Baseline Capital Requirements for Derivatives

In this paper we discuss Basel II and III approaches for Credit Risk capitalization. We summarize steps to compute Exposure at Default using Non-internal and Internal models; describe methods to translate exposure into capital using standardized and advanced methods. Finally, we demonstrate Default Risk and CVA risk capitalization of sample portfolio of derivatives. PrevioRisk software is employed as Internal Model.

The counterparty credit risk is the risk of loss that is incurred by an institution in the event of default of its counterparty; this risk arises if the counterparty fails to honor the contractual payments to the institution. In case of default, the surviving party has to close out his position and usually seeks to replace the trade in order to maintain its market position. The cost attached to that defines the exposure (1).

The total CCR capital charge is determined as the sum of the Default Risk capital charge and the CVA risk capital charge for potential marked-to-market losses.

The Basel Counterparty Credit Risk (CCR) framework undertakes two-step process to capitalize Default Risk capital charge into Risk Weighted Assets (RWA) and capital.

First, a bank must calculate the credit exposures arising from bilateral transactions (i.e. what is likely to be lost when the counterparty defaults), under exposure or Exposure at Default measures (EAD).

Second, these EAD calculations enter the credit risk regime and are multiplied by the risk weight of the counterparty according to either the Standardized or the Internal-Ratings Based (IRB) approach (2).

Standardized Approach, will be to measure credit risk in a standardized manner, supported by external credit assessments. Internal Ratings-based Approach would allow banks to use their internal rating systems for credit risk (3).

Basel III introduces CVA capital charge which is computed on counterparty level based on EAD obtained at stage one. There are two methods of computing CVA RWA. Under Standardized Method, CVA capital charge is derived directly from EAD. Under advanced method, bank can employ internal model to produce Expected Exposure and derive CVA RWA from it.

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**Figure 1. Basel CCR Capitalization Flow Cha**

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>Stage 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trades</td>
<td>Default RWA</td>
</tr>
<tr>
<td>Bilateral Agreements</td>
<td></td>
</tr>
<tr>
<td>Collateral</td>
<td>IMM</td>
</tr>
<tr>
<td>Market Prices</td>
<td>CVA RWA</td>
</tr>
<tr>
<td></td>
<td>IMM, SM, IMM or NIMM</td>
</tr>
<tr>
<td></td>
<td>CCR Risk Weight</td>
</tr>
<tr>
<td></td>
<td>EAD</td>
</tr>
<tr>
<td></td>
<td>EE, Stressed EE</td>
</tr>
</tbody>
</table>

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In general, the assessment of Exposure at Default for derivative transactions primarily depends on fluctuations in contract underlying market factors (prices, interest rates, credit spreads) which define market value of the contract, and, thus, exposure to the counterparty. Additionally, bilateral agreements with counterparties describing netting, and collateral and margining agreements may decrease EAD.

Methods of Computing EAD
Basel II framework employs one of three methods to compute EAD at Stage 1 depending on complexity of risk management systems: Current Exposure Method (CEM), Standardized Method (SM), and Internal Model Method (IMM).

Credit exposures under each of these methods is computed at the netting set level. In other words, long and short derivative transactions with the same counterparty that are subject to a legally enforceable netting would be allowed to perfectly offset, but no offset would be recognized across non-netted transactions.

However, CEM and SM methods are widely criticized mainly because of following limitations:

- margining is not taken into account;
- methods cannot capture increase of volatilities observed during stressed periods;
- the recognition of hedging and netting benefits does not reflect real economic relationship between counterparties;
- operational complexity of SM method.

The criticisms of the CEM and SM approaches for calculating counterparty credit risk exposures led the Basel Committee to develop a single non-internal model method (NIMM) that it is considering to replace both the CEM and SM in the Basel risk-based capital framework. The method retains a structure similar to the CEM. Importantly, however, the NIMM is calibrated to a stress period, recognizes the benefit of collateral and is more reflective of legal netting arrangements (2).

Following paragraphs briefly describe technique and workflow for each of methods listed above.

**Current Exposure Method (CEM)**
Under the non-internal CEM, the EAD is calculated as the sum of Replacement Cost of the instrument and netted Add-on component which represents Potential Future Exposure (PFE) – potential change in the instrument’s market value between the computation date and a future date on which the contract is replaced or closed out in the case of a counterparty default.

\[ \text{CEM EAD} = \text{RC} = \text{MTM} - \text{Collateral} \]

![Figure 2. Current Exposure Method to compute EAD (RC – Replacement Cost, NGR – Net to Gross Ratio).](image)

At the trade level, the gross PFE Add-on is calculated by multiplying the instrument’s notional amount by a supervisory add-on factor based on the asset class and remaining maturity of the trade.

At the netting set level, hedging and diversification benefits are recognized through the Net-to-Gross Ratio (NGR). The “net” PFE Add-on of a portfolio is derived from its “gross” PFE Add-on as the sum of
the individual PFE add-ons for each trade as adjusted by the NGR, which reflects the current level of hedging and netting benefits (3).

**Standardized Method (SM)**
Under the SM, EAD is calculated as the sum of the Net Risk Position calculated for each “hedging set”, which is defined as positions with common market risk factors. The resulting exposure cannot be less than the Current Market Value of the netting set.

Derivative transactions are converted into Delta Equivalent (DE) positions. The Delta Equivalents of a position describe the response of a position/portfolio to a change in the market factor. Delta Equivalent is the derivative of the Present Value with respect to a given risk factor, multiplied by the value (price or spread) of that particular risk factor.

Then, a supervisory credit conversion factor (CCF) applies to the net risk position to reflect its potential future change between the computation date and the date at which the contract should be able to be replaced or closed out in the case the counterparty defaults (3).

**Internal Model Method (IMM)**
EAD can be directly computed from 12-month Effective Expected positive Exposure (EEPE). EEPE is calculated by estimating Expected Exposure (EE) as the time-weighted average exposure at future date, where average value is taken across possible future values of relevant market risk factors. Note that under IMM bank need to employ a single model to simulate future outcomes of exposure.

**Non-Internal Model Method Basel III (NIMM)**
The exposures under the NIMM consist of two components: replacement cost (RC) and Potential Future Exposure Add-on (PFE).

The methodology for calculating the add-ons for each asset class hinges on the key concept of a “hedging set”. A “hedging set” under the NIMM is a subset of transactions within an asset class that share common attributes. The Basel Committee proposes the following methodologies for calculating the add-ons (2):

- Interest rate derivatives;
- Foreign exchange derivatives;
- Credit derivatives and equity derivatives;
- Commodity derivatives.
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Add-on is computed as product of Effective Notional (EN) by Supervisory Factor (SF).

Replacement Cost (RC) of the transaction is defined as the larger of:

- the Current Exposure minus net collateral held; or
- the largest net exposure including all collateral held or posted under the margin agreement (if any exists) that would not trigger a collateral call. This amount is represented as sum of Threshold Amount (TH) and Minimal Transfer Amount (MTA) less Net Independent Collateral Amount (NICA).

Replacement Cost cannot be negative.

**Practical Implementation**

**Portfolio Description and Assumptions**

To capture difference in CCR management and impact of credit quality, maturity etc. for different transactions and business agreements, we calculate CCR risk charges for diversified portfolio of typical universal bank. Portfolio is assumed to have significant share of interest rate swaps for ALM purposes, cross currency swaps and FX options are used to hedge foreign exchange risk. Transactions are performed in different currencies.

Figure 5. Non-Internal Model Method to compute EAD (RC – Replacement Cost, UE – Unmargined Exposure, CE – Current Exposure, SF – Supervisory Factor).

Most of trades have maturity up to 2 years. Notional-weighted average term to maturity of the portfolio is: 1 years (maximum 9 years).

Figure 6. Portfolio PFE (non-netted) by Deal Type

Sample derivative portfolio contains 186 trades with notional of USD 2 bln. Top 5 traded products include: Interest Rate Swaps, Cross Currency Swaps, Credit Default Swaps, FX Future, and Single Barrier FX Options.

**Figure 7. Portfolio Distribution by Maturity**

<table>
<thead>
<tr>
<th>Maturity</th>
<th>Number of Trade</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1 year</td>
<td>30</td>
</tr>
<tr>
<td>1-2 years</td>
<td>45</td>
</tr>
<tr>
<td>2-3 years</td>
<td>34</td>
</tr>
<tr>
<td>3-4 years</td>
<td>35</td>
</tr>
<tr>
<td>4-5 years</td>
<td>23</td>
</tr>
<tr>
<td>over 5 years</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 1. Portfolio Summary Statistics (mln, Additional statistics were simulated using PrevioRisk software).
Customer base include 95 corporate and SME counterparties with different credit quality. Most of customers have credit ratings which are used to obtain risk weights for Standardized Default Capital Charge Method. Credit quality for customers with no rating is defined by single-name or index credit spread curve or bond yield curve. Historical default rates for IMM PD calculation are performed by S&P research (4).

Recovery Rate is specified at 40-45% with few exceptions.

There are 10 Legal Agreements with customers with full netting and margining. Margining period is specified up to 20 days.

**Internal Model Description**

All the computations and reports for Internal Model Method are provided by PrevioRisk software. Exposure profile (particularly EEPE) is aggregated from more than 1000 of possible outcomes of future exposure paths which were priced based on Monte Carlo simulation for potential market scenarios.

Each market scenario describes set of market factors that can affect value of contract and, thus, future exposure. Trades values are priced for future horizons based on each scenario (single simulation). Those values are netted and margined according to legal agreements, and then translated into exposure.

**Exposure at Default: CEM, IMM, SM, and NIMM**

This chapter provides brief results of EAD computed using non-internal models: CEM, SM and NIMM (Basel III) and Internal Model.

As can be seen from the table below, CEM RWA is very close to IMM result.

Taking into account the fact, that CEM employs Net-To-Gross Ratio to capture netting (with 0.6 multiplier) and ignores margining, we confirm that IMM is more sophisticated in terms of legal agreements.

<table>
<thead>
<tr>
<th>Method</th>
<th>EAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEM</td>
<td>95.5</td>
</tr>
<tr>
<td>SM</td>
<td>134.4</td>
</tr>
<tr>
<td>IMM</td>
<td>101.6</td>
</tr>
<tr>
<td>NIMM</td>
<td>128.0</td>
</tr>
</tbody>
</table>

Non-internal methods have primarily EAD driver based on current market value of the transaction (CEM and NIMM – Replacement Cost, SM – Current Market Value). PFE add-on is defined based on notional. IMM EAD is computed based on EEPE only. As can be seen from figure below, value-based component results in most of variation of EAD across observation. R-squared for CEM is 89%, SM – 94%, NIMM – 98%.

Note, that NIMM method takes maximum of Replacement Cost and Unmargined Amount (as was discussed earlier). Results show, that UE has insignificant influence on final EAD because MTA were specified at very low level.
Figure 8. Primary Drivers for Basel EAD Methods (Risk weights: <20% -- blue, >50% -- red).

Figure below compares EAD between different methods. Non-Internal Methods are very close to each other. IMM method however, has large portion of outliers. Those are trades with negative market value and, thus, zero EEPE estimated by the model (assuming low volatility). Non-internal methods have PFE Add-on based on notional (which is always positive) and zero replacement cost. Thus, we can conclude that IMM saves capital for trades with negative present value and market factors with low volatility.

Additionally, IMM can fully take into account future collateral payments (margining agreement) in contrast to SM and CEM, which does not recognize margining as was mentioned above. We consider decrease of EAD up to 80% for trades with monthly margining period and up to 98% for trades with 2-days margining period under IMM.
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**Figure 9.** EAD computed using different methods (CEM EAD on horizontal axis).

**Standardized and IRB RWA**
To understand principal difference between Standardized and IRB methods of computing RW, we consider result given in the next table. An expected result is smaller RWA for IRB method. Main reason for this is that IRB method employs more sophisticated technique which captures counterparty-specific default and recovery rates. Moreover, unrated counterparties (which has highest risk weight in Standardized method) with PD models based on CDS spread or Bond yield are assigned with risk weight based on market expectation, thus, significantly reducing RWA.

<table>
<thead>
<tr>
<th>Method</th>
<th>RWA Std.</th>
<th>RWA IRB</th>
<th>Charge Std.</th>
<th>Charge IRB</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEM</td>
<td>45.4</td>
<td>27.3</td>
<td>3.6</td>
<td>2.2</td>
</tr>
<tr>
<td>SM</td>
<td>65.5</td>
<td>41.2</td>
<td>5.2</td>
<td>3.3</td>
</tr>
<tr>
<td>IMM</td>
<td>46.1</td>
<td>27.4</td>
<td>3.7</td>
<td>2.2</td>
</tr>
<tr>
<td>NIMM</td>
<td>62.4</td>
<td>37.0</td>
<td>5.0</td>
<td>3.0</td>
</tr>
</tbody>
</table>

**Standardized CVA**
The table below presents results for CVA capital charge for each of methods. Similarly to findings for default CCR capital charge, CVA capital charge obtained by IMM is significantly lower than the one obtained by NIMM and SM. This result can be attributed to calculation methodology, as the major drivers for CVA capital charge are the EAD and the weight applicable to counterparty (selected based on its rating). Also, note that CVA capital charge is comparable in size to the default capital charge under Standardized RW from the previous table.

<table>
<thead>
<tr>
<th>Method</th>
<th>CVA RWA</th>
<th>CVA Capital Charge</th>
<th>Total Charge</th>
<th>CVA Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEM</td>
<td>36.3</td>
<td>2.9</td>
<td>6.5</td>
<td>44.6%</td>
</tr>
<tr>
<td>SM</td>
<td>61.2</td>
<td>4.9</td>
<td>10.1</td>
<td>48.5%</td>
</tr>
<tr>
<td>IMM</td>
<td>46.3</td>
<td>3.7</td>
<td>7.4</td>
<td>50.0%</td>
</tr>
<tr>
<td>NIMM</td>
<td>65.0</td>
<td>5.2</td>
<td>10.2</td>
<td>51.0%</td>
</tr>
</tbody>
</table>

**Conclusion**
In this paper we discussed Basel II and III approaches for Credit Risk capitalization. We summarized steps to compute Exposure at Default using Non-internal and Internal models; described methods to translate exposure into capital using standardized and advanced methods.

Demonstration of Default Risk and CVA risk capitalization on sample portfolio of derivatives showed that internal models take more advantages from netting and margining for capitalizing.
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References


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