LCH The Markets' Partner

ForexClear
Liquidity Risk Margin: LRM
Methodology Document

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1. Purpose

This document is a technical information specification for ForexClear's *Liquidity Risk Margin* ("*LRM*") add-on. This document provides full details of the *LRM* methodology, specifically focused on foreign exchange non-deliverable forward ("NDF") contracts.

2. Overview

ForexClear is a foreign exchange clearing service for inter-bank and client clearers. ForexClear currently clears OTC foreign exchange non-deliverable forward ("NDF") contracts.

Initial Margin ("IM") is collected from each ForexClear member to cover the potential losses arising from a member's portfolio over a specified close-out period under prevailing market conditions. It represents the potential market risk on any open position. It is called regularly throughout the day and is used to cover an estimate of the worst probable potential future losses in the event of default of a clearing house member, given normal market conditions.

ForexClear IM is calculated using the *FxPAR ("Foreign Exchange Portfolio Analysis and Risk")* methodology based on a five-day holding period for House accounts (seven-day holding period for Client accounts) and an Expected Shortfall tail measure reflecting a minimum confidence level of 99.7%, consistent with LCH Board risk appetite. The model uses approximately ten years (2500 scenarios) of historical market to simulate potential changes in portfolio value. An estimate of potential loss is calculated based on the average of the 7 worst case simulated losses, which reflects a minimum confidence level of 99.7%.

IM measures are based on closing out portfolios within a market's trading capacity. However should a position be very large and beyond the normal market capacity, additional measures are required to deal with this liquidity risk. The *LRM* represents an additional margin that is called due to portfolio liquidity risk that could materially increase the costs incurred in resolving a default management process.

Where a member has an exposure above set thresholds in a particular currency, a multiplier is applied to the balance and an additional call is made. These thresholds are reviewed by Risk Management on a quarterly basis and take into account prevailing perceptions of market conditions.

3. Methodology

3.1 Default Management Context

In a default management process, the defaulted member's portfolio is liquidated through hedging and then an auction procedure.

The liquidity risk margin encapsulates the liquidity cost of hedging large/concentrated positions within the defaulter's portfolio or alternatively, the risk that hedging a position may take longer than five days to close out.

Hedging is performed as soon as a default is announced in order to minimise losses incurred on the defaulter's portfolio. The main purpose of the hedging carried out by the ForexClear Default Management Group ("DMG") is to reduce the FX spot delta, square some short dated and long dated cash flows as judged necessary by the DMG. While doing this, the DMG monitors the DV01 and ensures the interest rate risk figures stay reasonable. Thus the hedging is based on net delta across tenors, which is market practice for FX Non Deliverable Forwards.

By the end of the hedging phase, the underlying currency pair positions must be adequately hedged to ensure that levels of risk are sufficiently reduced to encourage member participation in auctions without requiring significant risk premia. Once a currency pair portfolio is adequately hedged, it will be put to auction during the relevant liquid hours for that currency.

An example of the liquidation of a portfolio during a default management firedrill can be found in Appendix B.

3.2 Model Approach

3.2.1 Portfolio level margin add-on

The Liquidity Margin (ΔIM) is an additional buffer to add on top of the Initial Margin (IM). This liquidity margin is considered as the cost of hedging and can be represented as follows:

$$\Delta IM = LRM * IM - IM$$

Whereby, LRM is the Liquidity Risk Multiplier.

The first step to compute this LRM is to split the portfolio in sub portfolios that contain all the trades relative to a given currency pair.

For each sub portfolio, we compute the Initial Margin per currency pair and a multiplier per currency pair ($IM_{ccypair}$ and $LRM_{ccypair}$).

The LRM is then given by:

$$LRM = \frac{\sum_{CcyPair} LRM_{CcyPair} \times IM_{CcyPair}}{\sum_{CcyPair} IM_{CcyPair}}$$

The calculation of the Initial Margin per currency pair is the standard calculation for Initial Margin (as per *FxPAR* Methodology).

The Liquidity Multiplier per currency pair ($LM_{ccypair}$) is defined in a pre-determined two dimensional grid. The two dimensions of this grid are the tenor across a range of net total Deltas per currency pair.

3.2.2 Setting up the two dimensional grid

DMG members agreed that the predefined thresholds size for emerging market currencies should start at $0m for all currencies, and be common to all currencies. They agreed on the following threshold to capture the liquidity jumps in the market where applicable

Trade Size (USD million)						
0-50	50-100	100-250	250-500	500-1000	1000-3000	>3000

Similar threshold will be defined for G10 currencies prior to go live.

Each quarter, LCH surveys members of the FXDMG and asks the following: "**Please provide your views on the slippage from mid point (in basis points) that would be incurred in executing the trades sizes indicated over one day under normal market conditions."**

The cost in basis points is requested for all currency pair, for all the predefined thresholds size across all the eligible tenors. These tenors are highlighted below:

Tenor
1W
1M
2M
3M
6M
9M
1Y
2Y

Therefore, grids by Delta threshold and by tenor could be built and stores the different bid/ask spreads for each currency. This grid is reviewed on a quarterly basis via a questionnaire sent out to the Default management group.

3.2.3 Relationship between liquidity risk and bid/ask spread

The liquidity multipliers enable LCH to hold additional margin for market conditions outside those captured in the initial margining process. Initial margin measures are based on closing out portfolios within a market's trading capacity at mid price, meaning that positions beyond market capacity are not being captured by this. The *FxPAR* approach is designed to give the clearing house a 5 day period (or 7 days for client accounts) to neutralize the risk of members' positions if they were to default. Liquidity multipliers mitigate the risk that a position may not be able to be closed within the assumed holding period and/or extra hedging costs may be incurred for trades above normal market capacity.

The bid/ask spread is the difference between the buying and the selling price for each risk factor. In effect, market makers always quote their assets/currencies/shares to provide two-way prices known as bid and ask. However, the mark-to-market, the IM and the sensitivities are computed in most of the risk management systems using the mid price. The assumption behind this is that the bid/ask spread for trades size below the maximum size the market can absorb is not significant and is quantifiable in the market. Therefore the impact incurred from using the mid price instead of the bid/ask price in risk management and hedging is immaterial.

On the other hand, for trade size that exceed the maximum size that the market can absorb, the bid/ask spread could be very large, fluctuates significantly and not always quantifiable. Hence, the liquidity multipliers allow to charge additional margin for these instances whereby the bid/ask spread are distorted and the market exceeds its capacity.

Finally, the bid/ask spread is a way to measure the liquidity risk and hence to determine the liquidity multipliers for different notional size up to the market daily turnover.

Based on the above, the liquidity multipliers will be applied as follows:

- The total net delta for a given currency pair expressed in USD is in the threshold
- The total net delta is further split across a term structure of tenors. The tenor that shows the maximum net Delta is the tenor used to locate the multiplier used in the liquidity grid.

3.2.4 Calculation of the Liquidity Multipliers at sub portfolio level

a) Economical approach

The Liquidity Margin (ΔIM) is an additional buffer to add on top of the Initial Margin (IM). This liquidity margin is considered as the cost of hedging and can be represented as follows:

$$\Delta IM = LRM * IM - IM$$

where LRM is the liquidity risk multiplier. Therefore,

$$LRM = \frac{\Delta IM}{IM} + 1$$

Given that ΔIM is materialized as being the hedging cost, the hedging cost is equal to the net Delta multiplied by the B/A spread. Therefore the equation above can be written as:

$$\boldsymbol{LRM = \frac{BA\ spread * Net\ Delta_{USD}}{IM_{USD}} + 1}$$

In effect, on the calibration date, the bid ask spread is rescaled by IM as a percentage of the Delta which encapsulates the risk factor volatility through the EWMA model. The bid ask spread volatility is therefore reflected in the following ratio (bid ask spread / IM%) and therefore presents a lower variance and provides more stability to the model. This ratio is calibrated quarterly to ensure accuracy.

b) Analytical approach

The liquidity Margin (ΔIM) is an additional buffer to add on top of the Initial Margin (IM). This liquidity margin is considered as the cost of hedging and can be represented as follows:

$$\Delta IM_{USD} = LRM * IM_{USD} - IM_{USD}$$

where LRM is the liquidity risk multiplier and can be written as:

$$LRM = \frac{\Delta IM_{USD}}{IM_{USD}} + 1$$

This can be written as:

$$LRM = 1 + \frac{\Delta IM_{USD}}{\Delta S_{CCY-USD}} \times \frac{\Delta S_{CCY-USD}}{IM_{USD}}$$

where,

$$\Delta S_{CCY-USD} = S_{CCY-USD,ask} - S_{CCY-USD,bid}$$

Assuming that the ratio $\frac{\Delta IM_{USD}}{\Delta S_{CCY-USD}}$ can be approximated as the net Delta in the NDF currency (δ_{ccy}), converting this in USD (δ_{USD}) one can write:

$$\frac{\Delta IM_{USD}}{\Delta S_{ccy-USD}} = \delta_{ccy} = \frac{\delta_{USD}}{S_{CCY-USD}}$$

We can then write the Liquidity Multiplier as:

$$\boldsymbol{LRM = 1 + \frac{\delta_{USD}}{S_{ccy-USD}} \times \frac{\Delta S_{CCY-USD}}{IM_{USD}}}$$

3.2.5 Calculation of the IM as a percentage of notional

Where each member's portfolio is different, and each currency traded has its own specificities, it is difficult to use a standard IM expressed in percentage of the exposure.

Therefore, on a monthly basis the risk management team is in charge of calculating the IM in percentage for each currency and tenor of the IMM matrices, for both buy and sell side of the distribution. As the side of the position is unknown at this stage and only one grid has been configured for each currency, the average of the IM buy and sell side is taken into account to calibrate the IM as a percentage of the exposure.

The IM % of Notional is calculated for each cell as the ratio of the IM of single $1million trade against each currency for each maturity corresponding to each tenor, as shown in the example in Table 4.1 below.

Table 4.1 - Example of IM % of Notional calculations for a given currency

Tenor	BUY/SELL	USDCNY
S/N	BUY	4.37%
	SELL	3.25%
1W	BUY	4.57%
	SELL	3.23%
1M	BUY	5.03%
	SELL	3.38%
2M	BUY	5.30%
	SELL	3.59%
3M	BUY	5.48%
	SELL	3.75%
6M	BUY	5.62%
	SELL	4.06%
9M	BUY	5.68%
	SELL	4.26%
1Y	BUY	5.38%
	SELL	4.30%
2Y	BUY	5.64%
	SELL	4.93%

The final IM% of Notional numbers are the average of the Buy/Sell IM % of notional for each tenor, as shown in the example in Table 4.2 below.

Table 4.2 - Example of Average IM % of Notional grid

Tenor	USDCNY
S/N	3.81%
1W	3.90%
1M	4.20%
2M	4.44%
3M	4.62%
6M	4.84%
9M	4.97%
1Y	4.84%
2Y	5.28%

4. Calibration of the LRM Multiplier Grid

4.1 Calibration Process

The multiplier grid calibration will be done per currency pair on a quarterly basis.

The ForexClear Risk Management team conducts a survey every quarter asking the traders of the DMG at member banks to provide the slippage in basis points (from mid points) for each currency and maturity eligible for Forexclear. An example for USD-CNY is shown in Table 4.3 below.

Table 4.3 - Example of slippage cost for USD-CNY

USD-CNY - Slippage from mid point in basis points						
Notional ($m)	**0 - 50**	**50 - 100**	**100 - 250**	**250 - 500**	**500 - 1000**	**1000-3000**
1W	5.0	7.0	10.0	12.0	15.0	25.0
1M	5.0	7.0	10.0	12.0	15.0	25.0
2M	5.0	7.0	10.0	12.0	15.0	30.0
3M	5.0	7.0	10.0	15.0	18.0	35.0
6M	5.0	10.0	12.0	16.0	20.0	30.0
9M	5.0	6.0	8.5	11.0	15.0	35.0
1Y	5.0	5.6	9.0	10.0	17.0	47.5
2Y	7.9	15.9	23.8	39.7	55.3	87.2

From the six members in the FXDMG, a minimum of four responses are required for each currency and tenor, and the median is taken from the available prices.

In parallel, the ForexClear Risk Management team perform a recalculation of the IM expressed in % of notional for each currency and tenor in the survey (as described in Section 3.2.5).

The median spreads and IM % of notional results will be used to compute the multiplier grids as per the relationship shown below:

$$LM = \frac{BA\ spread * Net\ Delta_{USD}}{IM_{USD}} + 1$$

If the total net delta for a given currency pair expressed in USD is above the maximum net delta, the multiplier used is the same as the previous tranche.

For example, based on the inputs shown in the tables above, the currency pair USD/CNY on the 6M tenor, the Bid/Ask spread provided by FXDMG for a net delta of $550m is 20bps and the IM_{USD}/*Notional* ratio is 1.51%. The Liquidity Multiplier is therefore equal to: 1+ 0.0020 / 0.0151 = 1.13

The intersection [500-1000; 6M] of the LRM grid for USD-CNY can then be updated as:

USD-CNY LRM Grid - Delta Thresholds (USD million)						
Notional ($m)	**0 - 50**	**50 - 100**	**100 - 250**	**250 - 500**	**500 - 1000**	**1000-3000**
1W						
1M						
2M						
3M						
6M					1.13	
9M						
1Y						
2Y						

This operation is repeated for each tenor and threshold to arrive at a complete LRM grid for the respective currency pair.

USD-CNY LRM Grid - Delta Thresholds (USD million)						
Notional ($m)	**0 - 50**	**50 - 100**	**100 - 250**	**250 - 500**	**500 - 1000**	**1000-3000**
1W	1.08	1.11	1.16	1.20	1.25	1.41
1M	1.06	1.08	1.12	1.14	1.18	1.30
2M	1.05	1.07	1.10	1.12	1.15	1.30
3M	1.04	1.06	1.08	1.13	1.15	1.30
6M	1.03	1.06	1.07	1.10	1.13	1.19
9M	1.02	1.03	1.04	1.06	1.08	1.20
1Y	1.02	1.03	1.05	1.05	1.09	1.26
2Y	1.02	1.05	1.08	1.14	1.20	1.32

4.2 Calibration Review

The liquidity multipliers are reviewed and adjusted frequently based on any changes in input to the calibration:

1. Monthly partial recalibration: The IM in % of notional is recalculated on a monthly basis the last Friday of the month and the liquidity multiplier grids are recalibrated based on the latest calculations.

2. Quarterly full recalibration: On a quarterly meeting three weeks before the quarterly DMG meeting, a questionnaire is sent out to the FXDMG members asking to provide the slippage in basis points for each currency, positions and tenors defined in the grids. On receipt of all 6 questionnaires, the IM % of notional matrices are calculated and the liquidity grids are recalibrated.

5. Appendix A – Example Spreadsheet

The attached spreadsheet contains an example of the LRM calculation.

LRM Example v4-0.xlsx

6. Appendix B – Firedrill illustration

In the context of default management process, the hedging is performed as soon as the default is announced to avoid LCH facing further risk. The main purpose of the hedging carried out by the DMG is to reduce the FX spot delta, square some short dated and long dated cash flows as judged necessary by the DMG. While doing this, the DMG monitors the DV01 as well makes sure the Interest Rate risk figures stay reasonable. Thus the hedging is based on net delta cross tenors which is market practice for FX Non Deliverable Forwards.

By the end of hedging, the defaulted member's portfolio must be sufficiently hedged to ensure that levels of risk are reduced sufficiently for members to feel able to participate in the auction. Hedged trades are included in the next available margin process and registered accordingly. Once a currency pair portfolio is hedged, it will be put to auction subject to the liquid hours in the specific market. If the initial auction fails or there is significant volatility during the auction, the DMG may carry out whatever additional hedging may be deemed appropriate.

Once the DMG has reduced/neutralised risk on the defaulting portfolio through hedging, the auction of this portfolio to the other members can take place. Market conditions may dictate the continuation of hedging up until the auction takes place. Details of the trades to be auctioned and an auction timetable are sent to members so that they can analyse the associated risks and formulate a measured response. The main aim is to dispose of the defaulter's portfolio as quickly as possible; this may mean holding simultaneous auctions.

Here below the default management process on the portfolio of the defaulted member chosen during the ForexClear firedrill on 07/11/2011 is presented to reflect the cost of liquidation of a USD/RUB example portfolio.

The portfolio used as an example for the defaulter's portfolio to liquidate is presented below. This table represents cash flows by date.

Date	Base Ccy	USD amount	Underlying Ccy	RUB amount	Forward rate	Swap Points
10/11/2011	USD	74,651,589.25	RUB	-2,290,165,287.50	30.67805134	85.51339378
14/11/2011	USD	22,213,127.89	RUB	-681,821,287.00	30.69451949	250.1949457
16/11/2011	USD	39,327,898.80	RUB	-1,207,477,870.00	30.70283201	333.32008
17/11/2011	USD	27,563,974.93	RUB	-846,412,703.00	30.7072077	377.0769601
18/11/2011	USD	294,469,677.72	RUB	-9,043,641,448.00	30.71162205	421.2205233
21/11/2011	USD	19,074,894.84	RUB	-586,078,000.00	30.7250973	555.9729684
22/11/2011	USD	25,579,641.26	RUB	-786,053,845.00	30.72966649	601.6649282
23/11/2011	USD	52,396,194.81	RUB	-1,610,359,031.00	30.73427444	647.7444106
25/11/2011	USD	-57,476,887.03	RUB	1,767,046,807.00	30.74360666	741.0666335
29/11/2011	USD	-114,178,027.99	RUB	3,512,428,635.00	30.7627369	932.3690285
30/11/2011	USD	14,812,787.15	RUB	-455,754,156.00	30.76761661	981.1660748
01/12/2011	USD	-3,093,621.55	RUB	95,198,578.00	30.77253521	1,030.35
02/12/2011	USD	-136,995,835.91	RUB	4,216,388,342.00	30.77749272	1,079.93
05/12/2011	USD	-93,759,362.08	RUB	2,887,094,431.00	30.79259891	1,230.99
06/12/2011	USD	118,258,563.13	RUB	-3,642,093,200.00	30.79771226	1,282.12
07/12/2011	USD	-10,975,148.06	RUB	338,066,000.00	30.80286462	1,333.65
08/12/2011	USD	-192,787,393.89	RUB	5,939,404,827.00	30.808056	1,385.56
09/12/2011	USD	-83,580,262.23	RUB	2,575,348,644.00	30.81288064	1,433.81
12/12/2011	USD	-4,388,087.20	RUB	135,273,750.00	30.82749814	1,579.98
14/12/2011	USD	46,354,565.57	RUB	-1,429,450,433.00	30.837317	1,678.17
16/12/2011	USD	10,991,242.47	RUB	-339,049,000.00	30.84719503	1,776.95
11/01/2012	USD	-55,483,838.68	RUB	1,718,918,000.00	30.98051687	3,110.17
12/01/2012	USD	16,257,514.77	RUB	-503,744,763.00	30.98534863	3,158.49
10/02/2012	USD	-82,043,556.10	RUB	2,553,623,164.00	31.12521306	4,557.13
13/02/2012	USD	-63,188,665.77	RUB	1,967,673,713.00	31.1396623	4,701.62
14/05/2012	USD	-23,669,685.24	RUB	747,627,226.00	31.58585416	9,163.54
15/05/2012	USD	-29,851,668.53	RUB	943,035,021.00	31.59069718	9,211.97
29/05/2012	USD	-302,288.81	RUB	9,570,000.00	31.6584657	9,889.66
09/08/2012	USD	40,174,048.87	RUB	-1,286,009,073.00	32.01094013	13,414.40
13/08/2012	USD	92,265,325.38	RUB	-2,955,321,207.00	32.03068103	13,611.81
09/11/2012	USD	23,396,287.51	RUB	-759,651,780.00	32.46890259	17,994.03
13/11/2012	USD	-24,007,175.36	RUB	779,971,187.50	32.48908611	18,195.86
09/05/2013	USD	-43,180,537.46	RUB	1,442,240,000.00	33.40023272	27,307.33
30/10/2013	USD	-11,919,789.51	RUB	409,125,750.00	34.32323612	36,537.36

The liabilities presented below are captured at different times: at the moment of default and at the end of the hedging session.

	At default	Hedge portfolio	After hedging
NPV	- 34,452,850.54	1,172,905.55	35,625,756.01
IM	23,379,660.40	- 12,151,601.88	- 1,893,813.46
CRIM	-	-	-
LRM	-	-	-
SRM	146,339.38	-	-
Total	23,525,999.78	- 12,151,601.88	- 1,893,813.46

NPV: Net Present Value
IM: Initial Margin
CRIM: Credit Risk Multiplier
LRM: Liquidity Risk Margin
SRM: Sovereign Risk Margin
Total: Sum of IM, CRIM, LRM and SRM

The variation margin below represented the difference of NPV between the default and the valuation at mid price during the auction. The cost of hedging represents the PL variation due to the hedge of the defaulter's portfolio.

VM	- 1,162,362.46
cost of hedging	- 984,229.00

Portfolio	Instrument	Currency	Usage	PL since default
LCH_HEDGE_NDF_1	USD/RUB	USD		-984,229

During the auction, the member's valuations were received during the 15 minutes allocated window as described below:

Member #	Auction Bid (USD)	% Diff to LCH
LCH.CLEARNET	**-35,615,213**	
1	-33,350,000	-6.4%
2	-35,473,583	-0.4%
3	-35,550,000	-0.2%
4	-35,556,182	-0.2%
5	-35,580,671	-0.1%
6	-35,605,062	0.0%
7	-35,605,000	0.0%
8	-35,700,000	0.2%
9	-35,700,000	0.2%
10	-35,870,836	0.7%
11	-35,892,923	0.8%

The LCH mid valuation and winning bid are presented below. In this case, the winning bid is higher than the mid valuation which entailed together with the hedging cost for the cost of liquidation to be a profit.

auction	
LCH mid valuation	- 35,615,213.00
Winning bid	- 33,350,000.00

Cash balance after auction	20,276,557.78

Cost of liquidation	3,249,442.00