An Enhanced Initial Margin Methodology to Manage Tail Credit Risk

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September 24, 2019
Agenda

1. Background: Counterparty Risk and Initial Margin
2. Motivation: Initial Margin before and after UMR
3. Methodology
4. Model Calibration
5. Results
6. Conclusion
7. Questions
8. PART 2: Working as a Quant
Disclaimer

The opinions expressed on this presentation are solely those of the authors and not necessarily those of their employers.
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8. PART 2: Working as a Quant
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The idea is to reduce the Exposure to a counterparty

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**The Role of Variation and Initial Margin**

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- **Initial Margin** – In the event of a default, the surviving firm could face losses resulting from an increase in replacement costs from the time of default to the time when the positions are unwound or replaced (i.e. the “MPoR”).
How is Initial Margin calculated?

Figure: Pic courtesy of the Tokyo Stock Exchange
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An example would look like this:

<table>
<thead>
<tr>
<th>TIER</th>
<th>CLIENT RATINGS / FIRM VIEW</th>
<th>IM BEFORE UMR</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Solid rating - big firms</td>
<td>0</td>
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<td>2</td>
<td>Smaller firms</td>
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Everyone posts the same IM and everyone has CVA ≈ 0

Table: CVA for different collateralization schemes for an at-the-money swap.

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<tr>
<th>Rating</th>
<th>Prob default (basis points)</th>
<th>Notional</th>
<th>Uncollateralised CVA</th>
<th>Collateralised CVA (VM)</th>
<th>Collateralised CVA (VM-IM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA</td>
<td>1</td>
<td>$1,000,000</td>
<td>$8,238</td>
<td>$98</td>
<td>$0.02</td>
</tr>
<tr>
<td>CCC</td>
<td>2682</td>
<td>$1,000,000</td>
<td>$570,198</td>
<td>$9,152</td>
<td>$0.25</td>
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Table: Figures in US dollars
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What are the incentives to trade with smaller counterparties, then?
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We define an add-on to the current IM that compensates for the credit risk of counterparty $j$.

$$IM^j_{specific} = IM_{general} + IM^j_{add-on}$$

(3)

where $IM_{general}$ accounts for the gap risk without any consideration on the credit quality of the counterparty (e.g. SIMM), and $IM^j_{add-on}$ is the add-on that is specific to the counterparty’s $j$ credit spread.
A Methodology to Improve Initial Margin

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- We express \( IM_{\text{add-on}}^j \) as a proportion of the \( IM_{\text{general}} \) giving us

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IM_{\text{specific}}^j = IM_{\text{general}} + \alpha^j IM_{\text{general}}
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As an example, an AAA-rated counterparty will always have to post \( IM_{\text{general}} \) (i.e. SIMM), while the rest will have to post \( IM_{\text{general}} + \alpha^j IM_{\text{general}} \).
The IM Add-on

- The graph below shows the proposed IM components: a “base” IM as given by for example SIMM, and the proposed add-on, given by the credit rating differentials.

- This is a simplified example with a single Swap on the netting set.

- We can see that the proposed add-on is significant. This means, that the tail risk not considered in SIMM is material for lower-rated counterparties.
The total IM requested to a party should compensate for 2 risks:

- Risk of defaulting – as given by the probability of default
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The values of \( \alpha^j \) are computed by equating the CVA of the counterparty in question (say CCC) with the CVA of the AAA-counterparty. We solve for the \( \alpha^j \) such that:

\[ CVA^{AAA}(PD_{AAA}) = CVA^{CCC}(PD_{ccc}, \alpha^j) \]
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\[ CVA^{AAA}(PD_{AAA}) = CVA^{CCC}(PD_{ccc}, \alpha^J) \]  \hspace{1cm} (6)

In this way, each counterparty will be equivalent to a AAA one from a credit-risk worthiness.
In practice, we solve numerically for $\alpha^j$ in the following equation:

$$
\mathbb{E} \left[ \int_0^T (V_t - VM_t - IM_t)^+ LGD_t PD_{t}^{AAA} DF_t dt \right] - \mathbb{E} \left[ \int_0^T (V_t - VM_t - IM_t - \alpha^j IM_t)^+ LGD_t PD_{t}^j DF_t dt \right] = 0 \quad (7)
$$

The value $\alpha^j$ that solves Equation 7 is used in Equation 6 (reproduced below) to determine $IM_{\text{add-on}}^j$ for Counterparty $j$ and compute today’s $IM_{\text{specific}}^j$.

$$IM_{\text{specific}}^j = IM_{\text{general}} + \alpha^j IM_{\text{general}} \quad (8)$$
Numerical Example - 5Y Libor Swap

- We compare the adjusted IM requirements against SIMM. We first present results for a single trade,

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Table: Specific Initial Margin = General IM + Add-On
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For comparison Below are SIMM’s risk weights for *regular currencies*

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<th>3m</th>
<th>6m</th>
<th>1y</th>
<th>2y</th>
<th>3y</th>
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Numerical Example - Portfolio of Swaps

Below we present an example of the method for a portfolio of Libor Swaps. The portfolio composition is as follows:

<table>
<thead>
<tr>
<th>Swap maturity</th>
<th>Notional</th>
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<tbody>
<tr>
<td>3Y</td>
<td>1 Million</td>
</tr>
<tr>
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</tr>
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<td>7Y</td>
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IM ADD-ON values per rating and maturity

<table>
<thead>
<tr>
<th></th>
<th>AAA</th>
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<th>BBB</th>
<th>BB</th>
<th>B</th>
<th>CCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>As dollar amount</td>
<td>0</td>
<td>1,064</td>
<td>10,398</td>
<td>23,436</td>
<td>36,956</td>
<td>41,046</td>
<td>43,924</td>
</tr>
<tr>
<td>As % over SIMM</td>
<td>0%</td>
<td>3%</td>
<td>28%</td>
<td>62%</td>
<td>98%</td>
<td>109%</td>
<td>116%</td>
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The table below shows the Total IM amount to post: SIMM + Add-on

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<tr>
<td>As dollar amount</td>
<td>37,802</td>
<td>38,866</td>
<td>48,200</td>
<td>61,238</td>
<td>74,758</td>
<td>78,848</td>
<td>81,726</td>
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- How does the model behave as the Portfolio changes?
- Example: take our dummy Portfolio and remove a trade.

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How much will SIMM change? Change in SIMM -25%

How much will the IM change under our method?

AAA SIMM
AA
A
BBB
BB
B
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As dollar amount: 28,449, 29,301, 33,179, 44,747, 55,389, 60,502, 62,746
As % over SIMM: -25%, -25%, -27%, -26%, -23%, -23%

We can see that the changes on the IM per credit cohort are in line with changes in SIMM. The method does not present big jumps in IM.
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As opposed to the current CVA amounts which are negligible, we have shown that the extra IM required is significant specially for the lowest rated counterparties.
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Insights on the Quant Profession

- Which are the skills required?
  - Skills to get the interview
  - Skills to get the job
  - Skills to get promoted

- Areas where quant skills are required.
  - Pricing Analysts, Risk Analyst, Traders, Quantitative Developer, Data Scientist, among others.
  - We’ll describe them further on the next slide
Areas where quant skills are required

- Pricing Analysts (i.e. Front Office Quants)
  
  What they do: Work on developing pricing formulas and numerical methods for new products.
  
  Knowledge required: Hard-core stochastic calculus is required ideally at PhD level. Mathematicians, engineers etc. are considered.
  
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- Risk Analyst
  
  What they do: Work on risk measurement for the Bank's inventory of products
  
  Knowledge required: Stochastic calculus is required at MSC/PHD level. Additionally, Statistics and Econometrics are used.
  
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- Traders
  
  What they do: Trade products and makes investment decisions. Decides how much risk to take on behalf of the Bank.
  
  Knowledge required: Skillset required is very broad, from MBA to maths. Can be engineering and statistics as well.
  
  Programming skills are not so relevant.
  
  Connections are key.

- Quantitative Developer
  
  What they do: Usually does not develop models but implement and industrialize them following the directives from the Front Office or Risk quants.
  
  Knowledge required: Solid programming skills are a must. Degrees in Computer Science or Engineering are the best suited for these roles.
  
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