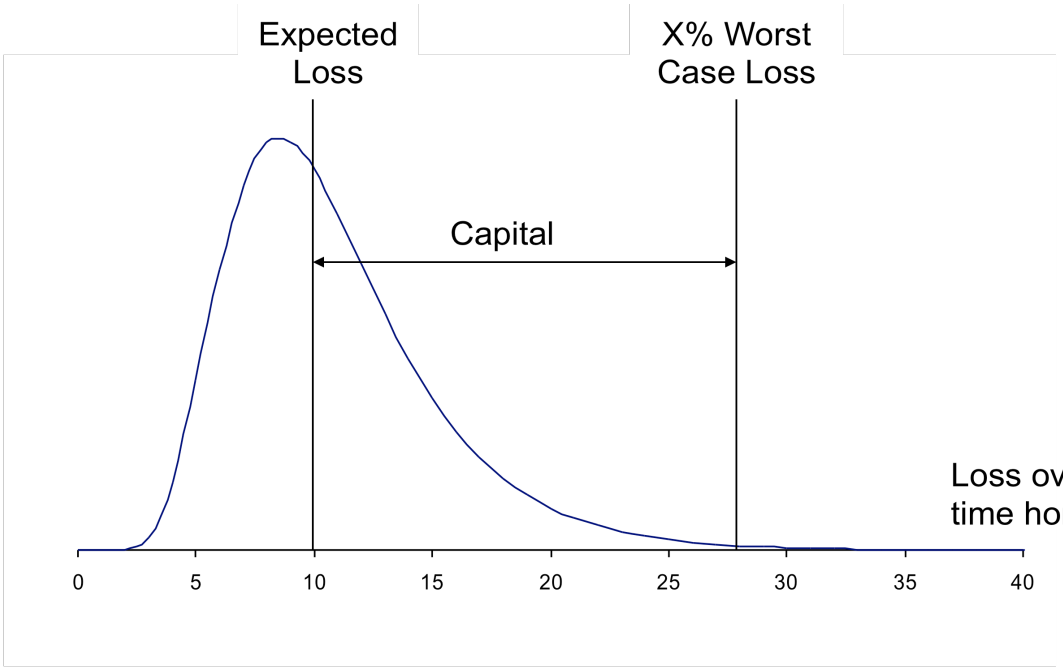
Outline

- Economic Capital and RAROC
- Risk Management Mistakes to Avoid

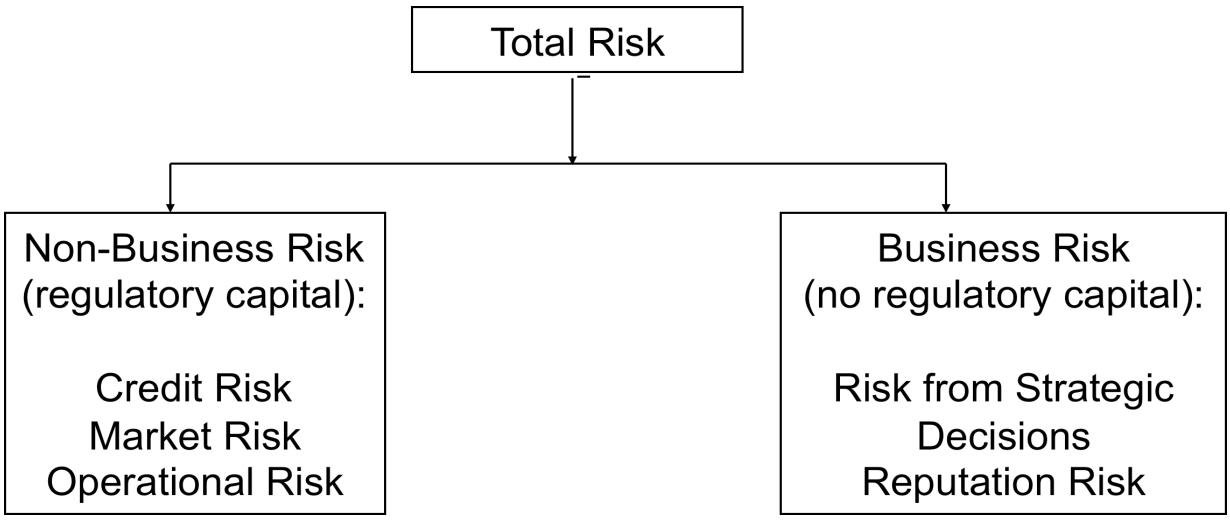
- Economic capital is a bank's own assessment of the capital it requires to absorb losses over a certain time horizon with a certain confidence level
- Choice of Parameters:

  The time horizon is usually one year

  The confidence level depends on the financial institution's objective. E.g., For a bank wishing to maintain a AA-rating, the confidence interval is 99.9% or higher; For a bank want to maintain a BBB-rating, the confidence level is about 99.8%
- Model Used for Economic Capital (Same as Regulatory Capital)



– Risks faced by a bank and the Basel Regulatory Environment



Note: operational is the risk of loss resulting from inadequate or failed internal processes, people, and systems or from external events. It includes model risk and legal risk.

– Components of Economic Capital

  - Market Risk Economic Capital

    The time horizon is usually one year and the confidence level is usually between 99.8% and 99.97%

    The simplest assumptions are

    (a) the probability distribution of loss for each day during the next year is the same as that estimated for the first day, and

    (b) the distributions are independent.

With central limit theorem, we can argue that the one-year loss distribution is approximately normal.

Assuming 252 business days in the year, the standard deviation of the one-year loss or gain equals the standard deviation of the daily loss multiplied by $\sqrt{252}$

We can also make a somewhat conservative assumption that the mean loss is zero.

Example:

Suppose that the one-day standard deviation of market risk losses for a bank is $5 million. If we made the assumptions above, what is the one-year 99.9% worst-case loss? What is the economic capital? Assuming the daily change in the portfolio is normal and independent, what is the market risk regulatory capital for banks that are assigned the lowest multiplicative factor of 3.0?

- Credit Risk Economic Capital

  For economic capital, banks are free to use their own models to calculate specific risk capital charge and incremental risk charge for credit risk in the trading book as well as for calculating credit risk economic capital in the banking book.

  E.g., CreditMetrics or Credit Risk Plus

  In calculating credit risk economic capital, a financial institution can choose to adopt a conditional (cycle-specific) or unconditional model (cycle-neutral). It is important to be consistent when calculating expected and unexpected loss.

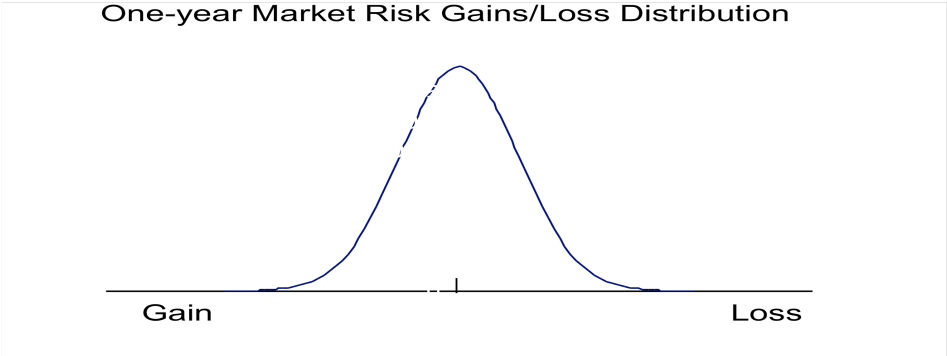
- Operational Risk Economic Capital

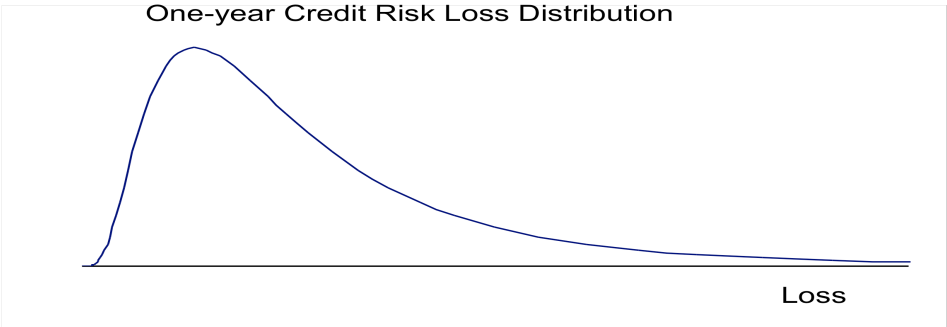
  It is likely that most banks using advanced measurement approach to calculate regulatory capital use the same approach for economic capital

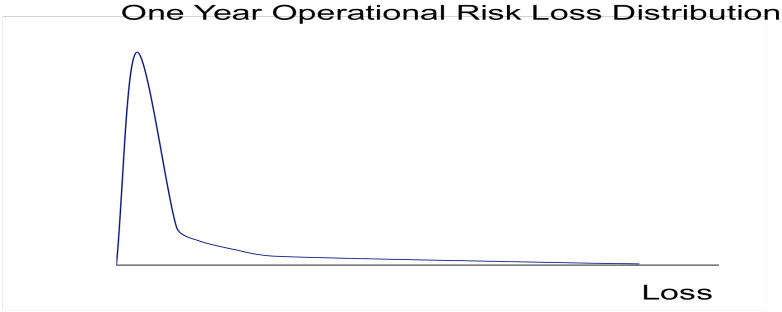
- Business Risk Economic Capital

  Business risk is even more difficult to quantify than operational risk and estimates are likely to be largely subjective.

– Typical Shapes of the Loss Distributions







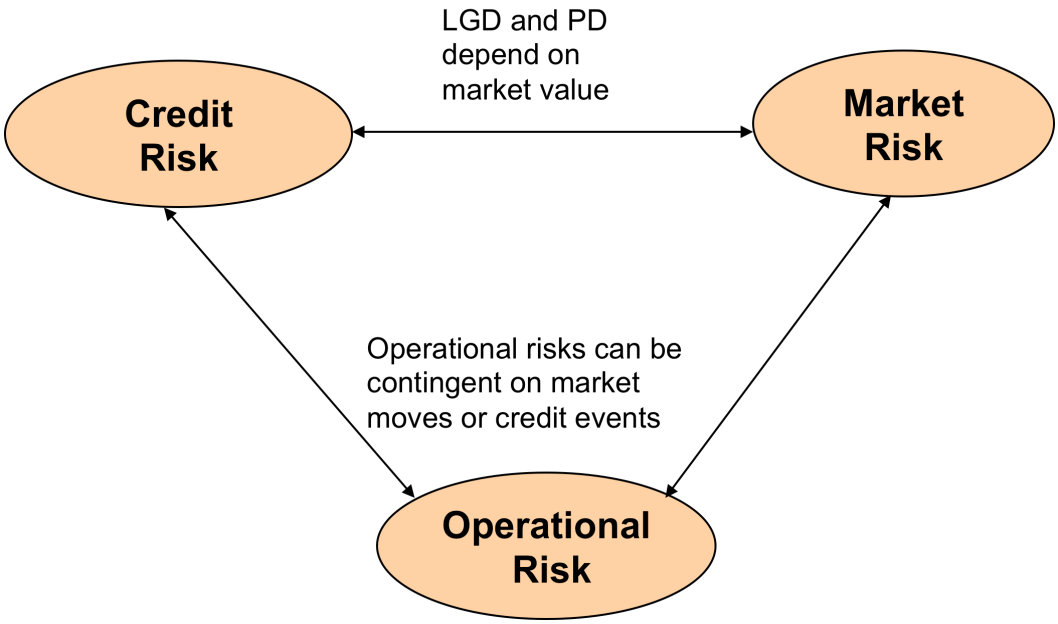
Characteristics of Distributions:

	2nd moment (Variance)	**3rd Moment (Skewness)**	**4th Moment (Kurtosis)**
Market Risk	High	Zero	Low
Credit Risk	Moderate	Moderate	Moderate
Operational Risk	Low	High	High

– Relative Importance of Risks

Type of Business	Most Important Risk
Commercial Banking	Credit Risk
Investment Banking & Trading	Market Risk and Credit Risk
Asset Management	Operational Risk

Interactions of Risks



– Aggregate Economic Capital

- Typically a bank calculates economic capital for different types of risk and different units
- It is then faced with the problem of aggregating the risks

- The simplest approach is

$$E_{total} = \sum_{i=1}^{n} E_i$$

where E_{total} is the total economic capital for the financial institution facing n different risks and E_i is the economic capital for the ith risk considered on its own.

Assuming perfect correlation overstates capital required.

- Assuming Normal Distributions

The standard deviation of the total loss from n sources of risk is then

$$\sigma_{total} = \sqrt{\sum_{i=1}^{n}\sum_{j=1}^{n} \sigma_i \sigma_j \rho_{ij}}$$

where ρ_{ij} is the correlation between risk i and risk j.

The excess of the X% worst-case loss over the expected loss is $N^{-1}(X)\sigma_{total}$

This approach tends to underestimate the capital requirement as it takes no account of the skewness and kurtosis of the loss distribution.

- Using Copulas

  Each loss distribution is mapped on a percentile to percentile basis to a standard well-behaved distribution.

  A correlation structure between the standard distributions is defined and this indirectly defines a correlation structure between the original distributions.

- The Hybrid Approach

$$E_{total} = \sqrt{\sum_{i=1}^{n}\sum_{j=1}^{n} E_i E_j \rho_{ij}}$$

  When the distributions are normal, this is exactly correct.

  When distributions are nonnormal, this approach gives an approximate answer – but one that reflects any heaviness in the tails of the individual loss distribution.

  Example:

  The estimates for economic capital for market, credit, and operational risk for two business units are shown below.

  Aggregate the economic capital using hybrid approach.

Economic capital estimates:

	Business Unit 1	Business Unit 2
Market Risk	30	40
Credit Risk	70	80
Operational Risk	30	90

Correlations between losses:

	MR-1	CR-1	OR-1	MR-2	CR-2	OR-2
MR-1	1.0	0.5	0.2	0.4	0.0	0.0
CR-1	0.5	1.0	0.2	0.0	0.6	0.0
OR-1	0.2	0.2	1.0	0.0	0.0	0.0
MR-2	0.4	0.0	0.0	1.0	0.5	0.2
CR-2	0.0	0.6	0.0	0.5	1.0	0.2
OR-2	0.0	0.0	0.0	0.2	0.2	1.0

The correlation between market and credit risk within the same business unit: 0.5

The correlation between market and operational risk or credit and operational risk within the same business unit: 0.2

The correlation of market risks across business units is 0.4

The correlation of credit risk across business units is 0.6

The correlation of operational risk across business units is 0

The correlation between two different risk types in two different business units is 0

- Alternative approaches to allocate economic capital to different business units:
  - A simple approach is to allocate economic capital in proportion to the stand alone economic capitals
  - Another approach is to calculate incremental economic capital for each business unit and then allocate economic capital to business units in proportion to their incremental capital

- The third approach is to work with the component economic capital and allocate

$$x_i \frac{\partial E_{total}}{\partial x_i} \approx \frac{\Delta E_{total}}{\frac{\Delta x_i}{x_i}}$$

to the ith business unit, where x_i is the investment in the ith business units

– Deutsche Bank's economic capital and regulatory capital (millions of euros):

Credit Risk	8,506
Market Risk	3,481
Operational Risk	3,974
Diversification benefits	*(2,651)*
Business Risk	301
Total economic capital	13,611
Total risk-weighted assets	314,845
Tier 1 Capital (% of RWA)	8.6%
Tier 2 capital (% of RWA)	3.0%
Total capital held (% of RWA)	11.6%

Allocation of economic capital (millions of euros):

Corporate banking and securities	10,533
Global transaction banking	430
Asset and wealth management	871
Private business clients	1,566
Corporate investments	207
Consolidation and adjustments	5
Total	13,611

– RAROC

RAROC is a type of Risk-adjusted performance measurement.

RAROC (risk adjusted return on capital) is the expected return on economic capital for a business unit

$$RAROC = \frac{Revenues - Costs - Expected\ Losses}{Economic\ Capital}$$

The numerator can be before or after tax and can include an interest at the risk-free rate on the economic capital

It is sometimes also referred to as RORAC (Return on Risk-adjusted capital)

Example:

When lending in a certain region of the world an AA-rated bank estimates its average losses from defaults as 1% of outstanding loans per year. The 99.9% worst case loss is 5% of outstanding loans. Economic capital per $100 of loans is $4 (ignoring diversification benefit). The bank's spread between cost of funds and interest charged is 2.5% and administrative costs are 0.7%. Calculate RAROC.

RAROC was originally suggested as a tool to be used on an ex-ante basis. This means that we have to forecast the expected loss. It is then used as a tool to allocate capital to the most profitable parts of the business

It is also sometimes used on an ex-post basis for performance evaluation. Realized loss then replaces expected loss

- Some big losses
  - Allied Irish Bank ($700 million)
  - Barings ($1 billion)
  - Enron's Counterparties ($ billions in lawsuits)
  - Hammersmith and Fulham ($600 million)
  - Kidder Peabody ($350 million)
  - LTCM ($4 billion)
  - National Westminster Bank ($130 million)
  - Orange County ($2 billion)
  - Procter and Gamble ($90 million)
  - Société Générale($7 billion)
  - Subprime Mortgage Losses ($ tens of billions)
- Risk Limit
  - Risk must be quantified and risk limits set. Procedures must be set up for ensuring the adherene of the limit
  - Exceeding risk limits not acceptable even when profits result
  - Do not assume that you can outguess the market
  - Be diversified

- Scenario analysis and stress testing is important

– Managing the Trading Room
  - Do not give too much independence to star traders
  - Separate the front, middle and back office
  - Do not blindly trust models
  - Be conservative in recognizing inception profits
  - Do not sell clients inappropriate products
  - Beware easy profits

– Liquidity Risk
  - The credit crisis of 2007 has emphasized the importance of liquidity risk
  - It is dangerous to assume large volumes of relatively illiquid instruments to be sellable at short notice at close to their theoretical values
  - Need to ensure that liquidity funding needs can be met in stressed market conditions
  - Beware when many are following the same strategy

- Using short-term borrowings for long-term funding can be dangerous
- Market transparency is important

– Lessons for Non-Financial Corporations

- It is important to fully understand the products you trade
- Beware of hedgers becoming speculators
- It can be dangerous to make the Treasurer's department a profit center

– Final Point:

Three types of risk

- Known
- Unknown
- Unknowable

Flexibility is important