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Portfolio Margin Methodology

Initial margin methodology applied for the interest rate derivatives market.

1. Background

Initial margin (IM) represents the primary prefunded line of defence for JSE Clear (JSEC) in managing the risks associated with clearing financial instruments. IM is calculated at an individual account level, and the IM posted against the exposures held in a particular account can only be used to satisfy the losses incurred in liquidating the positions held in said account, in the event of default. The aim of this document is to clearly specify the methodology used by JSEC when calculating account-level IM requirements in the interest rate derivatives (IRD) market.

An overview of the account level IM calculation is as follows:

1. Calculate the Value-at-Risk (VaR) for a particular account using the following parameters:

VaR Methodology	Confidence Interval	Liquidation Period	Look-Back Period
Historical VaR	99.7%	2-days	Rolling 750-day plus stressed 250-day

2. Calculate the cost, as it relates to the number of basis points away from mid-market rates, that would be incurred when liquidating all positions within the particular account;
3. Calculate the profit and loss for the particular account under a series of what-if scenarios, designed to estimate the extent to which the account could incur losses if historically observed correlation patterns break down; and finally
4. The account level IM is estimated as the smallest (most negative) of the following:
    a. The sum of the VaR and liquidation cost calculated in steps 1 and 2 above; and
    b. The smallest (most negative) loss calculated under the set of what-if scenarios calculated in step 3.

2. Notation

The following notation is adhered to throughout this document:

- D: An arbitrary date on which calculations are based;
- m: The total number of clearable instruments in the IRD market on day D;
- α: The confidence level used by JSEC when calculating VaR;
- μ: The liquidation period (margin period of risk) used by JSEC when calculating VaR;
- n: The number of observations used when calculating VaR;
- χ: The number of netting sets in the IRD market. Under the JSEC's VaR framework, IM netting is only allowed for instruments within the same netting set. Each contract can belong to one and only one netting set;
- Pos^{close}: The $[m \times 1]$ vector representing an arbitrary market participant's portfolio on day D;
- Pos^{χ}: The $[m \times \chi]$ matrix representing an arbitrary market participant's portfolio on day D, with cell (i, j) representing the participants net position in contract i, multiplied by the value 1 if the contract belongs to netting set j, and 0 otherwise.
- PV01: The profit and loss (PnL) for a particular instrument and/or account associated with a one basis point parallel shift in the yield curve.

3. The VaR calculation steps

The account level VaR calculation consists of the following steps:

1. Calculate the $[\boldsymbol{n} \times \boldsymbol{m}]$ contract level profit and loss (PnL) matrix, $\boldsymbol{PL^{contract}}$, with cell $(\boldsymbol{i}, \boldsymbol{j})$ representing the PnL associated with holding a long position in contract $\boldsymbol{j}$, under observation $\boldsymbol{i}$ in the look-back period;
2. Calculate the $[\boldsymbol{n} \times \boldsymbol{\chi}]$ account level PnL matrix, $\boldsymbol{PL^{account}}$, as the product of $\boldsymbol{PL^{contract}}$ and $\mathbf{Pos}^{\chi}$. Element $(\boldsymbol{i}, \boldsymbol{j})$ of $\boldsymbol{PL^{account}}$ thus represents the account level PnL for netting set $\boldsymbol{j}$, associated with observation $\boldsymbol{i}$ in the look-back period;
3. Calculate the $[\mathbf{1} \times \boldsymbol{\chi}]$ account level netting set VaR vector, $\boldsymbol{VaR^{net}}$, with element $\boldsymbol{i}$ calculated as the $(\mathbf{1} - \boldsymbol{\alpha})^{\boldsymbol{th}}$ percentile of the $\boldsymbol{i^{th}}$ row of $\boldsymbol{PL^{account}}$; and finally
4. Calculate the account level VaR estimate, $\boldsymbol{VaR^{account}}$, as the sum of all elements in $\boldsymbol{VaR^{net}}$.

Element (i, j) of $PL^{contract}$ is calculated by considering the extent to which the Mark-to-Market price of instrument j would change under the μ-day curve shift observed for day i in the look-back period. The exact pricing formulas used to revalue all cleared instruments are beyond the scope of this document. However, participants who wish to estimate account level IM requirements should note that the will JSE always publish the latest version of $PL^{contract}$ on its website. Furthermore, any amendments to $PL^{contract}$ will be published via an official JSE market notice at least 1-day prior to implementation.

The following represents a formulaic description of the above calculation steps, assuming $PL^{contract}$ is given:

$$PL^{account} = PL^{contract} \times \mathrm{Pos}^{\chi} \tag{1}$$

$$VaR^{net} = \{x \colon x_i = perc(PL_i^{account}; 1 - \alpha)\ \forall\ i = 1,2, \ldots\ \chi\}, \tag{2}$$
where $PL_i^{account}$ represent column i in $PL^{account}$.

$$VaR^{account} = \sum_{i=1}^{\chi} VaR^{net}(i) \tag{3}$$

4. Concentration margin

A key component of an IM methodology is its ability to incorporate the costs associated with liquidating a defaulting portfolio. To this end, JSEC's the account level IM methodology for interest rate derivatives applies a more punitive IM requirement (in relative terms) for large positions than for small positions, in order to acknowledge the higher liquidation costs typically associated with large positions.

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The PV01 ladder

The account level concentration margin calculation depends on the calculation of an account level *“PV01 ladder”*; positions (expressed in PV01 terms) in a set of standardized underlying instruments which can be used to replicate the market risk profile of a particular account. The calculation of the PV01 ladder for a particular account is as follows:

1. Determine the set of instruments $[\boldsymbol{x_1}, \boldsymbol{x_2}, \ldots, \ \boldsymbol{x_\theta}]$ which will define all PV01 ladders for all accounts in the interest rate derivatives market (this set will be published by the JSE)
2. Calculate the $[\boldsymbol{\theta} \times \boldsymbol{n}]$ contract level PV01 matrix, $\boldsymbol{PV01^{contract}}$, where element $(\boldsymbol{i}, \boldsymbol{j})$ represents the PnL for tradeable contract $\boldsymbol{j}$, associated with a one basis point change in the mark-to-marked yield of instrument $\boldsymbol{i}$ in the hedge equivalent set; and finally
3. Calculate the $[\boldsymbol{\theta} \times \mathbf{1}]$ account level PV01 ladder, $\boldsymbol{PV01}^{\ \boldsymbol{account}}$, as:

$$PV01^{\ account} = PV01^{contract} \times \mathrm{Pos}^{close} \tag{4}$$

Participants who wish to estimate account level IM requirements should note that the will JSE always publish the latest version of $PV01^{contract}$ on its website. Furthermore, any amendments to $PV01^{contract}$ will be published via an official JSE market notice at least 1-day prior to implementation.

The bid-offer estimate

Each element in $PV01^{\ account}$ will have an associated bid-offer estimate, $BidAsk^{account}$, representing an estimate of the bid-offer double which would typically be observed when executing a position of that size, in that particular hedging instrument. Each element of $BidAsk^{account}$ will be calculated using the following equation:

$$BidAsk^{account}(i) = \beta_i \left[\delta_i^{|PV01^{\ account}(i)| \lambda_i} \right] \tag{5}$$

where β, δ and λ are concentration margin parameters, set at a hedging instrument level, and published on a daily basis on the JSE’s website. Any amendments to concentration margin parameters will be will be published via an official JSE market notice, at least 1-day prior to implementation. It should be noted that each element of $BidAsk^{account}$ is rounded to two decimal places.

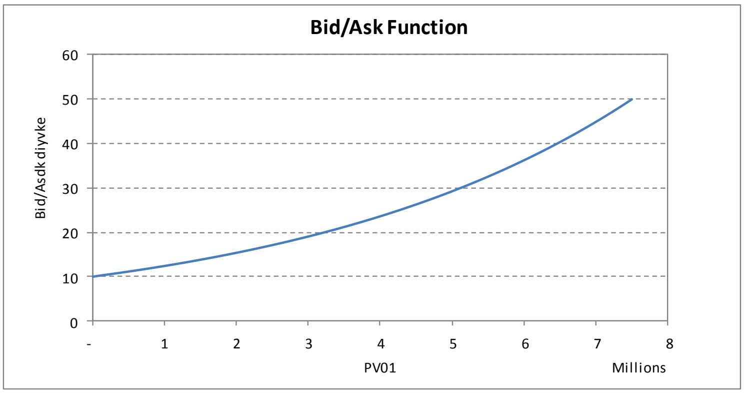

Figure 1: Example to illustrate the exponential nature of formula (5); as the PV01 increases, the bid/ask double associated with the position increases exponentially. Example calibrated with $\beta = 10, \delta = 2.8$, and $\lambda = 2.083 \times 10^{-7}$.

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The concentration margin calculation

Finally, the account level concentration margin, $Concentration^{account}$, is as follows:

$$Concentration^{account} = \sum_{i=1}^{\theta} \frac{1}{2} \times BidAsk^{account}(i) \times |PV01^{\ account}(i)| \quad (6)$$

5. Account level minimum margin requirements

In order to mitigate the extent to which a break-down in historically observed correlation patterns could cause losses in excess of IM, the JSE will require a minimum account level IM requirement. This is based on the PnL which would be observed for a particular account, under a set of prospective hypothetical scenarios. These scenarios take into the account the most basic curve moves (inter alia parallel moves, steepening and flattening) and include the a conservative estimate of liquidating a portfolio. These hypothetical scenarios are designed to act as a safety net, effectively enforcing a floor on the account level IM value.

Let υ represent the number of what-if scenarios to be considered on day D. The calculation of the account level minimum IM requirement is then as follows:

1. Calculate the $[\boldsymbol{\upsilon} \times \boldsymbol{m}]$ contract level scenario profit and loss matrix, $\boldsymbol{sPL^{contract}}$, with cell $(\boldsymbol{i}, \boldsymbol{j})$ representing the PnL associated with holding a long position in contract $\boldsymbol{j}$, under what-if scenario $\boldsymbol{i}$;
2. Calculate the $[\boldsymbol{\upsilon} \times \mathbf{1}]$ account level stressed PnL matrix, $\boldsymbol{sPL^{account}}$, as the product of $\mathbf{Pos}^{\boldsymbol{account}}$ and $\boldsymbol{sPL^{contract}}$. Element $(\boldsymbol{i})$ of $\boldsymbol{sPL^{account}}$ thus represents the account level PnL associated with what-if scenario $\boldsymbol{i}$;
3. Set the minimum account level IM requirement, $\boldsymbol{sIM^{account}}$, equal to the smallest element of $\boldsymbol{sPL^{account}}$.

Participants who wish to estimate account level IM requirements should note that the will JSE always publish the latest version of $sPL^{contract}$ on its website. Furthermore, any amendments to $sPL^{contract}$ will be published via an official JSE market notice at least 1-day prior to implementation.

The following represents a formulaic description of the above calculation steps, assuming $sPL^{contract}$ is given:

$$sPL^{account} = sPL^{contract} \times \mathrm{Pos}^{account} \quad (7)$$

$$sIM^{account} = \min_{i=1,2\dots,\upsilon} sPL^{account}(i) \quad (8)$$

6. The account level IM calculation

Finally, after performing the account level VaR, concentration IM, and minimum IM calculations, the account level IM value, $IM^{account}$, can be calculated as follows:

$$IM^{account} = -1 \times \min(VaR^{account} + Concentration^{account}, sIM^{account}) \quad (9)$$

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Appendix A: Example

Consider an arbitrary market participants portfolio in interest rate derivatives on day D:

Instrument Code	Instrument Type	Expiry Date	Unique Instrument ID	Closing Position
R186	Bond Future	May-17	May-17 R186	100
R209	Bond Future	May-17	May-17 R1209	(200)
R202	Bond Future	May-17	May-17 R202	350
IS05	Swap Future	June-17	June-17 IS05	500

Instrument data

Assume $PL^{contract}$ on day D is as follows:

Observation Date	May-17 R186	May-17 R209	May-17 R202	June-17 IS05
1-June-2008	(1,000)	(1,200)	50	800
2-June-2008	500	650	100	-100
⋮				
$D-1$	(600)	(900)	(300)	500

and that the netting sets to which each instrument belongs are as follows:

Instrument Code	Netting Set
R186	SA Sovereign
R209	SA Sovereign
R202	SA Linkers
IS05	SA Interbank

Furthermore, assume the hedging set for day D, together with the associated concentration margin parameters: :

Hedging Instrument	β	δ	λ
R186	10	2.8	2.083×10^{-7}
R209	10	2.8	2.083×10^{-7}
R202	10	2.8	2.083×10^{-7}
4-Year Swap	10	2.8	2.083×10^{-7}
5-Year Swap	10	2.8	2.083×10^{-7}
6-Year Swap	10	2.8	2.083×10^{-7}

Assume $PV01^{contract}$ is as follows:

Hedging Instrument	May-17 R186	May-17 R209	May-17 R202	June-17 IS05
R186	(70)	0	0	0
R209	0	(70)	0	0
R202	0	0	(32)	0
4-Year Swap	0	0	0	40
5-Year Swap	0	0	0	100
6-Year Swap	0	0	0	30

And that $sPnL^{contract}$ is is as follows:

Scenario	May-17 R186	May-17 R209	May-17 R202	June-17 IS05
Curve up 100	(7,000)	(7,000)	(3,200)	10,000
Curve down 100	7,000	7,000	3,200	(10,000)

Calculations

Pos^{χ} will be represented as follows:

Instrument	SA Sovereign	SA Linkers	SA Interbank
May-17 R186	100	0	0
May-17 R209	(200)	0	0
May-17 R202	0	350	0
June-17 IS05	0	0	500

From where It follows that $PL^{account}$ is given by (equation 1):

SA Sovereign	SA Linkers	SA Interbank
140,000	17,500	400,000
(80,000)	35,000	(50,000)
-	-	-
120,000	(105,000)	250,000

Assume that when ranked (each column ranked individually) from smallest to largest, the columns of $PL^{account}$ are as follows:

SA Sovereign	SA Linkers	SA Interbank
(260,000)	(140,000)	(400,000)
(200,000)	(130,000)	(370,000)
(180,000)	(120,000)	(360,000)
⋮	⋮	⋮

It follows that under a 99.7% confidence interval (equation 2):

$$VaR^{set} = [(180{,}000), (120{,}000), (360{,}000)],$$

from where it follows that (equation 3) :

$$VaR^{net} = (660{,}000) = (180{,}000) + (120{,}00) + (360{,}00).$$

From (equation 4) we have that $PV01\ ^{account}$ is given by:

Hedging Instrument	PV01	$\frac{1}{2} \times BidAsk^{account}(i)$	$\frac{1}{2} \times BidAsk^{account}(i) \times \lvert Pv01 \rvert$
R186	(7,000)	5.01	(35,070)
R209	14,000	5.02	70,280
R202	(11,200)	5.01	(56,112)
4-YearSwap	20,000	5.02	100,400
5-YearSwap	50,000	5.05	252,500
6-YearSwap	15,000	5.02	75,300

It follows (equation 6) that $Concentration^{account} = (589{,}9662)$.

Finally, (equation 7) implies that:

Scenario	May-17 R186
Curve up 100	4,580,000
Curve down 100	(4,580,000)

Finally, it follows from (equation 8) that $sIM^{account} = (4{,}580{,}000)$, from where it follows that:

$$IM^{account} = -1 \times \min\big((589{,}9662) + (660{,}000), (4{,}580{,}000)\big) = 4{,}580{,}000.$$