Economic capital allocation

Energyforum, ERM Conference
London, 1 April 2009
Dr Georg Stapper
Agenda

- ERM and risk-adjusted performance measurement
- Economic capital calculation
- Aggregation and diversification of risk types
  - Relevant risk types
  - Diversification benefits
  - Copula approach
  - Determining correlations
- Economic capital allocation
ERM: Market demand

Market demand for EC modelling and capital allocation exists in all profitability oriented departments and at all levels of management attention.
Benefits of a risk capital based allocation approach

- Deal decision
- Growth choice
- Business reduction
- Performance observation
- Stress testing

Resource capital

Risk sensitive allocation (diversification)

Regions
- Entity 1
- Entity 2
- Entity 3

Aggregation levels
- Desk
- Commodity
- Portfolios

Limit system
- Capital planning
- Rewarding employees
- Active portfolio management
- Reporting and disclosure

ERM and RAPM

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Risk adjusted performance measurement (RAPM)

- General approach:
  \[
  \text{performance} = \frac{\text{revenues} - \text{costs}}{\text{risk}} - \text{target return}
  \]

- Components
  - **target return**: Cost of Equity (CoE) for trading unit rather than WACC, since
    - trading is not based on capital investment, but highly leveraged
    - unlike operating business trading performance includes funding costs
    - WACC approach would underestimate cost of capital, not suitable for trading unit
  - **revenues**: backward looking: accrued profit and loss
  - **costs**: should cover operational expenses and expected losses
  - **risk**: suitable @risk figure covering all relevant risk types
Perspectives of RAPM

- **Forward looking: steering**
  - capital planning
  - impact of new acquisitions

\[
\text{RAROC} = \frac{\text{Revenues} - \text{Costs} - \text{Expected Loss}}{\text{Allocated Economic Capital}}
\]

- **Backward looking: measurement**
  - performance measurement of business units on a common basis
  - impact of hedging

\[
\text{RoE} = \frac{\text{Revenues} - \text{Costs} - \text{Realised Loss}}{\text{Book Equity} \times \text{Allocated EC} \times \text{CAF}}
\]
Economic Capital as a safety cushion

Scenario 1: company performs

Scenario 2: company does not perform

ERM and RAPM
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Economic Capital revisited

<table>
<thead>
<tr>
<th>Economic Capital (EC) is the amount of capital used to cover accumulated excess (“unexpected”) losses over a fixed risk horizon with a certain degree of belief (confidence level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk horizon usually 1 year</td>
</tr>
<tr>
<td>Confidence level according to target rating of the corporation. E.g. 99.98% targeting AA+ rating (1 default in 5000 years)</td>
</tr>
</tbody>
</table>
Calculation of Economic Capital

- Economic capital (EC) is the difference between the quantile (e.g. 99.90%) and the expected value of the portfolio loss distribution.

- Capital is used to absorb unexpected losses in the portfolio.

Economic capital (EC) is calculated using advanced portfolio modelling, quantifying the shortfall against which holding capital would be too expensive.
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Modelling Approach: Risk Classes and Risk Aggregation

Market Risk
- Market movements
  - Probability
  - Loss

Credit Risk
- Defaults, rating migrations
  - Probability
  - Loss

Operational Risk
- Operational events
  - Probability
  - Loss

Diversifying aggregation

Linear aggregation

Aggregation

Total @Risk capital

Quantification difficult

Aggregation and diversification of risk types

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Business motivation for risk aggregation

Value based management

- Obtain overall risk figure taking into account full diversification
  - All quantifiable risks have to be aggregated across all portfolios, departments, business units and across all risk types
  - Capital relief according to diversification between risk types is in the range of 20-30% compared to the “simple” addition of risk capital figures

- True risk profile to perform meaningful risk-return analysis
  - Re-allocation of diversification effects between risk types affects risk-return performance of business units
Modelling Framework for Market Risk: VaR(1d)

Internal Data
- Financial Exposures
- Trading/hedging strategies
- Hedge relations

Market Data
- Options prices
- Forward curves
- Spreads
- Interest/FX rates

Model Data
- Correlations
- Volatilities
- Mean reversion params.
- Jump probabilities/amplitudes

Monte Carlo simulation
- Biased dice
- Brownian Motion
- P/L distribution

Analysis
- Value at risk @ 95% C.L.

Market Risk EC
- ESF-Allocation:
  Identify value creators and capital destroyers

ESF
- Capital benefit
- Capital charge
- Business unit 1
- Business unit 2
- Business unit 3
- Business unit 4
- Business unit 5
- Business unit ...

Aggregation and diversification of risk types

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Modelling Framework for Credit Risk: CVaR(1y)

- Internal Data:
  - Exposure/PFE
  - Probability of default
  - Loss given Default
  - Maturity

- Market Data:
  - Interest rates
  - Credit spreads
  - Factor Indices

- Model Data:
  - Correlations
  - Migration matrices
  - Specific risk factor $R^2$
  - Factor weights

Monte Carlo simulation:
- Biased dice
- Asset return process
- Loss distribution

Analysis:
- EL Value at risk @ 99.9%
- EC
- ESF

Credit Risk Capital:
- ESF-Allocation: Identify value creators and capital destroyers
- Capital benefit
- Capital charge

Aggregation and diversification of risk types

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Modelling Framework for Operational Risk: OpVar(1y)

Aggregation and diversification of risk types

Internal Data

External Data

Scenario Analysis

Frequency

Severity

Gross Losses

Net Losses

Insurance

Diversification/Correlation

Aggregated Distribution

Risk Capital

Value at risk

EL

EC

Business division 1

Business division 2

Business division n

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Diversification across risk types

- Adding up standalone risk capital for individual risk types overestimates total risk because diversification effects between the risk types are not reflected.
- Model for risk type diversification combines loss distributions for credit, market, operational and other risk using correlations between these risk types.

Overall @risk capital reduction

Diversification Benefit
Modelling Framework for Risk Aggregation

- **Credit Risk Process**: Group portfolio -> Credit Risk Economic Capital
- **Market Risk Process**: Sub-portfolio 1 -> Market Risk Economic Capital
- **Copula Model**: Credit Risk Economic Capital -> Market Risk Economic Capital
- **Expected Shortfall Allocation**: Group portfolio -> Diversified Group EC
- **Capital Benefit**: Credit Risk Economic Capital
- **Capital Benefit**: Market Risk Economic Capital
- **Diversified Credit Risk**: Credit Risk EC
- **Diversified Market Risk**: Market Risk EC

**Aggregation and diversification of risk types**
Modelling Framework for Risk Aggregation

- **Linear combination of standalone risk figures for each risk type**
  Total risk capital: \( RC(\text{total}) = RC(\text{MR}) + RC(\text{CR}) + RC(\text{OR}) + \ldots \)
  - No diversification benefit at all
  - Worst case scenario (useful stress scenario case)
  - Overestimates total risk => not suitable for risk-reward based steering

- **Correlation matrix approach**
  Total risk capital:
  \[
  \text{VAR}_{\text{all}} = \sqrt{\sum_i \sum_j \rho_{ij} \cdot \text{VAR}_i \cdot \text{VAR}_j}
  \]
  - All loss distributions are assumed to be normally distributed
  - Underestimates total risk => not suitable for risk-reward based bank steering

- **Copula approach**
  - Free choice of dependence structure between risk types (Gauss-copula, student t-copula, others)
  - Marginal (asymmetric) loss distributions are taken into account
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Risk capital allocation scheme

Diversified Group EC

Expected Shortfall Allocation

Diversified Market Risk EC

Credit Risk EC

ESF-Allocation: Identify value creators and capital destroyers

Capital benefit
Capital charge

Business unit 1
Capital benefit

Commodity 1
desk 1

Business unit 2
Capital benefit

Commodity 2
desk 2

Business unit 3
Capital benefit

Commodity 3
desk 3

Market risk EC

Diversified Market Risk EC

Market Risk EC

Diversified Credit Risk EC

Market risk EC

Business unit n

Diversified market risk

EC business unit n

Capital benefit

Capital benefit

Identify value creators and capital destroyers

Capital charge

Capital benefit

Capital benefit

Capital benefit
Reporting:
Identification of value creators and capital destroyers

Concentration risk reports for each risk type at transaction level:
Hurdle rate is set to 20%.

\[ \text{RAROC} = 5.9\% \]
\[ \text{EVA} = -35,748 \]

\[ \text{RAROC} = 61.7\% \]
\[ \text{EVA} = 47,433 \]

\[ \text{RAROC} = 29.5\% \]
\[ \text{EVA} = 27,162 \]

\[ \text{RAROC} = 5.8\% \]
\[ \text{EVA} = -26,253 \]
## Risk aggregation, capital allocation & profitability

<table>
<thead>
<tr>
<th>Financial Institutions</th>
<th>Corporates</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICAAP, RAROC, deal decision for capital market portfolio</td>
<td>cash flow at risk, earnings at risk, profit at risk, EBIT at risk, RoE, exposure at horizon (EPE, PFE)</td>
</tr>
<tr>
<td>- Concept for risk sensitive top level aggregation methodology of market, credit &amp; operational risk (copula approach, correlations between risk types)</td>
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</tr>
<tr>
<td>- Allocation of diversified group EC to business unit level</td>
<td>- Allocation of diversified group risk capital to business unit level</td>
</tr>
<tr>
<td>- RAROC concept (hurdle rate, cost function of operational and administrative costs for different products, standard risk costs etc.)</td>
<td>- RoE concept (based on RAROC concept, hurdle rate, cost function of operational and administrative costs for different products)</td>
</tr>
<tr>
<td>- Reporting (process and design)</td>
<td>- Reporting (process and design)</td>
</tr>
<tr>
<td>- Evaluation and analysis of the risk profile of the bank (capital market portfolio)</td>
<td>- Evaluation and analysis of the risk profile (Concentration risk, what if analysis, etc.)</td>
</tr>
<tr>
<td>- Specification of methodological and technical requirements</td>
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</tr>
<tr>
<td>- Model selection: Internal solution vs. commercial software solution</td>
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</tr>
</tbody>
</table>
Summary

- Enterprise wide risk and capital management should be based on **risk sensitive** methods to identify concentration risk and to identify the true value creators and capital destroyers within the portfolio to enable according action.

- Best practice approach for risk aggregation is based on a **copula** method to model the dependence structure between risk types.

- Best practice approach for risk capital allocation is based on the method of **expected shortfall**.

- Risk capital reports should be available within each risk type at **transaction level** and across all **risk types**.
Profitability: RoE on the basis of RAROC

**RAROC =**

- **Steering**
  - Revenues – Costs – Expected Loss + Capital Benefit
  - Allocated Economic Capital

**RoE =**

- **Measurement**
  - Revenues–Costs– (Write Offs + Provisions) + Capital Benefit
  - Book Equity
  - Allocated EC * CAF

<table>
<thead>
<tr>
<th>Customer Rating</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposure</td>
<td>10,000,000</td>
</tr>
<tr>
<td>Margin</td>
<td>0.62%</td>
</tr>
<tr>
<td>+ Revenue</td>
<td>62,000</td>
</tr>
<tr>
<td>- Administrative Expenses</td>
<td>30,000</td>
</tr>
<tr>
<td>- Product Expenses</td>
<td>10,000</td>
</tr>
<tr>
<td>- Expected Loss</td>
<td>5,400</td>
</tr>
<tr>
<td>+ Capital Benefit @ 4.9%</td>
<td>4,498</td>
</tr>
</tbody>
</table>

RAROC: 23.0%

If Provisions = Expected Loss \( \Rightarrow \text{RoE} = \frac{\text{RAROC}}{\text{CAF}} \)

CAF in this example = 1.5

RoE: 15.3%
General Construction principle of EC Allocation

**Unexpected Loss** (Standard Deviation):

- Covariance Allocation: \( \frac{\text{Cov}[L_{\text{facility}}, L_{\text{portfolio}}]}{\text{Var}[L_{\text{portfolio}}]} \)
- distributes loss volatility

**Expected Shortfall**:

- Expected Shortfall Allocation: contributory EC is the average loss of a subportfolio in the “extreme loss scenarios” of the portfolio:
  \[ \text{ESF}(\text{facility}) = E[L_{\text{facility}} | L_{\text{portfolio}} > \text{quantile}_Q] - E[L_{\text{facility}}] \]
- distributes extreme losses

**Value-at-Risk**:

- Capital allocation by breakdown of VaR according to Covariance or Expected Shortfall contribution
Risk capital contribution should scale with the “riskiness” of the transaction/sub-portfolio

- Transactions/sub-portfolios with lower credit quality should consume more capital
- Transactions/sup-portfolios with higher correlations/concentration risk should consume more capital

Fulfilled by Coherent Risk Measure Expected Shortfall but not by Var/Covar allocation (Artzner, Delbaen, Eber & Heath, 1997/99)
Comparison Expected shortfall vs. Var/Covar allocation

Capital charge of top capital consumers

- Var/Covar Allocation: Capital charge > Exposure
- Related to non-normality of the credit loss distribution

Capital charge 100%: Economic capital equals exposure
Scaling of Market-VaR to Risk Horizon of Credit Risk

1 day VaR @ 95% C.L. × 1.98

1 year CVaR @ 99.95% C.L.

Quantile Adjustment

Adjustment of risk horizon

Market risk in banking book
\( \times \sqrt{250 \text{ days}} \approx 16 \)

Market risk the trading book
\( \times \sqrt{90 \text{ days}} \approx 9.5 \)

Aggregation possible
Determination of correlations

Calibration of correlations reflecting specific risk profile of company

Exposure weights

credit risk factors

market risk factors

credit risk proxy

market risk proxy

Credit risk

Market risk

Operational risk

Credit risk factors

Market risk factors

Time series

Credit risk + + +.. +

Market risk + + +.. +

Correlation matrix for Gaussian Copula

CR  MR  OR

CR

MR

OR

Qualitative analysis/expert judgement/best practice values