Initial Margin Methodology for Interest Rate Derivatives

Methodology Document

May 2019

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 base IM requirements (i.e. excluding any potential large exposure IM add-ons)[1] in the interest rate derivatives (IRD) market.

THE BASE LEVEL IM CALCULATION

The base level IM calculation consists of two distinct components:

- $\mathrm{PFE}^{\mathrm{mid}}$, which estimates the extent to which the Mark-to-Market (MtM) exposure of a particular participant's portfolio could change over an assumed liquidation period; and
- $\mathrm{PFE}^{\mathrm{double}}$, which estimates the losses that could be incurred as a result of closing/unwinding positions away from mid-market rates (i.e. the impact of a bid/ask spread).

It follows that:

$$\mathrm{IM}^{\mathrm{base}} = \mathrm{PFE}^{\mathrm{mid}} + \mathrm{PFE}^{\mathrm{double}} \qquad (1)$$

2.1 The $\mathrm{PFE}^{\mathrm{mid}}$ calculation

The $\mathrm{PFE}^{\mathrm{mid}}$ measure is estimated through the use of a historical Value-at-Risk (VaR) framework supplemented with a series of prospective stress scenarios - specifically designed to mitigate the risk associated with a break-down in historically observed correlation patterns. In particular:

$$\mathrm{PFE}^{\mathrm{mid}} = \max(\mathrm{VaR}, \mathrm{sLoss}), \qquad (2)$$

where sLoss represents the absolute value of the worst loss that the particular participant could incur after considering all of the abovementioned correlation-break scenarios, and VaR represents the absolute value of the participant's portfolio level VaR metric.

The algorithm underlying the sLoss calculation for a particular participant is as follows:

1. For each contract create a profit and loss vector, sPnL , with each element representing the PnL associated with a single, long position in the particular contract, under a particular curve shift scenario[2];
2. Calculate the net position level sPnL vector for a particular participant by multiplying said participant's net closing position in each contract by the relevant sPnL vectors calculated in step 1;
3. Calculate account level sPnL vector for the particular participant by aggregating all of the position level sPnL vectors calculated in step 2; and finally
4. Estimate $\mathbf{sLoss}$ as the absolute value of the worst loss associated with in the account level sPnL vector calculated in step 3.

[1] As per JSE Clear's IM methodology document: IM Methodology. This document should, however, be read in JSE Clear's IM methodology document.

[2] For bond index futures, each element of **s**PnL are assumed to be zero.

A summary of the scenarios used to estimate contract level $\mathbf{s}$PnL vectors is as follows

Scenario types	Prospective what-if scenarios[3]
Curves used	JSE Zero Coupon Yield Curves.
Type of curve shifts applied	Relative curve shifts.
Volatility scaling applied (Y/N)	No
Parameter recalibration frequency	Weekly

Table 1: Parameters underlying $\mathbf{s}$PnL *calculations.*

The VaR calculation, on the other hand, is performed per account, per netting set; where a netting set is defined by a group of instruments exposed to the same risk driver. As an example, all futures linked to the South African Zero-Coupon Government Bond Curve could form part of particular netting set, whilst all futures linked to the South African Inflation-Linked Zero-Coupon Government Bond Curve could form part of a separate netting set. The reference data illustrating the netting sets to which each contract belongs is published here.

The algorithm underlying the VaR calculation a for a particular participant's position in a particular netting set is as follows:

1. For each contract within the particular netting set, create a profit and loss vector, PnL , with each element representing the PnL associated with a single, long position in the particular contract, under a particular curve shift scenario;
2. Calculate the net position level profit and loss vector for a particular participant by multiplying said participant's net closing position in each contract within the specific netting set by the relevant PnL vectors calculated in step 1;
3. Calculate the netting set level PnL vector for the particular participant by aggregating all of the position level PnL vectors calculated in step 2; and finally
4. Estimate VaR_i, the value-at-risk associated with the participant's positions in contracts belonging to netting set i, as the absolute value of the element in the netting set level PnL vector which corresponds to JSE Clear's chosen confidence level.

Finally, the participants portfolio level VaR is calculated as:

$$\mathrm{VaR} = \sum \mathrm{VaR}_i \qquad (3)$$

Where the summation is taken across all netting sets. The logic underlying the use of netting sets is to limit reductions in IM as a result of opposite positions in contracts which fundatmentially different risk drivers.

[3] See Appendix A for an in depth description of the calibration framework underlying these scenarios.

A summary of the scenarios used to arrive at the contract level PnL vectors is as follows

Scenario types	Historical scenarios
Curves used	JSE Zero Coupon Yield Curves.
Type of curve shifts applied	Relative curve shifts.
Volatility scaling applied (Y/N)	No
Parameter recalibration frequency	Weekly
Look-Back period used for historical scenarios	Rolling 3-year period supplemented with the most extreme 1-year stressed period observed during the past 10 years[4].
Current stressed period	4-August-2015 to 2-August-2016
Stressed period review frequency	Annual

Table 2: Parameters underlying contract level parameter calculations.

THE PFE^{DOUBLE} CALCULATION

The PFE^{double} measure is estimated through the use of a market survey whereby market participants are requested to indicated the bid/ask spreads typically associated with positions in various sizes. More specifically, each participant is asked to provide an estimate of the bid/ask spread that would be applicable when executing a trade in a particular underlying, for a series of potential trade sizes (measured in terms of PV01), under stressed market conditions.

Bond/PV01	$[-\infty; -1m)$	$[-1m; -0.5m)$	$[-0.5m; 0)$	$[0; 0.5m)$	$[0.5m; 1m)$	$[1m; \infty)$
R186	20	10	4	4	10	20
R209	30	15	8	8	15	30
R213	30	15	8	8	15	30
R214	40	20	10	10	20	40

Table 3: Example of the market polling survey used to calibrate PFE^{double}.

As an example, a value of 4 in the $[-0.5m; 0)$ bucket for the R186 indicates that a bid/ask spread of 4bps would typically be applicable when executing a trade in the R186 with a PV01 of less than zero but more than –R500k, under stressed market conditions.

Once all feedback has been collated, the JSE calibrates $\theta^i(x)$; a function which estimates the bid/ask spread applicable when executing a position of size x (expressed in terms of PV01) in the i^{th} underlying. The calibration is performed by averaging the feedback per PV01 bucket, after removing outliers.

[4] Seen Appendix B for clarification on how the most extreme period is defined. The JSE can extent the historical period to be considered if, in its sole discretion, it deems such an extension to be appropriate.

Once θ is calibrated, $\mathrm{PFE}^{\mathrm{double}}$ is estimated as follows:

$$\mathrm{PFE}^{\mathrm{double}} = \sum_{i=1}^{n} \frac{1}{2} \left|\mathrm{PV01}^{i}\right| \times \theta^{i}(\mathrm{PV01}^{i}), \quad (4)$$

where:

- $\mathrm{PV01}^{i}$ represents the change in the value of the particular participant's closing position in the i^{th} underlying instrument, under a scenario where the entire zero curve moves up in parallel by one basis point. For bond index futures, $\mathrm{PV01}^{i}$ is taken to be 0.

Parameter recalibration frequency	PV01 estimates per underlying are recalibrated every week, alongside contract level PnL vectors. Market poll to estimate θ is conducted quarterly.
Treatment of outlier in the market polling exercise	Averaging is performed after removing the 2 highest, and 2 lowest contributions per underlying, per PV01 bucket.
Position netting	Netting applied across expiry dates to arrive at a single exposure to each underlying instrument[5]

Table 4: Parameters underlying the $\mathrm{PFE}^{\mathrm{double}}$ *calculation.*

[5] Options are converted to their delta equivalent futures positions, whilst bond index futures are excluded from this calculation.

APPENDIX A: PROSPECTIVE SCENARIOS

It should be noted that the aim of the prospective scenarios is specifically to mitigate the risk associated with a break-down in historically observed correlation patterns. The aim of these scenarios is not to capture the impact of extreme but plausible parallel shifts in the yield curve, as these should be captured by the historical set of stressed scenarios. Against this backdrop, the prospective scenarios are designed by considering various curve shifts that would be possible, if certain sections of the yield curve were to change independently of one another. The exact logic underlying the selection criteria is discussed below.

Assume that the yield curve can be defined by linearly interpolating the zero coupon rates observed at the following anchor tenors (measured in years): $t = \{\frac{1}{365}; 0.25; 1; 2; 5; 10; 20; 30\}$. Furthermore, assume that over an $n - day$ period, where n denotes the chosen liquidation period for the interest rate derivatives market, each of the zero coupon rates corresponding to the above anchor points can either move up by 60[6] bps, down by 60 bps, or remain unchanged, and that the change observed in the zero coupon rate corresponding to a particular tenor is independent of that observed for any other tenor. It follows that $3^8 = 6{,}561$ curve shifts are possible over an $n - day$ period:

Scenario	$t = \frac{1}{365}$	$t = 0.25$	$t = 1$	$t = 2$	$t = 5$	$t = 10$	$t = 20$	$t = 30$
1	+60	+60	+60	+60	+60	+60	+60	+60
2	+60	+60	+60	+60	+60	+60	+60	-60
3	+760	+60	+60	+60	+60	+60	+60	+0
⋮								
6,559	-60	-60	-60	-60	-60	-60	-60	+60
6,560	-60	-60	-60	-60	-60	-60	-60	-60
6,561	-60	-60	-60	-60	-60	-60	-60	+0

Table 5: Prospective yield curve shifts scenarios, defined as absolute shifts and to be applied using linear interpolation.

[6] Chosen by considering the 99.7th percentile change of the $3 - day$ changes that have historically been observed in the individual zero coupon rates.

APPENDIX B: STRESS PERIOD CALIBRATION

The historical stressed period to be included in the sample of scenarios used to quantify PFE^{mid} is determined by considering the rolling 30-day realized volatility for the benchmark bond, as implied by the prices derived from historically observed zero coupon yield curves. In particular, the stressed period is defined by considering the 12-month window adjacent to the date on which the maximum volatility was observed.

From Figure 1 it can be seen that the maximum 30-day realized volatility for the R186 was observed on 26-January-2016. Accordingly, the stressed period is defined as the period from 4-August-2015 to 2-August-2016.

If the stressed period (or any part of it), as defined above, falls within the rolling historical look-back period, the stressed period is adjusted to avoid the overlap. In particular, the stressed period is adjusted such that:

1. The stressed period ends on the first date preceding the date on which the overlap starts; and
2. The stressed period starts 250 business days prior to the date calculated in step 1.

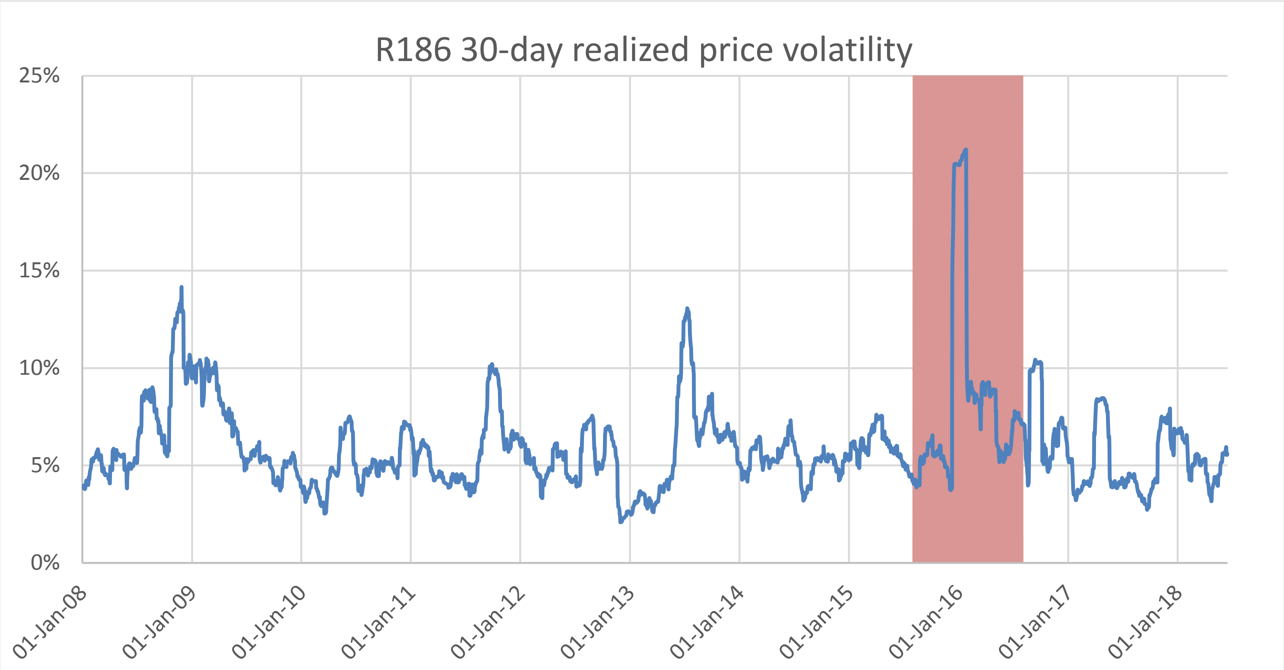

Figure 1: Justification for the chosen historical stressed period to be used when calculating PFE^{mid}.