Incremental Risk Capital (IRC) and Comprehensive Risk Measure (CRM): Modelling Challenges in a Bank-wide System

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- IRC and CRM: Definition
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  - Modelling choices
  - Selected examples
- Backtesting feasibility
- Industry and regulator views
- Conclusion and outlook
New capital charges on trading books: Overview (I)

- With internal models missing major market (and credit) risks during the recent financial crisis, the Basel Committee has suggested new capital charges for trading books.

- Targeted shortcomings:
  - Differences in the underlying liquidity of trading book positions.
  - 99%/one-day or ten-day Value-at-Risk (VaR): No adequate reflection of large default losses that occur less frequently as well as the potential for large cumulative price movements over several weeks or months.

- The proposed framework has evolved since 2007, accompanied and driven by extensive Quantitative Impact Studies (QIS).

- EBA draft guidelines on IRC were published in November 2011.

- Focus of this talk are those new charges based on internal models, which require validation by home regulators and are to be introduced together with other requirements (e.g., designated stress tests).
New capital charges on trading books: Overview (II)

- Current market risk capital formula:*

\[
\text{Capital} = (m_c + b) \cdot \text{VaR} + \text{VaR} \text{ (specific)}
\]

- \text{VaR} is the standard Value-at-Risk measure, based on 99% 10-day loss
- \( m_c \) is a model-based multiplier, \( m_c \geq 3 \)
- \( b \) is an additional factor, depending on \( \text{VaR} \) backtesting excesses, \( 0 \leq b \leq 1 \)

- Coming soon:*

\[
\text{Capital} = (m_c + b) \cdot \text{VaR} + (m_s + b) \cdot \text{Stressed VaR} + \text{IRC} + \max \{\text{CRM}, \text{Floor}\} + \text{SC}
\]

- \text{Stressed VaR} is \( \text{VaR} \) calibrated to financial crisis data, e.g., 2007-2008; \( m_{c/s} \geq 3 \)
- \text{IRC} is an incremental charge for default and migration risks for non-securitised products (at least weekly computation)
- \text{CRM} is an incremental charge for correlation trading portfolios (at least weekly computation)
- \text{Floor} is calculated as \( \alpha \) times capital charge for specific risk according to the modified standardised measurement method for the correlation book (a.k.a “banking-book charge”); \( \alpha = 8\% \)
- \text{SC} is standardised charge on securitisation exposures (not covered by CRM), comparable to the banking book

* Ignoring the averaging over quarters etc.
IRC and CRM: Definition

- **Incremental Risk Capital (IRC)**
  - **Products**: flow products – bonds and CDS (if not part of CRM, as defined below); may include listed equities
  - **Simulated risks**: credit rating migrations and default

- **Comprehensive Risk Measure (CRM)**
  - Although initially considered part of securitisation positions, correlation trading portfolio are “carved out” of standardised charge and subject to CRM and floor (the CRM cannot be lower than 8% of the standard charge)
  - **Products**: correlation instruments and their hedges (*including CDS*), but without “re-securitisation positions” (e.g., CDO\(^2\)) or LSS
  - **Simulated risks**: Default and migration (as in IRC) and all price risks (multiple defaults, credit spread volatility, volatility of implied correlations, basis risks, recovery rate)

- **Risk measure**
  - Both are based on 99.9% loss quantile at 1-year capital horizon
  - This contrasts with VaR and stressed VaR, which are much more short-term
  - Rebalancing may be taken into account via shorter liquidity horizons coupled with a “constant level of risk” concept
  - For CRM, the modelling of dynamic hedging and its cost are allowed
IRC: Modelling default and migration (I)

- The IRC charge must capture default and migration risk
- Range of **modelling** choices, for example:
  - Rating-based simulation (usually through asset values/returns)
  - Direct simulation of spreads with migration/default barriers
- **Granularity** of simulation (e.g., in the case of bonds)
  - Guarantor/obligor
  - Issuer
- **Parameterisation** choices, for instance:
  - Historical vs. market-implied default (and migration) probabilities
  - Granularity of factors to capture asset and/or credit spread dependence
- Different possibilities regarding **trade revaluation**:
  - “As of today” or in the future; recognition of cash flows or not
  - Full revaluation or approximation
  - On-the-fly (for each scenario) vs. pre-computation
- **Interpretation** of the constant level of risk concept: Simplifying assumption to rebalance frequently or rollover the positions (at the **liquidity horizon**) in a manner that maintains the initial level of risk
IRC: Modelling default and migration (II)

Example of a concrete approach:

- Rating-based simulation for each obligor (e.g., CDS entity/bond guarantor)
- Marginal default probabilities based on historical transition matrices (“through-the-cycle”); differentiation between sovereigns and corporates
- Dependence between obligors via multi-factor asset return model
- Conversion of rating moves to credit spread moves via mapping tables

![Diagram of correlated asset returns and final rating](image)

Correlated Asset Returns

Final rating

Spread-to-Rating mapping

Spread multiplier to apply on par spread

Graph showing the relationship between initial ratings, correlated asset returns, and final ratings.
IRC: Modelling default and migration (III)

- **Trade revaluation**
  - “As of today”, i.e., no ageing of deals
  - Full revaluation where possible, since approximation via sensitivities, for example, not well suited for large credit spread moves
  - Pre-calculation of PVs possible, given the limited number of “target” ratings
  - Full revaluation where possible
  - Par bond approximation for the rest:

\[
P_V = 100 \left[ 1 - \frac{1 - \exp[-(S/(1-R)+r)T]}{(S/(1-R)+r)} \right]\]

\(S\) – spread; \(r\) – risk free rate; \(C\) – bond coupon; \(R\) – recovery rate.

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<thead>
<tr>
<th>Name</th>
<th>Rating 1</th>
<th>Rating 2</th>
<th>Rating 3</th>
<th>...</th>
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- **Constant level of risk** concept: Full “reset” of a deal at the liquidity horizon, to the original maturity and credit quality
IRC: Modelling default and migration (IV)

- Illustration of IRC simulation with liquidity horizon of 6 months and capital horizon of 1 year (assumed current obligor rating: Aa2):

- Usually high number of simulations required (1m+) to achieve stable results
Credit derivatives flow trading is usually less impacted by IRC since positions are hedged in terms of credit risk.

For example, positions on risky bonds will be hedged by buying protection on the obligor.

Though the overall default risk is reduced, on a large portfolio, risk might arise from positions with different durations as shown below:

<table>
<thead>
<tr>
<th>Obligor</th>
<th>Rating</th>
<th>Notional per position (EUR)</th>
<th>Maturity</th>
<th>Total default risk (EUR)</th>
<th>IRC charge (EUR)</th>
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<td>X3</td>
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<td>2y 5y</td>
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IRC charge (EUR): 662,400
The IRC charge will usually substantially impact business lines such as IR/FX where credit risk is dealt with differently:

- For example, positions in government bonds might not be fully hedged because the main purpose is not credit but rather interest rate and/or repo trading.
- Under these conditions, IRC will capture default risk. The magnitude of the impact can be significant and depends on the obligors’ ratings (recovery rate: 40%):

<table>
<thead>
<tr>
<th>Obligor</th>
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<th>Maturity</th>
<th>Total default risk (EUR)</th>
<th>IRC charge (EUR)</th>
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<td>X5</td>
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<td>2y, 5y</td>
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<th>Total default risk (EUR)</th>
<th>IRC charge (EUR)</th>
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<td>2y, 5y</td>
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<td>5,000,000</td>
<td>2y, 5y</td>
<td>6,000,000</td>
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</table>
CRM: Additional risk factors for credit correlation products

CRM is an IRC-type charge with the requirement for additional risk factors:

“... a bank may incorporate its correlation trading portfolio in an internally developed approach that adequately captures ... all price risks ... in particular ... the following risks ... must be adequately captured:

- the cumulative risk ... from multiple defaults, including ordering of defaults ...
- credit spread risk, including the gamma and cross-gamma effects
- volatility of implied correlations, including the cross effect between spreads and correlations
- basis risk, including both
  - the basis between the spread of an index and those of its constituent single names; and
  - the basis between the implied correlation of an index and that of bespoke portfolios
- recovery rate volatility, as it relates to the propensity for recovery rates to affect tranche prices
- to the extent the comprehensive risk measure incorporates benefits from dynamic hedging, the risk of hedge slippage and the potential costs of rebalancing such hedges.”

CRM: Modelling choices (I)

- Modelling CRM poses a range of challenges
- What to model for each risk factor and how
  - Choice between model inputs and market observables is often non-trivial (e.g., base correlations vs. tranche prices)
  - Values (levels) or changes in them
  - Match whole distribution or particular range (e.g., tail)
- Dependence between factors is crucial
  - Well-documented empirical evidence of correlation between some of the factors
  - Overall correlation vs. tail dependence
  - Calibration of factors is not independent: for example, given spreads and recovery rates, implied correlations are constrained by tranche prices
- Technical
  - Simulated values for risk factors may need to satisfy complicated no-arbitrage conditions
  - Simplified and/or accelerated pricers to be used for the complicated products involved, given the number of evaluations required
CRM: Modelling choices (II)

- Non-parametric or semi-parametric fit
  - Look at time series of chosen factor or its increments/returns over certain window
  - Fit distribution or estimate parameters of likely distribution (e.g., mean and variance)
  - For multi-dimensional risk factors, for example, “tenor” and “strike” dimensions: Approaches such as PCA may perform well, but judgement and interpretation of signals by risk managers is severely reduced

- Parametric analysis
  - Choose stochastic drivers for each factor: single values or curve/surface characteristics, such as level, slope, curvature, etc. (parameterise)
  - Assume a tractable model, amenable to calibration; introduce dependence
  - Use stochastic model outputs to calculate observable quantities (market prices or quoted values) and fit parameters to reproduce realised time series
  - This way we have more control of the model, but become more sensitive to validity of initial assumptions
  - Fitting distribution and especially dependence parameters may be a tricky process
CRM: Modelling choices (III)

- Simulation-based modelling approach applied in the following:
  - Asset return model to capture default and migration events – as in IRC
  - Short-term spread volatility
  - Implied correlation volatility
  - Index-CDS basis (skew) volatility
  - Recovery rate volatility
- Ruled out:
  - Basis between implied correlation of an index and that of bespoke portfolios (non-observable, better captured as reserve)
  - Dynamic hedging
- Trade revaluation
  - The multitude of risk factors prevents the use of pre-calculated P&Ls
  - Simplified pricers to achieve sufficient speed
  - No “ageing” of positions and rebalancing of hedges (conservative assumption)
- High number of simulations required (100K+) to achieve stable results, usually less compared to IRC since correlation trading portfolio well balanced
CRM: Selected examples (I)

- Only the credit structured business is impacted
- Example – typical “vanilla” CDO position with different hedging strategies:
  - Buy protection on a mezzanine bespoke tranche
  - 3 - 7%, 5Y maturity, EUR 10m notional
The floor on the charge – which is based on standard charges for long and short positions – might give entirely wrong hedging incentives (!)
Limited backtesting feasibility (I)

- High confidence levels and long projection horizons make the backtesting in the “classical” sense hardly feasible
  - Monitoring over time (e.g., P&L of constant portfolio snapshots vs. IRC/CRM) seems advisable – likely without statistically valid conclusion
  - Many technical obstacles, for example, how to identify a purely rating migration-induced P&L for IRC?
  - “Backward-looking” backtesting (i.e., repricing of today’s portfolio over previous time periods) usually does not capture defaults
Limited backtesting feasibility (II)

The below graph shows an example of a “backward-looking” backtesting on CRM. Default not being captured by this method, CRM is simulated using migration only.

![Graph showing CRM with migration only]

**CRM with migration only**

Forward (PV(t+1y)-PV(t)), 1-year sliding P&Ls from t=26/11/2007

<table>
<thead>
<tr>
<th>Date</th>
<th>Hedging products</th>
<th>Correlation products</th>
<th>All products</th>
<th>CRM Model (migration only) 99.9th percentile</th>
<th>CRM Model (migration only) 0.1th percentile</th>
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</table>
EBA draft guidelines raise several points of discussion:

- On defaulted names: “positions in defaulted debt held in the trading book shall be included. […] the risk of the price changes of defaulted debt […] shall be capitalised in all cases, ideally using the IRC mode.”
  - Except if the institution is trading many defaulted bond, this is a second order risk

- On the constant level of risk concept: “[…] the institution does not have to integrate the time effect: positions keep their original residual maturities at the end of each liquidity horizon […]”.
  - This should be valid only for on-going activities. For trade maturing, the institution should be able to assume ageing of the book.

- On unexpected loss: “Over the one-year capital horizon or when replacing original positions with risk-equivalent positions […] institutions only need to model unexpected loss […]”.
  - The motivation is not clear since the unexpected loss is not always conservative
  - Taking into account theta effect (ageing of positions) seems more adequate

- On basis risk: “In order to reflect basis risk appropriately, valuation for the purposes of the IRC for related positions […] must be differentiated”.
  - Capturing loss at the 99.9th percentile makes the basis risk immaterial.
Industry and regulator views (II)

- Shortcomings of VaR-based capital charge are recognised, and the requirement that banks increase capital is understandable after the crisis.

- Furthermore, it is in the banks’ own interest to strengthen risk measurement and management procedures – Example: CRM and VaR
  - Correlation trading books are still subject to VaR-based risk calculation.
  - Currently, a sensitivity-based approach to measure market risk in correlation trading (complemented by stress tests and a range of risk limits) is common, with alternatives based on history or conservative simulations.
  - A CRM-compliant model can be enhanced to create a more sophisticated VaR engine:
    - Can add more risk factors if necessary,
    - Calibrate model parameters using 10-day moves to calculate 10-day VaR
    - Risk factor dependence is already captured better than in most live VaR systems
    - More accurate than sensitivity-based approach, since full revaluation is used, albeit with simplified pricers.
At the same time, the approach to additional capital charges taken by regulators raises questions:

- Still based on loss quantiles, so inherits all the drawbacks of VaR combined with a higher percentile
- Model risk increases substantially; backtesting for such a high quantile at such a long horizon is likely to be far less accurate, if possible at all
- Double-counting effect of market risks between VaR and IRC/CRM
- Specifically for CRM with floor:
  - Exclusion rules (especially CDO2 and LSS, but not their hedges) are likely to trigger capital charge driven trading activity, rather than sound risk practices
  - Even though dynamic hedging is mentioned in principle, the constant level of risk concept makes it very unclear how this can be implemented in practice
  - Application of the banking book-style floor
    - severely misrepresents the risk and
    - gives wrong hedging incentives

Concern that market activity will be focused around capital arbitrage and not sound risk management, as must have been the regulators’ intention
The introduction and regulatory approval of new internal market risk models ("Basel 2.5") has posed – and still poses – significant challenges for banks:
- Regulatory auditing finishing in many jurisdictions these days
- So far missing industry standards for consistent compliant models

Participation of the industry and work-intensive QIS over the past years have helped to achieve more coherent risk measures compared to original plans.

EBA guidelines yet to be published while all European banks have already been subject to validation missions.

Concepts like
- Stressed VaR and
- the CRM floor based on the standardised method
are still not considered suitable approaches by the industry.

US and European banks are no longer following the same rules.
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